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SPECIFICATION

of

MECHANICAL WORK

for

SMITHERS REGIONAL AIRPORT TERMINAL EXPANSION

for

TOWN OF SMITHERS, BC

ARCHITECT
Moore Wilson Architects Inc.
531 Herald Street
Victoria, BC V8W 1S5

MECHANICAL CONSULTANT
Integral Group
Suite 180 – 200 Granville Street
Vancouver, BC V6C 1S4

PROJECT NO: 151014.000

ISSUED FOR CONSTRUCTION

ISSUE DATE: August 9, 2017

SEALED

Table of Contents

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Description of Work

.1 Fire Suppression Contractor shall retain Professional Engineer registered in Province of British Columbia to provide engineering design and field review services including signed and sealed CAD fire suppression drawings and hydraulic calculations.

.2 The following specification is a "Performance Type" specification outlining the standard of the installation. The detailed design of the fire protection system shall be provided by the Fire Protection System contractor and their Professional Engineer. A Schedule 'S', and/or Schedule B Letter of Assurance will be required from the Fire Protection Design Engineer, to be submitted to this Consultant. This includes all fire suppression systems and requirements in this specification.

.3 Fire Suppression Contractor's Professional Engineer shall provide field reviews of work on site as work progresses and provide Field Review Reports.

.4 Submit documentation to Authorities Having Jurisdiction, arrange for, pay for and obtain trade permits prior to commencing installation work on site.

.5 Obtain static and residual water supply pressure information from utility or municipality in writing and submit copy of information with shop drawings. If this information is not available, arrange for, pay for and perform hydrant flow test.

.6 Provide fire suppression systems throughout buildings including:

- .1 Wet sprinkler systems in heated areas.
- .2 Dry sprinklers in exterior and unheated areas including underground and covered parking levels, loading areas, attics, concealed spaces, balconies, etc.
- .3 Portable fire extinguishers.

.7 Refer to Code Consultant or equivalency reports, obtain copies through Architect and provide fire suppression systems outlined therein including water curtains, window and glazing sprinkler suppression systems.

.8 Provide additional fire suppression sprinkler system protection per NFPA for high piled storage and in-rack sprinklers in warehouses and storage areas.

.9 Connect to combined fire suppression/potable water supply main or dedicated fire suppression water main located as indicated on drawings.

.10 Refer to Civil Consultant's drawings for work beyond 36" (914 mm) from building.

.11 Provide Testing, Adjusting and Balancing, Commissioning, Identification, Insulation and Heat Tracing for fire suppression systems as described in associated specification Sections.

1.3 Codes, Bylaws, Standards and Approvals

.1 Installation, workmanship and testing shall conform to the following standards:

- .1 BC Building Code and BC Fire Code.

.2 National Fire Protection Association NFPA 10 - Standard for Portable Fire Extinguishers.

.3 National Fire Protection Association NFPA 13 - Standard for the Installation of Sprinkler Systems.

.4 National Fire Protection Association NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.

.5 National Fire Protection Association NFPA 25 - Standard for the inspection, testing and maintenance of water based fire protection systems.

.2 Installation shall be subjected to design approval, inspection and testing of Authority Having Jurisdiction.

.3 System components shall be of one Manufacturer. Normally, materials and devices listed by nationally recognized fire test laboratories will be acceptable.

1.4 Document Submittals

.1 Provide Letters of Assurance signed and sealed by Fire Suppression Contractor's Registered Professional Engineer.

.2 Submit 'Schedule B Letters of Assurance of Professional Design and Commitment for Field Review and in accordance with **BC Building Code and BC Fire Code** to Consultant and Authority Having Jurisdiction at time of shop drawing submission.

.3 Submit static and residual water supply pressure information.

.4 Submit AutoCAD drawings of fire suppression sprinkler systems and other fire suppression or fire extinguishing systems.

.5 Submit hydraulic calculations for water based fire suppression sprinkler and standpipe systems.

.6 Submit 'Schedule C-B: Assurance of Professional Field Review and Compliance' in accordance with the **BC Building Code and BC Fire Code** to Consultant and local Authority Having Jurisdiction minimum 10 working days prior to Occupancy.

.7 Submit "Contractor's Material and Test Certificate" for each underground and each aboveground section of work in accordance with Authority Having Jurisdiction test procedure requirements, to Consultant and local Authority Having Jurisdiction minimum of 10 working days prior to Occupancy.

.8 Submit Backflow Prevention Test Certificate for backflow prevention devices.

.9 Submit signed letter from firestopping installation firm on company letterhead certifying penetrations of fire suppression piping through vertical and horizontal rated separations have been firestopped in accordance with CAN4-S115. Refer to Submittals in Section 23 05 05 Firestopping for additional requirements.

.10 Obtain from Electrical Contractor, and submit copy of Fire Alarm Verification Certificate.

.11 Submit maintenance data for systems and arrange for inclusion in project Mechanical Maintenance and Operations Manuals as outlined below.

.12 Submit shop drawings as noted below.

.13 Submit samples as noted below.

1.5 Shop Drawings

.1 Submit shop drawings for the following items:

.1 Piping materials.

.2 Valves, fittings and couplings.

.3 Fire department Siamese connections.

.4 Backflow preventers.

.5 Alarm and dry pipe valves.

.6 Air compressors.

.7 Supervisory switches.

.8 Flow switches.

.9 Pressure switches.

.10 Sprinkler heads and escutcheon plates.

.11 Fire extinguishers and cabinets.

.12 Fire stopping component data sheets and ULC or Warnock Hersey listings.

1.6 Samples

.1 Submit two samples for sprinkler types and other samples as required in other Sections of Specifications.

1.7 Maintenance Data

.1 Provide maintenance data for fire suppression systems complete with Table of Contents and coordinate with plumbing and HVAC trades for incorporation into designated section of project Mechanical Operation and Maintenance Manual.

.2 Include copy of National Fire Protection Association NFPA-25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

.3 Detailed instructions for normal maintenance of installed equipment including operational procedures, frequency of operational checks, service instruction and troubleshooting instructions. Information provided must be suitable for incorporation into Fire Department’s operation manual if so requested by Authority Having Jurisdiction.

.4 Local source of supply for each item of equipment, indicating Manufacturer’s and local supplier’s company names, addresses, phone numbers, faxes and e-mails.

.5 Labelling and identification schedules.

.6 Valve schedule including location, service type and normal position.

.7 Warranties, certificates and miscellaneous reports.

.8 Manufacturer’s operating and maintenance brochures, including wiring diagrams.

.9 Comprehensive description of operation of systems, including function of each item of equipment in system.

.10 Lubrication schedule, indicating recommended lubricants and grades (grease or oil), for lubricated equipment components.

.11 Shop drawings for components as listed in Shop Drawings clauses above.

.12 Documentation as listed in Document Submittals clauses above.

1.8 Seismic Protection

.1 Supply and install sway-bracing hangers on fire suppression piping systems in accordance with NFPA 13 requirements.

.2 Power-driven fasteners shall not be used to attach braces to building structure, unless ULC listed for service in seismic zone fire suppression systems are being installed.

1.9 Pipe, Fittings and Couplings

.1 Responsibility for including for pipe, fittings, couplings valves, nipples, drains, test connections and accessory pipe work for complete installation is to be included in this Section of work within base tender price.

.2 No extra cost will be considered based on failure of Contractor to allow for extra pipe, fittings and pipe work as required during construction to provide offsets to avoid structural components, and coordinate with other piping services, ductwork, cable trays, conduits or other obstacles.

.3 All grooved joint couplings, fittings, valves, and specialities shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

.4 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

.5 All mechanical jointing systems shall be spot-checked and inspected by the suppliers' factory trained representative and inspection reports shall be provided along with materials and test certificates.

1.10 Sprinklers

.1 Responsibility for allowing for sprinklers for complete installation to be included in this Section of work within base tender price. Layout on drawings shows general intention of work and sprinkler locations with respect to other ceiling elements such as ceiling tiles, lights and diffusers. However, Contractor shall provide additional sprinklers as required.

.2 Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

.3 No extra cost will be considered based on failure of Contractor to allow extra sprinklers as required during construction to conform to NFPA requirements and Authority Having Jurisdiction.

1.11 Clean Up

.1 Leave systems operating with work areas clean to satisfaction of Consultant, Architect or Owner's Representative.

Part 2 Products

2.1 General

.1 Materials shall be ULC Listed for intended service and shall be supplied in original factory packaging. Manufacturer and brand for all pipe and fittings shall match and based on one brand or manufacturer.

2.2 Hangers and Supports

.1 Hangers and supports including seismic restrains shall be ULC Listed and shall conform to appropriate NFPA standards.

.2 Toggle hangers or strap hangers are unacceptable.

2.3 Firestopping

.1 Provide firestopping materials listed in accordance with CAN4-S115 at pipes penetrating horizontal and vertical fire rated separations. Refer also to Section 23 05 00 for additional requirements.

.2 Refer to Section 23 05 05 Firestopping for firestop requirements.

2.4 Miscellaneous Metal related to Fire Protection System

.1 Miscellaneous metal related to fire suppression systems including metal back up plates, stands, brackets and supports for roof, floor or wall supported equipment and piping systems is part of this Section of work.

.2 Provide two coats of heavy red oxide primer to steel components after fabrication, and touch-up on site after installation.

2.5 Backflow Prevention Stations

.1 Provide ULC Listed double check valve assembly (DCVA) complete with OS and Y inlet and outlet shut-off valves.

.2 Backflow prevention stations shall be in accordance with manual “Cross Connection Control Manual” published by the Pacific Northwest Section of the American Water Works Association.

.3 Isolation valves shall be provided with supervisory switches connected to supervisory signals at fire alarm system.

Part 3 Execution

3.1 Grading and Drainage of Piping

.1 Grade fire suppression piping to be drained through drain cocks.

.2 Pipe sprinkler system drains to floor drains in mechanical/service rooms.

3.2 Building Movement

.1 Install piping systems, including take-offs installed within building, so piping and connected equipment will not be distorted by expansion, contraction or building settlement.

.2 Provide offsets and/or piping expansion components at building expansion joints, building seismic joints and firewalls.

.3 For water systems, Victaulic flexible couplings may be used in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. (In accordance with Victaulic installation instructions and as approved by the Engineer.)

.4 Provide anchors where necessary to control pipe expansion and pipe movement.

3.3 Pipe Sleeves and Escutcheons

.1 Supply and installation of pipe sleeves and escutcheons for fire suppression system piping is included in this Section of work.

.2 Do not cast piping into concrete walls, slabs or masonry walls.

.3 At exterior wall or slab penetrations, provide sleeves minimum 2 nominal pipe diameters larger than pipe (i.e. a 12" (300 mm) sleeve for nominal 8" (200 mm) diameter pipe).

.4 Install pipe concentric with sleeves.

.5 Remove plastic sleeves, where they are used, and prior to installation of pipe penetration. Resulting hole shall be classified as sleeves except in wet areas.

.6 Provide minimum Schedule 10 steel pipe sleeves where piping penetrates masonry walls.

.7 Extend sleeves 2" (50 mm) above floor slabs in wet areas. Wet areas include but not limited to penthouse equipment rooms, janitor's rooms, utility rooms and washrooms.

.8 Seal penetrations through aboveground exterior walls, and underground exterior walls and slabs including slabs on grade, where no hydrostatic pressure exists, with flexible, non-hardening, weatherproof caulking compound. Seal around exterior circumference of sleeves and annular space between pipes and sleeves.

.9 Seal penetrations through underground exterior walls and slabs, including slabs on grade where hydrostatic pressure exists, with mechanical seals, such as Link Seal.

.10 Install chrome-plated escutcheons on exposed piping passing through walls, floors and ceilings in finished areas.

.11 Risers for fire suppression systems with horizontal branch takeoffs passing through sleeves set rigidly in structure adjacent to risers shall be set to accommodate long term structural movement.

3.4 Firestopping

.1 Provide fire stopping to CAN4-S115 at pipes penetrating horizontal and vertical rated separations.

.2 Smooth finished surface in neat workmanlike appearance.

.3 Refer to Section 23 05 05 Firestopping for firestop requirements.

3.5 Core Drilling

.1 Fire Suppression Contractor shall be on site and coordinate sleeves and block-out requirements in accordance with project construction schedule to minimize coring.

.2 Arrange and pay for costs of core drilling required for fire suppression systems in this Section.

.3 Verify location of existing service runs and structural reinforcement within existing concrete floors and walls prior to core drilling and cutting. Core drilling and cutting of structural building components shall only take place upon receipt of specific written approval of Structural Consultant. Repairs that may be required to existing services damaged during core drilling is included in this Section.

.4 Penetrations up to 6" (150 mm) nominal pipe size in pre-cast concrete may be cored on site as per Fire Suppression Contractor. Larger penetrations shall be located and arranged for in pre-cast work with pre-cast Manufacturer prior to shipping to site.

3.6 Backflow Prevention Stations

.1 Install backflow prevention stations in complete accordance with "Cross Connection Control Manual" published by Pacific Northwest Section of American Water Works Association. Mount backflow preventers maximum 5'-0" (1.5 m) above floor level for servicing.

.2 Complete testing of backflow prevention devices shall be carried out under this Section of work prior to final acceptance of fire suppression systems. Submit certificate signed and witnessed that testing was satisfactorily completed and include copy in project Mechanical Operation and Maintenance Manual.

3.7 Hangers and Supports

.1 Provide hangers and supports as outlined in NFPA including supports to secure piping to restrict movement upon activation of fire suppression systems including activation and charging of systems through fire department Siamese connections.

.2 Power/powder actuated fastenings and drop-in anchors are not permitted to be used for tensile loading (i.e. suspension of mechanical equipment) or for seismic anchorage and/or restraint.

3.8 Pressure Gauges

.1 Provide pressure gauges at the following locations and additional gauges as required by NFPA, Authority Having Jurisdiction and system configuration:

  .1 Water entry valve station both upstream and downstream of backflow preventer.

  .2 Upstream and downstream of pumps.

  .3 At top of fire suppression standpipe and sprinkler risers.

3.9 Seismic Restraints

.1 Provide seismic restraints as outlined in NFPA and to seismic zone listed in applicable building code or bylaw.

.2 Anchorage and seismic restraints of fire suppression systems as listed in Letters of Assurance Schedules B and C-B is included in this Section.

3.10 Test and Inspection

.1 Furnish labour, materials, equipment and instruments necessary for required tests. Work shall be subject to review by Consultant, Owner's Representative, and Authority Having Jurisdiction.

.2 Provide minimum of 120 business hours' notice in advance of making required tests.

.3 Tests on fire suppression systems shall include pressure tests and conform to standard of Authority Having Jurisdiction. Fire Department Siamese connection lines shall also be hydrostatically tested.

3.11 Substantial Completion Requirements

.1 The following items must be completed with documentation prior to the date of Substantial Completion:

  .1 All seismic restraints checked and verified by the suppliers British Columbia Registered Engineer and a report has been submitted to/by the Sprinkler/Fire Protection Engineer of Record.

.2 Fire protection Contractor’s materials and test certificates submitted.

.3 Fire protection system Engineer of Record inspection reports, including the most recent report has been made and submitted to the Consultant.

.4 Fire protection system Engineer of Record’s Schedule C Letter of Assurance has been signed/sealed/dated and submitted to the Consultant.

.5 Electrical Contractor’s fire alarm system test and verification report has been submitted and copied to this Consultant.

.6 All fire alarm shutdowns and emergency start-ups for HVAC systems have been tested, verified and commissioned, with a report submitted to this Consultant.

.7 Backflow preventer/check valves at fire protection water supply has been tested, verified and commissioned, with a report submitted to this Consultant.

.8 Final As-built Record drawings have been submitted to this Consultant for review.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Also refer to Section 21 07 19 Fire Suppression Piping Insulation.

1.2 Scope of Work

.1 Refer to Section 23 05 33 Heat Tracing for HVAC Piping. Comply with requirements of that Section of work as related to general requirements, products and execution.

.2 In addition to piping and systems listed in Section 23 07 19, heat tracing for freeze protection on fire suppression piping systems in exterior or unheated areas, including the following:

- .1 Fire suppression piping.
- .2 Combined domestic water and fire suppression piping.

.3 Provide heat trace controllers and coordinate with Electrical for monitoring of heat tracing systems as dedicated trouble signal on fire alarm annunciator panel.

Part 2 Products

2.1 Protection of Wet Fire Protection Systems from Freezing

.1 Piping freeze protection system shall conform to CSA and ULC Standards in accordance with Electrical code requirements and the requirements of **BC Building Code and BC Fire Code**.

.2 System shall be complete with power connections, grommets, splices, end seals, splices and tee components in accordance with the Manufacturer's requirements complete with sealants.

.3 Provide voltage monitor device for connection to fire alarm panel upon failure of heat tracing or power supply to heat tracing.

.4 Alarm point on fire alarm annunciator panel shall consist of indicator light, audible alarm and test switch.

.5 Heaters shall be two 16 ga (1.61 mm) AWG tinned-copper bus wires embedded in parallel in self-regulating polymer core specifically designed to vary its output along its length to maintain temperature specified. Cover heater with radiation cross-linked, modified polyolefin di-electric jacket and protected by tinned-copper braid. Provide separate ambient sensing thermostat in lockable enclosure with amperage rating to suit each cable length to provide tracing operation below a 40°F (4.4°C) setpoint. Heaters shall operate on 208/1/60 VAC without the use of transformers. Heaters shall be RAYCHEM 5XL5CR or approved equivalent for pipe sizes to 6" (150 mm); 8XL2CR for pipe sizes 8" (200 mm) and larger with ambient temperature 8.6°F (-13°C).

.6 Extent of tracing shall be to provide complete coverage of wet standpipe or sprinkler piping in unheated area. Coverage and attachment of cable to piping, fittings and valve bodies shall be in accordance with Manufacturer's recommendations.

.7 Provide pipe insulation on heat traced piping in accordance with Section 23 07 19 – Insulation.

.8 The heat output shall be based on ambient air temperature of 8.6°F (-13°).

.9 Insulation to be minimum 1" (25 mm) thick fibreglass media with suitable protection. On piping larger than 3" (75 mm), minimum of 2" (50 mm) thick fibreglass media shall be used. Provide full metal jacket on piping susceptible to damage.

.10 Heating circuits shall be thermostatically controlled and continuously monitored for loss of incoming supply voltage, loss of control power, ground fault and continuity.

.11 Monitoring of heat tracing for fire suppression systems shall use a packaged device provided by the same manufacturer as the heat trace cable to monitor status of heat tracing system, and ambient air temperature (e.g. Raychem DigiTrace Remote Monitoring Module "RMM"). A standalone thermostat is not acceptable. A separate relay may be used as required to signal loss of power supply to heat tracing. Controls shall be protected from direct sunlight and moisture, provided with a lockable enclosure.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Refer to Section 23 05 53 Identification for HVAC Piping and Equipment. Comply with requirements of that Section of work as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems, listed in Section 23 05 53, provide identification on fire suppression piping, equipment and systems including the following:

- .1 Wet sprinkler systems.
- .2 Dry sprinkler systems.
- .3 Standpipes systems.
- .4 Piping with heat tracing cables.

.3 Identification of all fire suppression systems must comply with the requirements of the applicable NFPA Standard where the requirements of that standard exceed these specifications.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Also refer to Section 21 08 00 Commissioning of Fire Suppression.

1.2 Scope of Work

.1 Refer to Section 23 05 93 Testing, Adjusting and Balancing for HVAC. Comply with requirements of that Section of work as related to general requirements, products and execution.

.2 In addition to systems listed in Section 23 05 93, provide testing, adjusting and balancing for fire suppression piping, equipment and systems in accordance with NFPA 25 – Standard for the inspection, testing and maintenance of water based fire protection systems, including the following:

- .1 Wet sprinkler systems.
- .2 Dry sprinkler systems.
- .3 Standpipes systems.
- .4 Carbon dioxide fire extinguishing systems.
- .5 Megger testing of heat tracing systems.

.3 Fire Suppression Contractor shall provide testing, adjusting and balancing of fire suppression and fire extinguishing systems.

.4 Provide completed copies of Contractor's Material and Test Certificates for Aboveground Piping, and for Underground Piping, as per NFPA 13.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Also refer to Section 21 05 33 Heat Tracing for Fire Suppression Piping.

1.2 Scope of Work

.1 Refer to Section 23 07 19 HVAC Piping Insulation. Comply with requirements of that Section of work as related to general requirements, products and execution.

.2 In addition to piping and systems listed in Section 23 07 19, provide piping insulation on wet fire suppression piping systems in exterior or unheated areas, including the following:

   .1 Heat traced fire suppression piping.

   .2 Heat traced combined domestic water and fire suppression piping.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Refer to Section 23 08 00 Commissioning of HVAC. Comply with requirements of that Section of work as related to general requirements, products and execution.

.2 In addition to systems listed in Section 23 08 00, provide testing, commissioning of fire suppression piping, equipment and systems including the following:

- .1 Wet sprinkler systems.
- .2 Dry sprinkler systems.
- .3 Standpipes systems.
- .4 Carbon dioxide fire extinguishing systems.
- .5 Heat tracing systems.

.3 Fire Suppression Contractor shall provide testing, adjusting and balancing of fire suppression and fire extinguishing systems.

.4 Manufacturer's authorized Representative shall provide commissioning of the heat tracing systems, including submission of report for each system.

END OF SECTION

Part 1 General

1.1 General

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

Part 2 Description of Work

.1 Combined automatic sprinkler systems/wet standpipe systems.

.2 Wet sprinkler systems.

.3 Equivalencies. Refer to drawings.

2.2 Sprinkler Contractor Qualifications

.1 Acceptable Sprinkler Contractors: TDN Constructors Fire Protection, Elite Fire Protection, Grinnell Fire Protection Systems Ltd., National Installations Ltd., Troy Life & Fire Safety Ltd., Pacific Rim Fire Protection Ltd., Apex Fire Protection Ltd., Gisborne Group, Viking Fire Protection Inc., Westech Fire Protection Systems Ltd., Trainor Mechanical Contractors Limited, Phaser Fire Protection, Impact Fire Protection Ltd., Precision Fire Protection Ltd., Kraico Mechanical Ltd., Superior Fire Protection Systems Ltd., Martex Sprinklers Installations Ltd., J & C Industries, Okanagan Fire Protection Services Ltd., Creekside Fire Protection Ltd., Five Star Fire Protection, Active Fire and Safety Services Ltd., Escape Fire Protection Services Ltd., T & G Fire Protection Ltd., Trotter and Morton Fire Protection Ltd., .

.2 Sprinkler Contractors (other than those pre-qualified) intending to bid this project shall submit the following information not less than seven days before close of Sub-Trade tenders for Consultant review for acceptance. ANY FIRM THAT DOES NOT COMPLY WILL NOT BE ACCEPTED BY CONSULTANT.

- .1 List previous projects of similar scope with dates projects were executed, contract value and references.
- .2 Outline depth of firm including principals, years of operation, address and phone number.
- .3 List name of job site supervisor and provide resume of his specific work experience.
- .4 Name of individual who will prepare shop drawings and hydraulic calculations.

.3 Contractor shall be regularly engaged in installation of sprinkler systems.

2.3 Quality Assurance

.1 Provide sprinkler systems throughout building, in accordance with listed codes, bylaws, standards and approvals including NFPA 13 and **BC Building Code and BC Fire Code**.

.2 Obtain copy of Code Consultant’s report and include equivalency requirements, glazing system requirements and other works described relative to fire suppression sprinkler systems.

.3 Sprinkler fitter with Province of BC Tradesman Qualifications in sprinkler installations shall be on site at all times during system installation.

.4 All grooved joint couplings, fittings, valves, and specialities shall be the product of a single Manufacturer. Grooving tools shall be of the same Manufacturer as the grooved components.

.1 Acceptable Products: Victaulic, VGS (Viking Grooved System).

.5 All castings for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

2.4 Related Work

.1 Refer to Section 21 12 00 Fire Suppression Standpipes where combined fire suppression standpipe/fire suppression sprinkler system is involved, for requirements of work considered to be fire suppression standpipe portion of system.

.2 Coordinate with Electrical for connection of supervised isolation valves to supervisory signals, flow switches to alarm signals, and supervisory switches to supervisory signals on fire alarm system.

.3 Coordinate work of this Section with HVAC trades, plumbing trades, electrical trades and ceiling trades.

2.5 Sprinkler System Shop Drawings

.1 Fire suppression Sub-Contractors Registered Professional Engineer shall prepare electronic AutoCAD fire suppression sprinkler system drawings, to scale. Drawings prepared by Consultant were done to show general features of systems, and general concepts of arrangement and locations of sprinklers and piping.

.2 Fire suppression Sub-Contractor and Registered Professional Engineer shall include for sprinklers as required to fully comply with NFPA 13 and the **BC Building Code and BC Fire Code**.

.3 Indicate on drawings information required by Authority Having Jurisdiction, including features of building construction, direction and size of beams, ceiling configurations, partition locations, light fixtures (noting the depths of surface mounted light fixtures where these occur) and diffuser locations.

.4 Stipulate positions and elevations of sprinklers relative to floor elevation, temperature rating of sprinklers, spacing and types of hangers, drains and low point drains, test and flushing connections, types of sprinkler alarms, locations and types of sprinkler control valves, backflow preventers and other essential features of piping systems.

.5 Sprinkler products shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

.6 Include detailed sprinkler plans and hydraulic calculations as described in NFPA 13.

.7 Only shop drawings that have been reviewed, signed and sealed by fire suppression Sub-Contractor’s Registered Professional Engineer shall be submitted.

.8 Include Letters of Assurance Schedule B, signed and sealed by fire suppression Sub-Contractor’s Registered Professional Engineer with shop drawing submission.

.9 Submit additional signed and sealed sets of shop drawings as requested by Owner for their use and for review by their insurer, and incorporate requirements indicated during review process.

.10 Submit to Authority Having Jurisdiction for review and/or approval, complete sets of shop drawings and hydraulic calculations for each area.

.11 Arrange for, pay for and obtain fire suppression system/sprinkler permit prior to commencing fire suppression system installation.

.12 Submit shop drawings for the following items:

.1 Backflow preventers.
.2 Pipe valves, fittings and couplings.
.3 System and zone isolation valves.
.4 Water flow switches.
.5 Pressure switches.
.6 Supervisory switches.
.7 Test and drain assemblies.
.8 Sprinkler heads.
.9 Dry pipe valves and trim.
.10 Air compressors.
.11 Wiring diagrams and interlock line diagram for electric and electronic devices.

2.6 Samples

.1 Submit to Consultant at shop drawing submission, two samples of each type of sprinkler of same model number, response rating, temperature rating, orifice size and finish as shop drawings.

Part 3 Products

3.1 General

.1 Pipes, fittings, couplings, valves, devices and materials used in fire suppression standpipe system shall be of Code approved or acceptable type.

.2 System components shall be rated for working pressure not less than maximum pressure to be developed at their corresponding locations within systems under any condition

3.2 Sprinkler Piping and Fittings - Above Ground

.1 Piping:

.1 Steel pipe, black or hot dipped galvanized, standard weight or light wall, material and IPS dimensions conforming to NFPA 13 and ASTM A53, ASTM A135 or ASTM A795.
.2 Seamless copper tube to ASTM B75, seamless copper water tube to ASTM B88, wrought seamless tube to ASTM B251 of wall thickness Type “K”, “L” or “M”. Brazing filler metal (Classification BCuP-3 or BCuP-4) to AWS A5.8.
.3 Ductile iron pipe or copper pipe for combined potable water and fire suppression system upstream of ULC listed backflow prevention device, as per Section 21 12 00.
.4 Provide copper pipe where specifically indicated on drawings.

.2 Fittings:

.1 Compatible with piping material and suitable for maximum pressures in system, but not less than 175 psi (1,210 kPa) working pressure.

.2 Welded fittings shall conform to ANSI B16.5, B16.9, B16.11 and B16.25 and ASTM A234.

.3 Threaded fittings conforming to ANSI B16.1, B16.3, and B16.4 are acceptable on minimum Schedule 40 steel pipe up to 6" (150 mm) diameter and minimum Schedule 30 steel pipe for 8" (200 mm) diameter and larger and shall have ULC corrosion resistance ratio of 1.00 or greater.

.4 Grooved end fittings shall be short-pattern ductile iron conforming to ASTM A536, and shall provide full flow design. Fittings, couplings and gaskets shall be of one Manufacturer and shall provide a rigid joint. Victaulic FireLock™/VGS (Viking Grooved System).

.5 Couplings shall consist of two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts.

.1 Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA 13. Couplings shall be fully installed at visual pad-to-pad offset contact (tongue and recess type couplings, or any coupling that requires exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed).

.1 1-¼" (32 mm) through 8" (200 mm): Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 009-EZ and Style 107H, VGS V-204/V-7705.

.2 5" (125 mm) and Larger: Victaulic FireLock™ Style 005 and Zero-Flex Style 07, VGS V-205/V-7705.

.2 Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for seismic applications. Victaulic Installation-Ready Style 177, Style 75 and 77.

.6 Branch connections may be provided by bolted mechanical branch connection complete with synthetic rubber gaskets approved for line service. Acceptable Products: Victaulic Style 920/920N, 921, 925 and 929, Viking Grooved System equivalents (V-M21).

.7 Victaulic 922 outlet tees shall have cast upper and lower housings and may be used for up to 1" (25 mm) branch outlets and individual sprinklers.

.8 Victaulic "Pressfit System" utilizing Schedule 5 pipe and cold drawn carbon steel fittings with integral synthetic O-ring is not acceptable.

.9 For dry pipe systems, use flush seal coupling gasket in rigid and flexible couplings where required by NFPA 13. Acceptable Products: Victaulic Style 005 FireLock and 75.

.10 Gaskets for Victaulic Couplings:

Fire Protection Service	**Temp. Range**	**Gasket Recommendation**
Dry Systems	Ambient	FlushSeal®, Grade EPDM, Type A
Freezer Applications	-40°F (-40°C) to 0°F (-18°C)	FlushSeal®, Grade L, Silicone
Water/Wet Systems	Ambient	Grade EPDM, Type A

.11 Submit requests for consideration of other products or systems in accordance with submittal procedures, prior to closing of tender.

3.3 Sprinkler Piping and Fittings - Below Ground

.1 If piping is required to be routed below grade, refer to Section 21 12 00 Fire Suppression Standpipes and contact Consultant.

3.4 Valves

.1 Gate - 175 psi (1,210 kPa) - Underwriters' Laboratories Canada (ULC) Listed:

.1 ½" (12 mm) - 2" (50 mm): Jenkins 305-U, Crane 459, Nibco T-104-0.

.2 2-½" (65 mm) and Larger: Victaulic Series 771 (OSandY) and 772 (NRS) for all grooved end valves; Jenkins 825, Crane 467, Nibco F-607-0TS and F-607-RW.

.2 Butterfly/Ball - 175 psi (1,210 kPa) - ULC or UL Listed and FM Approved:

.1 ½" (12 mm) - 2" (50 mm): Victaulic 728 Firelock ball valve with weatherproof actuator and supervisory switches, Milwaukee BB-SCS Butterball slow close butterfly valve with indicator and integral supervisory switch, Nibco KT-505-8.

.2 2" (50 mm) - 12" (300 mm): Victaulic Style 705 and 728 grooved end Fireball complete with weatherproof actuator and factory installed double throw/double pole supervisory switches.

.1 The stem on butterfly valves shall be offset from the disc centerline to provide full 360-degree circumferential seating, and the seat shall be pressure responsive.

.3 4" (100 mm) - 12" (300 mm): Demco Series NE-H with tapped lug end design, Nibco L-002-N6 complete with gear operator and indicator.

.3 Pressure Regulating Sprinkler Zone Control Valve - 400 psi (2,760 kPa) - ULC Listed:

.1 2-½" (65 mm): NFE model A203NB cast brass, straight pattern valve, rough brass finish with red wheel handle, female threaded outlet, 400 psi (2,760 kPa) rated. Capable of field adjustment of pressure.

.4 Test and Drain Valves -175 psi (1,210 kPa) - ULC Listed:

.1 1" (25 mm) and 2" (50 mm): Victaulic TestMaster II, cast bronze construction, tapped gauge outlet and integral sight glass.

.2 1" (25 mm) and 1-¼" (32 mm): NFE model A61 forged brass construction, tapped ¼" (6.0 mm) gauge outlet, and integrated sight glass.

.5 Check - 175 psi (1,210 kPa) - ULC Listed/FM Approved:

.1 2-½" (65 mm) and Larger: Victaulic Style 717, (all grooved end valves), Jenkins 477, Crane 375, Mission, Nibco F-908-W, Kennedy.

.2 Provide spool piece to ensure full check valve opening where adjacent to alarm or gate valve.

.6 Wet Sprinkler Pipe Valve Station:

.1 The wet sprinkler station shall be ULC listed for automatic wet sprinkler systems.

.2 Acceptable Products: Fire Flex, Tyco and Simplex/Grinnell and Viking

.3 Valve internal components shall be replaceable without removing the valve from the installed position.

.4 Valves shall be externally resettable.

.7 Valves shall be ULC listed for fire suppression systems.

.8 Where working pressure exceeds 150 psi (1,034 kPa) provide 300 psi (2,070 kPa) valves.

.9 Grooved end valves shall be of one Manufacturer. Acceptable products: Victaulic.

.10 Drain valves shall be provided with hose end adaptors complete with caps and chains, and auxiliary drains shall be provided with drum drip.

.11 Dry Sprinkler Valve Station:

- .1 The dry sprinkler valve station shall be ULC listed for automatic wet sprinkler systems.
- .2 Acceptable Products: Victaulic Series 768-NXT, Fire Flex, Tyco, Simplex/Grinnell and Viking.
- .3 The dry valve station shall be complete with ULC, air compressor, excess pressure device, accelerator(s), starter, motor, disconnect valves, pressure gauges, electric alarm and water motor gong, all controls, etc., to NFPA standards. Electrical shall wire all motors, switches, etc.
- .4 Valve internal components shall be replaceable without removing the valve from the installed position.
- .5 Valves shall be externally resettable.
- .6 Required air pressure shall be 13 psi (90 kPa).

3.5 Wet Sprinkler Zone Control Valves Assembly and Cabinets

.1 Sprinkler Zone Control Valve Assemblies:

- .1 Cabinet shall be National Fire Equipment model CV-200 recessed wall mounted 30" (762 mm) wide x 30" (762 mm) high x 8" (200 mm) deep cabinet.
- .2 Fully recessed steel cabinet with ½" (12 mm) turn back frame for 12" (300 mm) wall depth.
- .3 Full length semi-concealed piano hinges for 180° swing.
- .4 Flush stainless steel door latch with no exposed fasteners.
- .5 18 ga (1.31 mm) baked enamel corrosion protected steel tub.
- .6 14 ga (1.99 mm) baked enamel corrosion protected full metal steel door. Doors hinged as indicated on plans, or if not shown, orient to maximize cabinet access and not obstruct exit doors or exit routes.
- .7 Grey prime coated enamel finish ready for field painting; reconfirm colour per Architect prior to ordering.
- .8 Acceptable Products: National Fire Equipment.

3.6 Sprinklers

.1 Sprinkler body shall be integrally cast with hex-shaped wrench boss to reduce the risk of damage during installation.

- .1 Wrenches shall be provided by the sprinkler manufacturer to directly engage the wrench boss on the fire sprinkler. Basis of Design: Victaulic Company.

.2 Sprinklers with rubber O-rings are not acceptable.

.3 Upright: Plain brass, quick response, glass bulb in unfinished mechanical and service rooms without ceilings.

.4 Upright: Chrome-plated, quick response, glass bulb in finished rooms and spaces without ceilings such as skylights and sprinklered exterior covered areas.

.5 Recessed Pendent: Recessed, quick response, glass bulb, chrome-plated finish on sprinklers and escutcheons in finished areas with ceilings except noted below.

.6 Concealed Pendant: Concealed, quick response, chrome-plated flat cover plate, at locations as indicated on drawings.

.7 Recessed Horizontal Sidewall: Recessed, quick response, glass bulb, chrome-plated finish on sprinklers and escutcheons.

.8 Extended Throw Sidewall: Recessed, glass bulb, quick response, chrome-plated finish on sprinklers and escutcheons.

.9 Dry Horizontal Sidewall: Recessed, glass bulb, quick response, chrome finish on sprinklers and escutcheons.

.10 Intermediate Temperature and High Temperature Sprinklers: Provide at top of each elevator shaft, elevator machine rooms and electrical rooms and other required locations as per NFPA 13, complete with wire guards.

.11 Dry Sprinklers: Provide dry pendant or dry sidewall sprinklers where serving exterior area or area subject to freezing from wet sprinkler system piping.

.12 Equivalencies:

  .1 Refer also to drawings.

.13 Refer to table on mechanical schedule for sprinkler finishes.

.14 Escutcheon plates shall allow accessible (T-bar) ceilings to be removed without removing sprinklers. Construction consists of cup and skirt, cup retaining sprinkler and skirt the removable portion around exterior perimeter of cup that covers tile hold. Finished escutcheon installation shall not project more than ¼” (6.0 mm) below finished ceiling surface. Recessed two piece escutcheons and single piece escutcheons that are specifically manufactured with sprinklers to permit escutcheons and ceiling tile removable without sprinkler removal are acceptable. Escutcheons shall match sprinkler finish, be of same Manufacturer as sprinkler and coordinate with architectural features.

.15 Provide wire sprinkler guards in areas such as mechanical rooms, service rooms, elevator shafts, below lower level stair landings, gymnasiums, exterior locations, etc., where sprinklers are susceptible to mechanical damage or vandalism.

.16 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler Manufacturer.

.17 Sprinklers shall be ULC listed for use in occupancies in which they are to be installed.

.18 Sprinklers shall be quick response, unless otherwise noted.

.19 Sprinklers shall be for commercial/institutional applications unless stated otherwise. Residential sprinklers are only permitted in residential areas of residential buildings.

3.7 Flow Switches

.1 ULC listed flow switches suitable for 24 V DC with one set of normally open and one set of normally closed contacts, time delay feature and paddle indicator specifically chosen and ULC listed for size of pipe in which flow switch is mounted.

.2 Flow switch test and drain assembly immediately downstream of each flow switch in addition to normal inspector’s test connections required by NFPA 13.

.3 Flow switches shall be manufactured specifically for sprinkler systems rated minimum 175 psi (1,210 kPa).

.4 Standard of Acceptance: Victaulic System Sensor Model WFD.

3.8 Pressure Switches

.1 ULC listed pressure switches where indicated on drawings. Pressure switches shall be suitable for 24 V DC contact rating unless otherwise specified, rated minimum 175 psi (1,210 kPa).

3.9 Supervisory Switches

.1 ULC listed supervisory switches, Potter complete with “J” hooks (on gate valves of OS and Y type) Potter PIVS- (on NRS valves) or “Potter” BF (on butterfly valves) complete with 1 set of normally open contacts and 1 set of normally closed contacts, or 2 sets of SPDT contacts.

.2 Switches shall be suitable for 24 V DC contact rating unless otherwise specified, rated minimum 175 psi (1,210 kPa).

.3 Looped cable devices are not acceptable.

.4 Approved valves with integral and/or factory installed indicators and supervisory controls are acceptable products.

3.10 Air Compressors

.1 Select air compressors for capacity as determined by hydraulic calculation design of dry sprinkler systems. Confirm electrical characteristics with electrical drawings and specifications.

3.11 Spare Sprinklers

.1 Provide red baked enamel steel cabinet containing minimum of two spare sprinklers of each pattern, but in addition, not less than the following of all types:

Number of Sprinklers	Total Spares
up to 300	6 minimum
300 - 1000	12 minimum
over 1000	24 minimum

Part 4 Execution

4.1 Fire Suppression Sprinkler Systems

.1 Supply and install fire suppression sprinkler systems throughout building, in accordance with listed codes, bylaws, standards and approvals, including NFPA 13 and **BC Building Code and BC Fire Code**.

.2 Test sprinkler systems to listed requirements and submit certificate stating that such testing has been carried out and approved.

.3 Provide inspector’s test valves and drain pipes at remote points in system to NFPA 13 requirements.

.4 Supply and install fire suppression sprinkler systems in accordance with general piping configuration indicated on drawings. Sprinkler Contractor shall hydraulically calculate sprinkler systems in accordance with the following provisions:

  .1 Calculations shall be responsibility of, and signed and sealed by fire protection Sub-Contractor's Registered Professional Engineer. Submit Letters of Assurance to Consultant and Authority Having Jurisdiction in accordance with the **BC Building Code and BC Fire Code**.

  .2 Such calculations shall be based on general piping configuration indicated on drawings.

  .3 Water supply hydraulic data shall be confirmed in writing by Contractor with water utility or municipal authority prior to submission of shop drawings.

.5 Supply and Installation of sprinkler systems on basis of hydraulic calculations shall be responsibility of fire suppression Sub-Contractor and their Registered Professional Engineer.

.6 Locate sprinklers in general conformance with locations indicated on sprinkler design drawings. For exact locations, refer to architectural reflected ceiling plans. In absence of reflected ceiling plans, sprinklers shall be installed at centre point, quarter point and/or third point in long dimension of ceiling tiles, and in centre point of short dimension of ceiling tiles, and/or in line with other ceiling elements, light fixtures, diffusers, audio devices and other fittings, in symmetrical and aesthetic pattern acceptable to Architect. Coordinate sprinkler layout with architectural, structural, electrical and mechanical HVAC ceiling elements.

.7 Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

.8 Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

.9 At substantial completion, and minimum of 10 working days prior to scheduled Occupancy date, submit 'Schedule C-B: Assurance of Professional Field Review and Compliance' to Consultant and Authority Having Jurisdiction in accordance with the **BC Building Code and BC Fire Code**.

.10 Submit to Consultant completed Contractor's Material and Test Certificate for fire suppression systems, and provide copy in project Mechanical Operation and Maintenance Manuals.

4.2 Pipe and Fittings

.1 Welding shall be done in shop using welding fittings. Field welding is not permitted.

.2 Flanged pattern fittings shall be used for piping 8" (200 mm) diameter and larger, and at valve stations and fire department connections.

.3 Provide expansion joints or flexible couplings at building expansion joints, building earthquake joints, building firewalls and other locations as necessary.

.4 Grooved end components including vales, fittings and couplings shall be of one Manufacturer and shall be installed in accordance with Manufacturer's instructions.

.1 Grooved coupling Manufacturer's factory trained Representative shall provide on-site training for Contractor's field personnel in the use of grooving tools and installation of grooved joint products. Representative shall periodically visit the jobsite and review Contractor is following best recommended practices in grooved product installation. (A Distributor's Representative is not considered qualified to conduct the training or jobsite visit(s).)

.5 Victaulic FIT products shall be installed in accordance with Manufacturer's instructions and piping shall be clearly marked at each joint to indicate pipe insertion depth.

.6 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.

.7 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.

4.3 Flushing of Sprinkler Systems

.1 Flush underground water mains and fire department Siamese connection lines before connection to fire suppression standpipe systems.

.2 Flush pipe lines until effluent is clear and free debris.

.3 Rate of flushing flows shall be as indicated in NFPA 13.

.4 Provide proper drainage for flushing operation.

4.4 Flow Switches

.1 Provide pipe drain connections from test valves to open discharge at floor drains, service sinks, or other discharge points acceptable to Owner or Consultant.

.2 Conduct tests in conjunction with Electrical on each device to ensure indication of "alarm" signal and correct location and labelling on fire alarm system.

4.5 Supervisory Switches

.1 Install supervisory switches on valves supplying fire suppression sprinkler systems inside the building perimeter.

.2 Conduct tests in conjunction with Electrical on each device to ensure indication of "supervisory" signal and correct location and labelling thereof on fire alarm system.

4.6 Electrical Equipment Protection from Water

.1 Sprinkler piping and sprinklers are to be installed in various areas containing electrical equipment as indicated on drawings.

.2 Responsibility for water damage to electrical equipment in these areas from sprinkler system installation whether due to testing or leakage prior to Owner's acceptance of building shall be responsibility of this Section.

.3 Provide and install in this Section of work minimum 20 ga (1.00 mm) sheet metal protective hoods individually located over electrical equipment susceptible to water damage upon release of sprinklers in electrical areas. Such electrical equipment shall include transformers, equipment with ventilation grilles and other switchgear with openings that allow water entry into equipment. Protective hoods shall be sloped to shed water and shall project horizontally beyond equipment perimeter and shall not be integrally mounted on equipment unless prior approval obtained from electrical authorities. Holes through protective hoods that cannot be avoided, shall be sealed with waterproof sealing compound.

.4 No piping shall be installed in Electrical Rooms. Only the sprinkler branch and head serving the Electrical Room may be installed in the electrical as per BICSI.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Reference Standards

.1 National Fire Protection Association, NFPA 10 Standard for Portable Fire Extinguishers.

BC Building Code and BC Fire Code.

1.3 Shop Drawings and Products Data

.1 Submit shop drawings and product data for fire extinguishers and extinguisher cabinets.

1.4 Maintenance Data

.1 Provide maintenance data for incorporation into Mechanical Operation and Maintenance Manuals.

Part 2 Products

2.1 Recessed Cabinet with Extinguisher (FE-1):

.1 NFE model CE-950-3-2-R-G-T extinguisher cabinet.

.2 9” (225 mm) wide x 24” (600 mm) high x 6” (150 mm) deep cabinet.

.3 Semi-recessed steel cabinet with turn back frame for 4” (100 mm) wall thickness.

.4 Full length semi-concealed piano hinges for 180° swing.

.5 Flush stainless steel door latch with no exposed fasteners.

.6 18 ga (1.31 mm) steel tub.

.7 16 ga (1.61 mm) steel door and trim with optional 3⁄16” (4.8 mm) clear tempered glass (-G-T).

.8 Grey prime coated finish ready for field painting.

.9 NFE 10 lb (4.5 kg) ABC dry chemical multipurpose fire extinguisher.

2.2 Surface Mounted Cabinet with Extinguisher (FE-2):

.1 NFE Classic Cabinet model ECS-999 extinguisher cabinet.

.2 10-½” (265 mm) wide x 24” (600 mm) high x 6-¼” (160 mm) deep cabinet.

.3 Surface mount steel cabinet.

.4 18 ga (1.31 mm) steel tub.

.5 Plexiglas panel, break glass hammer and instruction decal.

.6 White baked enamel finish.

.7 NFE 10 lb (4.5 kg) ABC dry chemical multipurpose fire extinguisher.

2.3 Multi-Purpose Dry Chemical Fire Extinguishers

.1 Pressurized with hose and shutoff nozzle or integral shutoff nozzle suitable for Class A, B and C fires; charge indicator.

Part 3 Execution

3.1 Installation

.1 Install fire extinguishers in cabinets at locations as indicated on drawings.

.2 Coordinate locations of fire extinguisher cabinets with framing trades in order to facilitate recessed and semi-recessed installations.

.3 Mount fire extinguishers and cabinets such that top of extinguisher is 4’-0” (1.2 m) above floor.

.4 Install fire extinguisher cabinet doors, glazing panels and fire extinguishers in cabinets prior to project substantial completion review by Consultant.

3.2 Identification

.1 Identify fire extinguishers in accordance with recommendations of NFPA 10.

.2 Attach tag or label to fire extinguishers, indicating month and year of installation, with space for recording subsequent service dates.

END OF SECTION

Part 1 General

1.1 General

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 General Conditions, Supplements, Amendments and this section shall govern plumbing sections (i.e. 22 00 00 to 22 99 99 sections) of work (read in conjunction with the Instructions to Tenderers or Bidders). This section covers items common to 22 00 00 series sections and is intended only to supplement the requirements of Division 1.

.3 Plumbing drawings are diagrammatic and approximately to scale. They establish scope of plumbing work and general location and orientation of plumbing facilities. Plumbing facilities shall be installed generally in locations and generally along routings shown, close to building structure with minimum interference with services. Piping shall be concealed within walls, ceilings or other spaces and shall be routed to maximize head room and intended use of space through which they pass, unless specifically noted otherwise.

.4 Coordinate with the Electrical Contractor for all required electrical connections to plumbing equipment and accessories. Where alternate or substituted equipment requires an electrical connection, the contractor shall include all costs to provide a complete operating system.

1.2 Related Work

.1 Electrical Division 26

.2 Concrete Division 03 05 00

.3 Piped Utilities Section 33 05 00

.4 Trenching and Backfilling Division 33

1.3 Codes, Standards and Approvals

.1 Installation, workmanship and testing shall conform to the following standards:

.1 **The British Columbia Building Code Latest Edition**.

.2 Canadian Gas Association, CGA B149.1-M10 and Natural Gas.

.3 **British Columbia Gas and Safety Branch Bulletins**.

1.4 Shop Drawings

.1 Shop drawings are required for all materials and equipment including, but not limited to, the following:

.1 Cleanouts and access panels.

.2 Floor drains.

.3 Hot water tanks and heaters.

.4 Hydrants/hose bibbs.

.5 Plumbing fixtures.

.6 Pumps and controls.

.7 Roof drains.

.8 Trap primers.

.9 Valves.

.10 Water hammer arrestors.

.11 Compressor units.

.12 Fire stopping.

1.5 Maintenance Data

.1 Refer to Section 23 05 00 Common Work Results for HVAC.

.2 Comprehensive description of operation of systems, including function of each item of equipment within systems.

.3 Operating electrical switchgear schedule indicating location of equipment.

.4 Lubrication schedule indicating recommended lubricants and grades (grease or oil) for lubricated equipment components.

1.6 Record Drawings (As Built Drawings)

.1 Section 23 05 00 Common Work Results for HVAC shall apply to Plumbing Systems.

.2 In addition, as a minimum, during the construction period, keep on site clean set of drawing marked up, IN COLOUR, to reflect as built state, for examination by Consultant on regular basis. Include elevations, rough-in details and details and detailed locations of hidden services, including locations of maintenance items and their associated identification code (i.e. Values). Underground services and/or concealed piping shall be dimensionally located and noted (use gridlines or structure as the reference).

.3 At the time of 'Substantial Completion' submit to Consultant one complete full sized COLOUR photocopy of Record Drawing information produced as per above section.

1.7 Temporary Usage of Plumbing Equipment

.1 Plumbing equipment and systems shall not be used without written permission of Consultant and under no circumstances shall be used prior to testing and inspection.

1.8 Acoustical Treatment

.1 This project includes special acoustical requirements to ensure low noise levels in noise sensitive areas. The Contractor shall, in particular, give careful consideration to equipment selection and pay close attention to detail during the rough-in stage in order to assure maximum acoustical benefit.

.1 Conference rooms.

.2 Library.

.3 Private offices.

.4 Residences.

.5 Quiet rooms.

.6 Study/testing rooms.

.7 Theatres.

1.9 Seismic Protection

.1 Refer to Section 22 05 49 Seismic Restraint Systems for Plumbing Piping and Equipment.

1.10 Building Operation during Construction

.1 To minimize operational difficulties for building's staff, Contractor shall cooperate with Owner throughout entire construction period and particularly ensure that noise and service disruptions are minimized.

.2 Convenient access for staff and public to building must be maintained. Minor inconveniences and interruption of services will be tolerated, provided advance notice is given, but Contractor shall coordinate his work with Owner.

1.11 Existing Services

.1 Protect existing services encountered. Every effort has been made to show known existing services, however, removal of concealing surfaces may reveal other existing services. Work with Owner's staff to trace. Obtain instructions from Consultant when existing services require relocation or modifications.

.2 Arrange work to avoid shut-downs of existing services. Where shut-downs are unavoidable, obtain Owner's approval of timing and work to minimize any interruptions.

.3 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping may be required.

.4 Be responsible for any damages to existing system by this work.

.5 Owner reserves right to withhold permission for reasonable period with respect to shut-downs, if shutting off of service will interfere with important operations.

Part 2 Products

2.1 Access Doors

.1 Design:

.1 Plaster or wet wall construction: 14 ga (1.99 mm) thick bonderized steel flush with wall or ceiling type with concealed flange, complete with gasket.

.2 Masonry or drywall construction: 16 ga (1.61 mm) thick for 16" (400 mm) x 16" (400 mm) and smaller, 14 ga (1.99 mm) for 18" (450 mm) x 18" (450 mm) and larger bonderized steel face of wall type with exposed flange, complete with gasket. - Acceptable Product: Acudor UF-5000.

.3 Water resistant finished walls, tile, ceramic tile, water resistant drywall, plaster or wet wall construction in washroom and other wet areas: 14 ga (1.99 mm) thick stainless steel flush with wall or ceiling type with concealed flange, complete with gasket - Acceptable Product: Acudor PS-5030 stainless.

.4 Acoustic tile ceiling and similar block materials: 14 ga (1.99 mm) thick bonderized steel recessed ceiling type. Acceptable Product: AT-5020.

.5 Feature wall construction: Recessed wall type that is selected to complement and conform with architectural module, treatment, or panelling, complete with gasket. Size shall conform to adjacent finishes.

.2 Minimum Requirements:

.1 Materials:

.1 Concealed hinges.

.2 Adjustable anchoring straps or lugs to suit construction.

.3 Gasket.

.2 Finish:

.1 Prime coat bonderized steel type.

.2 Brushed stainless steel for stainless steel type.

.3 Size:

.1 8” (200 mm) x 8” (200 mm) for cleanout access.

.2 12” (300 mm) x 12” (300 mm) for hand access.

.3 24” (600 mm) x 24” (600 mm) for body entry access.

.4 Locking Devices

.1 Screwdriver cam locks.

.3 Access panels in fire separations and fire walls shall have compatible fire rating and ULC label (i.e. Acudor Fire Rated FW-5050 or FB-5060).

.4 Submit shop drawings.

.5 Supply and locate access doors under this section of work. Installation shall be by Prime Contractor - Acceptable Products: Acudor, Can-Aqua, Mifab, Milcor, Nystrom, Van-Met.

2.2 Cleanouts

.1 Cleanouts shall be full size for pipe sizes up to 4” (100 mm) and not less than 4” (100 mm) on larger sizes. Cleanouts installed inside finished areas shall all be of same shape, either round or square.

.2 Cleanouts passing through waterproofed floor or slab on grade subject to hydrostatic pressure shall have a clamping collar clamped to floor membrane.

.3 Pipe Manufacturers’ cleanouts are acceptable for vertical installation at base of soil and waste stacks or rainwater leaders only.

.4 Make cleanouts with Barrett type fitting with bolted cover plate and gasket, fitting that has threaded plug, or cleanout ferrule installed in wye or extended wye.

.5 Outside area and vehicle area cleanouts shall be heavy duty construction and have fully exposed scoriated cover. Acceptable Product: Zurn Z1400, Jay R Smith 4231 Series, Wade 6000-Z Series.

.6 Lino or lino tiled area cleanouts shall have centre portion of cover recessed to receive tile that matches adjoining tile. Acceptable Product: Zurn DNE 1400-X or ZN 1400-TX, Jay R Smith 4140, Wade 6000-1 Series.

.7 Ceramic tile floor area cleanouts shall have fully exposed scoriated cover. Acceptable Product: Zurn DNE 1400 or ZN 1400-T, Jay R Smith 4020, Wade 6000-1 Series.

.8 Terrazzo tile floor area cleanouts have centre portion cover to receive terrazzo to match adjoining terrazzo finish. Acceptable Product: Zurn ZN 1400-Z, Jay R Smith 4180, Wade 6000-1 Series.

.9 Carpet area cleanouts shall be fully concealed with a small raised marker. Acceptable Product: Zurn ZN 1400-CM, Jay R Smith 4020-Y, Wade 6000-1 Series.

2.3 Hangers and Supports

.1 Refer to Section 22 05 29 for Hangers and Supports for Plumbing Piping and Equipment.

2.4 Pipe Sleeves and Escutcheons

.1 Provide and locate pipe and duct sleeves.

.2 Provide detailed information on openings required in pre-cast members for mechanical work. Cast holes larger than 4" (100 mm) diameter and field cut holes smaller than 3-½" (90 mm) diameter.

.3 Provide separate sleeves for piping passing through walls, floors, roof and ceilings. Sleeves shall be 20 ga (1.00 mm) galvanized iron and standard weight steel piping sleeves in concrete beams, foundation walls and footings. Plastic sleeves may be used in concrete wall form work where permitted by Authorities having Jurisdiction.

.4 Sleeves shall be sized large enough to allow for movement due to expansion and to provide for continuous pipe insulation where not passing through fire rated assemblies.

.5 Sleeves passing through basement walls or potentially wet floors shall be set with integral "puddle flanges".

.6 Provide Link Seal wall gasket to seal exposed sides of opening between pipe and sleeve on foundation walls with caulking fill. Provide water proofing mastic seal on concealed side of opening.

 .1 Acceptable Sealing Products: Metraflex MetraSeal

.7 For finished floor areas, provide pipe sleeves 1" (25 mm) above floor with annular fin.

.8 Install chrome-plated escutcheons with set screws where insulated or uninsulated piping passes through finished floor, ceiling and wall surfaces. Copper piping shall not be in contact with ferrous metals. Use cast-iron or galvanized sheet metal escutcheons for equipment rooms.

.9 Coordinate installation of concrete curbs around duct openings in mechanical room floors with General Contractor.

.10 Provide plastic grommets, equivalent to Pipe Tytes or Greenlee 712-M, for pipes passing through metal stud partitions.

2.5 Pipe Bedding

.1 All buried piping inside the building below floors and slabs, except for footing drains, shall be supported on a bed of well compacted sand (i.e. 95% Modified Proctor Density). Bedding shall extend 6" (150 mm) below pipe and support pipe barrel, not joints and/or couplings. Before backfilling, complete line shall be inspected and approved by Authorities Having Jurisdiction.

Part 3 Execution

3.1 Pressure Piping Installation

.1 General

 .1 Install piping straight, parallel and close to walls and ceilings, with fall of not less than 1:50 for gravity piping and with slope to drain cocks, fixtures or equipment for pressure piping, unless otherwise indicated on drawings. Use standard fittings for direction changes. Provide drain cocks as required.

 .2 Install groups of piping parallel to each other, spaced to permit application of insulation, identification and service areas, on trapeze hangers.

 .3 Where pipe size differs from connection size to equipment, install reducing fitting close to equipment. Reducing bushings are not permitted.

.4 Brass and copper pipe and tubing shall be free from surface damage. Replace damaged pipe or tubing.

.5 Ream ends of pipe and tubes before installation.

.6 Install copper pipe to not contact with dissimilar metal and not be crimped or collapsed. Joints on cast or ductile iron pressure service piping shall be made electrically conductive.

.7 Install flanges or unions and shut-off valves to permit removal of equipment without disturbing piping systems.

.8 Clean ends of pipes or tubing and recesses of fittings to be jointed. Assemble joints without binding.

.9 Install piping to connections at fixtures, equipment, outlets and other appurtenances requiring service. Trap and vent waste connections to fixtures. Grade all vents to drain back to waste piping.

.10 Plug or cap pipe and fittings to keep out debris during construction.

.11 Joint material shall be compatible with type of pipe used.

.12 Non-corrosive lubricant or Teflon tape shall be applied on male thread of threaded joints.

.13 Flush and clean out piping systems after testing.

.2 Equipment Drainage:

.1 Install drain valves at low points.

.2 Extend equipment drain piping to discharge into floor or hub drain.

.3 Expansion and Contraction and Building Seismic Joints:

.1 Support piping to prevent stress or strain.

.2 Install pressure piping with loops and offsets to permit expansion and contraction without damaging pressure piping system.

.4 Buried Piping:

.1 Lay pipe on compacted bedding of clean, coarse sand, free from clay, snow or ice, organic matter or stones.

.2 Do not lay pipe in water or when conditions are unsuitable.

3.2 Plumbing System Acoustical Requirements

.1 Ensure no rigid contact between pipes and supporting framing and gypsum wall board.

.2 Provide minimum 12mm pipe size for fixtures.

.3 Provide flexible connections for all fixtures.

.4 Domestic pipes shall be wrapped in the area of the attachments with minimum ¼" (6.0 mm) thick Rubatex or Armaflex sleeving and secure over insulation using oversized clamps. If piping is insulated, this requirement is waived if clamps mount over insulation. Hard plastic pipe sleeves are not acceptable. An alternate is to provide resilient pipe mounting system such as Acoustoplumb

.5 Supply, waste and vent pipe penetrations of gypsum wall board shall be ⅛" (3.2 mm) to ¼" (6.0 mm) oversized, pipe centred in hole, gap caulked with silicone sealant and covered with escutcheon. This requirement does not eliminate need for firestopping. Refer to Section 23 05 05 Firestopping for firestop requirements.

.6 Do not allow pipe work to contact gypsum wall board, framing, conduit, electrical or ductwork fans connected to room services.

.7 Water supply lines penetrating floors must not contact structure.

.8 Waste stacks and rainwater leaders shall not touch structure and shall be resiliently supported at floor penetration with neoprene pad isolators sized for minimum ⅜" (9.5 mm) static deflection. Neoprene pad isolators shall be equal to Mason "Super W". Ensure piping does not touch framing or gypsum wall board.

3.3 Access Doors

.1 Install access doors at concealed cleanouts, traps, unions, expansion joints, valves, control valves, air vents, water hammer arrestors, special equipment, trap primers, vacuum breakers and other equipment for which periodic access will be required.

.2 Locate access doors so concealed items are accessible for adjustment, operation, maintenance and replacement.

.3 Do not locate access doors in feature walls or ceilings without prior approval of Consultant. Locate in service areas and storage rooms wherever possible.

3.4 Cleanouts

.1 Install cleanouts at the following locations:

  .1 Building drain leaving building on upstream side of exterior wall.

  .2 Changes of direction of more than 90° in drainage piping.

  .3 Nominally horizontal branch or building drain at intervals of not more than 25'-0" (7.5 m) for pipe sizes 2-½" (65 mm) and less, 50'-0" (15 m) for 3" (75 mm) and 4" (100 mm) pipe sizes, and 100'-0" (30 m) for pipe sizes larger than 4" (100 mm).

  .4 Fixture drain of a sink

  .5 Base of soil or waste stacks and rainwater leaders.

  .6 As called for by British Columbia Plumbing Code

.2 Locate wall cleanouts 3" (75 mm) minimum above top of base board or minimum 8" (200 mm) above finished floor level where no baseboard.

.3 Coordinate cleanout location with millwork and other obstructions; place in accessible location with sufficient clearance for rodding and cleaning.

.4 Extend cleanouts to finished floor or wall unless exposed in basement room, pipe tunnel or accessible crawlspace.

.5 Extend cleanouts in wet floor areas above floor in walls, or provide with gasketted, waterproofed tops.

.6 Bring cleanouts on outside drains to grade and anchor in a concrete collar.

3.5 Hangers and Supports

.1 Refer to section 22 05 29 for Hangers and Supports for Plumbing Piping and Equipment.

3.6 Pipe Sleeves and Escutcheons

.1 Install chrome-plated escutcheon plate on exposed piping passing through walls, floors and ceilings in finished areas.

.2 Sleeves shall be concentric with pipe and, except at fire separations, shall be sized to allow for the continuity of insulation.

.3 Extend sleeves 2” (50 mm) above floor slabs in wet areas. Wet areas include equipment rooms, janitor’s rooms, utility rooms and washrooms.

.4 Extend sleeves through outside walls to 1” (25 mm) beyond the exterior face and caulk with flexible caulking compound.

.5 Remove removable plastic sleeves are used prior to pipe penetration and sleeve the resulting hole.

.6 Extra high vertical risers for cold water and hot water systems with many horizontal branch takeoffs passing through sleeves set in rigid structure adjacent to main risers, set sleeves to accommodate long term structural movement to avoid imposing stress on these systems.

.7 Refer to Section 23 05 05 Firestopping for firestop requirements.

3.7 Core Drilling and Cutting

.1 Arrange and pay for cost of core drilling and cutting for plumbing systems.

.2 Verify location of existing service runs and structural reinforcement within existing concrete floors and walls prior to core drilling and cutting. Coring and cutting of structural building components shall only take place upon specific written approval of Structural Engineer. Provide repairs to existing services damaged as result of core drilling.

.3 Penetrations up to 6” (150 mm) nominal pipe size in precast concrete may be cored on site by plumber. Locate larger penetrations and arrange to have pre-cored with pre-cast Manufacturer prior to shipping to construction site.

3.8 Piping Expansion

.1 Install piping systems, including all take-offs, so that the piping and connected equipment will not be distorted by expansion, contraction or settling.

.2 Install anchors where necessary to control expansion. Install expansion joints or loops on hot water piping where required.

3.9 Testing and Inspection

.1 Refer to Section 22 05 93 – Testing, Adjusting and Balancing for Plumbing.

.2 Furnish labour, materials, instruments, etc. necessary for required tests. Work shall be inspected by local plumbing inspector and review by Consultant.

.3 Correct leaks by remaking joints. Retest systems until no leaks are observed.

.4 Do not cover any plumbing system before being inspected and approved by Plumbing Inspector.

.5 If plumbing system or part thereof is covered before being inspected or approved, Contractor will uncover system upon the direction of the Plumbing Inspector or Consultant.

3.10 Project Photographs

.1 Provide digital photographs of all systems prior to covering.

.2 Provide digital photographs in “jpeg” format to Consultant complete with text description of each photograph, including date, system type, materials used, and location/direction for sections of underground piping prior to backfilling. Submit photographs via email and/or disc as requested by Consultant. Individual email sizes not to exceed 7MB in size.

.3 Provide additional digital photographs of work as requested by Consultant to assist in resolution of RFIs, prior to covering work.

3.11 Substantial Completion Requirements

.1 The following items must be completed, with documentation, prior to the date of Substantial Completion:

.1 All pipe expansion compensators and flexible connections checked by Supplier with an inspection report submitted to the Commissioning Agent and this Consultant.

.2 Seismic restraints reviewed and inspected by the Suppliers/Contractors’ British Columbia Registered Professional Engineer, with a report submitted to the Commissioning Agent and this Consultant, with supporting Schedule S/Schedule C Letters of Assurance.

.3 All plumbing fixtures have been tested, adjusted, cleaned and in proper operation.

.4 All plumbing access doors and panels are in place and not painted closed.

.5 Potable water systems have been cleaned, flushed, chlorinated, and copies of final chlorination and water quality tests have been submitted to the Commissioning Agent and this Consultant.

.6 All backflow prevention stations and devices have been tested, with test reports submitted to the Commissioning Agent and this Consultant.

.7 All domestic hot water recirculation systems have been balanced and maximum wait time at fixtures verified, with written balancing report submitted to the Commissioning Agent and this Consultant.

.8 Final plumbing Inspectors sign-off to be submitted to this Consultant.

.9 Final gas inspection sign-off to be submitted to this Consultant.

.10 Final As-built Record drawings have been submitted for review to this Consultant.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Refer to Section 23 05 13 Common Motor Requirements for HVAC Equipment. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to equipment and systems listed in Section 23 05 13, provide motors complying with requirements of Section 23 05 13 plumbing equipment including the following:

- .1 Domestic hot water recirculation pumps.
- .2 Sanitary waste sump pumps.
- .3 Storm drainage sump pumps.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Refer to Section 23 05 19 Meters and Gauges for HVAC Piping. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems listed in Section 23 05 20, provide thermometers and pressure gauges complying with requirements of Section 23 05 20, on plumbing piping systems and equipment including the following:

  .1 Domestic cold water

  .2 Domestic hot water and recirculation.

  .3 Natural gas.

  .4 Tanks, pumps and all other equipment.

.3 Provide thermometers in brass or stainless steel wells at heat exchangers, water heaters, and other equipment intended to change temperature of fluid.

.4 Provide pressure gauges complete with isolation ball valves on both sides of pressure reducing valves, backflow prevention stations, pumps, compressors and other equipment intended to change pressure of fluid. Provide snubbers for pressure gauges located adjacent to pumps or compressors. Provide vacuum gauges at vacuum units.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 05 48 Vibration Isolation for Plumbing Piping and Equipment, and Section 22 05 49 Seismic Restraint Systems for Plumbing Piping and Equipment.

1.2 Scope of Work

.1 Refer to Section 23 05 29 Hangers and Supports for HVAC Piping and Equipment. Comply with requirements of Section as related to general requirements, products and execution.

  .1 Acceptable Products: Hubbard Enterprises – Holdrite Systems.

.2 In addition to piping, equipment and systems listed in Section 23 05 29 provide hangers and supports complying with requirements of Section 23 05 29 on plumbing piping and equipment including:

  .1 Domestic cold water
  .2 Domestic hot water and recirculation.
  .3 Sanitary waste and venting.
  .4 Storm drainage.
  .5 Natural gas.
  .6 Tanks and all other equipment.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 07 19 Plumbing Piping Insulation.

.3 Refer to Section 22 05 34 Hot Water Heat Tracing for Temperature Maintenance.

1.2 Scope of Work

.1 Refer to Section 23 05 33 Heat Tracing for HVAC Piping. Comply with all requirements of Section as related to general requirements, products and execution.

.2 In addition to piping and systems listed in Section 23 05 33 provide heat tracing for freezing protection complying with requirements of Section 23 05 33 on plumbing piping systems in exterior or unheated areas including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Storm drainage piping and underside of drain bodies.
- .4 Sanitary Waste

Part 2 Products

2.1 Pipe Heat Tracing

.1 Provide complete, CSA approved system of heat tracing on piping exposed outdoors where indicated.

.2 Entire design and installation of system shall comply with Canadian Electrical Code and requirements of local inspection authority.

.3 Provide necessary materials to provide complete system.

.4 Use Raychem Chemelex Auto Trace self-regulating, shielded, jacketed cable type XL-TRACE (use XTV for hot water piping systems) or equal.

.5 Monitoring of heat tracing for plumbing systems shall use a packaged device provided by the same manufacturer as the heat trace cable to monitor status of heat tracing system, and ambient air temperature (e.g. Raychem DigiTrace Remote Monitoring Module “RMM”). A standalone thermostat is not acceptable. A separate relay may be used as required to signal loss of power supply to heat tracing. Controls shall be protected from direct sunlight and moisture, provided with a lockable enclosure.

.6 Acceptable Products: Raychem, Hevi-Duty, Nelson, Thermon,

Part 3 Execution

3.1 Installation

.1 Install heat trace system in accordance with Manufacturer’s instructions/recommendations and these specifications.

.2 Prior to installing heating cables, ensure pipe systems are complete and have passed tests.

.3 Cables to be secured to pipes using Raychem Type G554 glass cloth tape at 12" (300 mm) intervals.

.4 Follow Manufacturer's recommendations for installation of cable around valves and flanges.

.5 After pipes are traced, test prior to installation of pipe insulation.

.6 Provide suitable identification for those pipe systems provided heat tracing. At intervals of 20'-0" (6.1 m), provide on outside surface of insulation adhesive backed nameplate "Caution - Heat Tracing."

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 05 49 Seismic Restraint Systems for Plumbing Piping and Equipment.

1.2 Scope of Work

.1 Refer to Section 23 05 48 Vibration Isolation for HVAC Piping and Equipment. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems listed in Section 23 05 48 provide vibration isolation complying with requirements of Section 23 05 48 on plumbing piping and equipment including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Sanitary waste and venting.
- .4 Storm drainage.
- .5 Natural gas.
- .6 Tanks, pumps and all other equipment.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 05 48 Vibration Isolation for Plumbing Piping and Equipment.

1.2 Scope of Work

.1 Refer to Section 23 05 49 Seismic Restraint Systems for HVAC Piping and Equipment. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems listed in Section 23 05 49 provide seismic restraints complying with requirements of Section 23 05 49 on plumbing piping and equipment, including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Sanitary waste and venting.
- .4 Storm drainage.
- .5 Natural gas.
- .6 Tanks, pumps and all other equipment.

1.3 Document Submittals

.1 Provide Letters of Assurance signed and sealed by Contractor’s specialist Registered Professional Engineer.

.2 Submit Schedule B Letters of Assurance or in accordance with **BC Building Code and BC Fire Code** to Consultant and local Authority Having Jurisdiction at time of shop drawing submission.

.3 Submit ‘Schedule C-B: Assurance of Professional Field Review and Compliance’ in accordance with **BC Building Code and BC Fire Code** to Consultant and to local Authority Having Jurisdiction minimum of 10 working days prior to Occupancy.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Refer to Section 23 05 53 Identification for HVAC Piping and Equipment. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems listed in Section 23 05 53, provide identification on plumbing piping, valves and equipment, including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Sanitary waste and venting.
- .4 Storm drainage.
- .5 Natural gas.
- .6 Trap primer access points.
- .7 Tanks and all other equipment.

1.3 Pipe Identification Colour Schedule

Service	Identification Lettering	Primary Colour	Secondary Colour
Boiler Blow Off Piping	-	yellow	black
Boiler Blowdown	-	yellow	black
Boiler Feed Water	B.F.W.	yellow	black
Chilled Water Return	CH.W.R.	green	-
Chilled Water Supply	CH.W.S	green	-
Cold Water Service	C.W.	green	-
Domestic Cold Water	D.C.W.	light blue	-
Domestic H.W. Recirc.	D.H.W.R.	red	black
Domestic H.W. Supply	D.H.W.S.	red	black
Glycol Heating Return	GLR - do not drain	yellow	black
Glycol Heating Supply	GLS - do not drain	yellow	black
Heat Pump Water return	H.P.W.R.	orange	black
Heat Pump Water supply	H.P.W.S.	orange	black
Hot Water Return	H.W.R.	yellow	black
Hot Water Supply	H.W.S.	yellow	black
Natural Gas	Gas	yellow	black
Safety Valve Blowdown	-	yellow	black
Fire Sprinkler lines	SPR	red	white
Fire Sprinkler lines (Dry)	SPR (DRY)	Red	white
Sanitary Drain	SAN	None	None (-)
Plbg. Vent	PVent	None	(-)
Storm Drain	Storm	None	(-)

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 08 00 Commissioning of Plumbing.

1.2 Scope of Work

.1 Refer to Section 23 05 93 Testing, Adjusting and Balancing for HVAC. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to the piping, equipment and systems listed in Section 23 05 93 provide testing adjusting and balancing complying with requirements of Section 23 05 93 for plumbing piping, equipment and systems including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Sanitary waste and venting.
- .4 Storm drainage.
- .5 Natural gas.
- .6 Trap primers.
- .7 Tanks, pumps and all other equipment.

.3 Balancing of domestic hot water recirculation systems by recognized balancing agency and submission of balancing report is mandatory.

.4 Pressure test plumbing piping systems in accordance with specific requirements of specification sections for those systems.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 07 19 Plumbing Piping Insulation.

1.2 Scope of Work

.1 Refer to Section 23 07 16 HVAC Equipment Insulation. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems listed in Section 23 07 16, provide equipment insulation on plumbing equipment and systems including the following:

  .1 Domestic hot water storage tanks and heat exchangers.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 22 07 16 Plumbing Equipment Insulation.

1.2 Scope of Work

.1 Refer to Section 23 07 19 HVAC Piping Insulation. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping and systems listed in Section 23 07 19 provide piping insulation on plumbing piping systems including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Storm drainage piping and underside of drain bodies.
- .4 Sanitary waste and P-traps in exterior and unheated areas.
- .5 Piping provided with heat tracing cable for freeze protection, domestic hot water temperature maintenance, or grease waste lines in unheated areas.
- .6 Offset waste piping, P-traps and supplies under wheelchair accessible lavatories and sinks.
- .7 Provide foil faced flexible insulation on components requiring adjustment or servicing including booster pumps, meter sets, pressure reducing valves, valve bodies, strainers, etc.
- .8 Sanitary vent stacks for last 10’-0” (3.0 m) prior to penetrating roof.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Refer to Section 23 08 00 Commissioning of HVAC. Comply with requirements of Section as related to general requirements, products and execution.

.2 In addition to piping, equipment and systems listed in Section 23 08 00 provide commissioning complying with requirements of Section 23 08 00 plumbing piping, equipment and systems including the following:

- .1 Domestic cold water
- .2 Domestic hot water and recirculation.
- .3 Sanitary waste and venting.
- .4 Storm drainage.
- .5 Natural gas.
- .6 Tanks and all other equipment.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Domestic water systems include domestic cold water and domestic hot water systems.

.2 Domestic water piping shall be provided as depicted on drawings to all plumbing fixtures, appliances and equipment that require domestic water service.

.3 New domestic water piping shall be connected to exterior cold water building service as indicated on drawings.

.4 Non-functioning interior domestic water piping shall be removed where access is readily available or capped off and abandoned in place as indicated on drawings.

.5 Refer to "Common Work Results for Fire Suppression," Section 21 05 00 where domestic water supply and supply to fire suppression systems are combined in one common supply line.

.6 Mechanical makeup water piping systems and force main or pressure waste water piping systems shall be constructed of materials, installed and tested as specified in this section.

.7

1.3 Cross Connection and Backflow Control

.1 Provide cross connection in accordance with the BC Building Code and **CSA B64.10**.

.2 Double check valve assemblies and reduced pressure principle backflow prevention devices shall have approval from the Foundation for Cross Connection Control, University of Southern California.

.3 Vacuum breakers shall conform to the requirements of CSA B64.5.

.4 Following installation, test report completed by certified tester shall be submitted to Owner, indicating satisfactory operation of each device.

.5 Tests shall be conducted 30 to 60 days prior to date of Substantial Completion.

.6 Provide one repair kit for every cross connection control device installed.

1.4 Freeze Protection

.1 Provide freeze-proof hose bibbs where required due to ambient temperatures.

Part 2 Products

2.1 General Standards: Piping and fittings shall be in accordance with current edition or applicable revisions of applicable codes or governing regulations. Pipe and pipe fittings must be of the same manufacturer. All products shall be UL/ULC classified in accordance with ANSI/NSF-16 for portable water service and certified to the no/low lead standard of NSF-372.

2.2 Mechanical grooved pipe couplings, fittings, butterfly, ball and check valves, expansion joints, Mechanical-Ts and other products as manufactured and/or supplied by Victaulic Company or SHURJOINT, may be used for piping systems and mechanical equipment connections (in lieu of welded, flanged and threaded methods) (and also may be used as unions, seismic joints, flexible connections, expansion compensators, vibration reducers) in systems specified. Operating conditions not to exceed 30°F (-34°C) to 250°F (120°C) temperature range according to the gasket or valve lining selected and working pressures as shown in the coupling Manufacturer's current product specifications, as detailed under specific systems specifications (subject to local code approval).

2.3 Pipe and Fittings

Size	Pipe	Fittings
Domestic Water Piping Above Grade		
Up to 1-½" (38 mm)	Certified Type "L" or Type "K" hard copper	Wrought copper or cast bronze with stainless steel components and EPDM O-ring seals. Victaulic 'Permalynx'.
All sizes	Certified Type "L" or Type "K" hard copper	Wrought bronze or cast brass with Silvabrite 100 lead free solder. Roll grooved copper may be used in lieu of sweated joints; grooved couplings to be installation ready and designed with angle bolt pads to provide rigid joint. Gasket shall be grade – EHP. Victaulic 600 series

Size	Pipe	Fittings
2" (50 mm) - 24" (600 mm)	Schedule 10 Stainless Steel	Roll Grooved Stainless steel pipe and fittings may be used as an alternative on sizes 2" (50 mm) and greater if acceptable to Local Authority having jurisdiction. Pipe shall be IPS sized, conforming to ASTM A-312, Type 304/034L or 316/316L. Where Schedule 10 Stainless steel pipe is used 2" (50 mm) and above, all roll grooves must be formed using Stainless Steel "RX" rolls ("RWX") rolls 14" (355 mm) and above. Couplings shall be specifically designed to provide a rigid joint for stainless steel. Joints shall be rated to 300 psi (2,070 kPa) on Schedule 10S stainless steel pipe, and 200 psi (1,380 kPa) on Schedule 5S stainless steel pipe. Gasket shall be "E" grade EPDM rated for -30°F (-34°C) to 230°F (110°C), UL Classified to ANSI/NSF 61 for cold and hot potable water services. Standard of Acceptance: Victaulic Style 89 & W89 couplings, fittings and valves, Shurjoint C305 or XH1000 rigid coupling.
4" (100 mm) and up	Grooved end cement lined ductile iron pipe grooved in accordance with AWWA Standard C606	Fittings shall be cement lined ductile iron, ASTM A-536, grade 65-45-12, conforming to requirements for AWWA C110 for center to end dimensions, AWWA C153 or AWWA 21.10/AWWA C110 for wall thickness and AWWA C606 rigid radius grooving dimensions for end preparation. Couplings shall be cast of ductile iron conforming to ASTM A-536 Supplied with Grade "M" FlushSeal® gasket for potable water service. Victaulic AWWA fittings and Style 31, 307 couplings and 341 flange adapters or Shurjoint style A505, A507, A512 Flange Adapter.

2.4 Grooved Mechanical Pipe Couplings, Fittings and Valves

.1 Victaulic Piping Systems (Victaulic Manufacturer only). Where the name Victaulic is used, it refers to Victaulic the Manufacturer. Shurjoint grooved piping products are an acceptable alternate product.

.2 The use of grooved end pipe, fittings and couplings is acceptable for potable water in sizes 2” (50 mm) and larger.

.3 When using the grooved piping concept, provide grooved end valves for isolation. Acceptable Products: Victaulic Butterfly Valve, “PPS” coated.

.4 For AWWA/Ductile iron pipe, Halogenated Butyl, Grade “M”, green indicator markings.

.5 Gaskets:

.1 All gaskets in potable water application shall be UL classified in accordance with ANSI/NSF-61 for potable water service.

.2 For copper, ‘EHP’ -30°F (-34°C) to 250°F (120°C) and EPDM Grade “E” for use on water systems -30°F (-34°C) to 230°F (110°C). Gaskets shall have green indicator markings.

.6 For Victaulic Grooved Joints: Ensure that grooved pipes are in compliance with the current Victaulic specifications and recommendations. Ensure that the "A" dimension (i.e. the area from the pipe end to the front edge of the groove) is clean and free from indentations, scores, seams, projections or roll marks for proper gasket sealing. Gasket style and elastomeric material (grade) verified as suitable for the intended service as specified. Ensure that correct tool and rolls are used for pipe being grooved. A pipe tape should be used to verify proper grooved dimensions.

.1 Grooved coupling Manufacturer’s factory trained Representative shall provide on-site training for Contractor’s field personnel in the use of grooving tools and installation of grooved joint products. Representative shall periodically visit the jobsite and review Contractor is following best recommended practices in grooved production installation. (Distributor’s Representative is not considered qualified to conduct the training or jobsite visit(s).)

.7 For copper systems, provide installation-ready couplings with angled bolt pad for rigidity and Victaulic Style 607H coupling, complete with EHP EPDM gaskets, lined with PVDF resin, Shurjoint C305.

.8 Provided copper system shall be manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)

.9 For combined domestic/fire water line inside building, provide Victaulic 717 PPS Coated Check Valve and 7BZ Monitored BFV, joined with a Style 07/107H coupling complete with Flush Seal EPDM Gasket and Style 307 coupling complete with FlushSeal® Halogenated Butyl gasket for potable water or Shurjoint SJ900 monitored BFV and A507 coupling. See details for transition to incoming supply lines.

.10 When transitioning from grooved end ductile iron pipe to grooved end copper pipe, provide style 47GG di-electric water way.

.11 On Domestic Ductile Iron Systems, provide Victaulic 300 MasterSeal™-and Series 717 PPS and 732 PPS coated valves for shutoff, check and straining or Shurjoint SJ300 and SJ900 check valve.

2.5 **Metal Protection:** All ferrous metal work buried underground shall be of stainless steel construction. Retainer rod, washers and nuts on underground water/pressure mains shall be 316 stainless steel, hangers shall be 316 stainless steel where used for piping supported below grade.

2.6 **Valves**

.1 Gate (for shut-off and isolation):

- .1 2" (50 mm) and smaller, bronze body, solid wedge disc, bronze or stainless steel trim, non-rising stem, 125 psi (860 kPa) rating.
  - .1 Acceptable Products:
    - .1 Solder Joint Type: NHA-42, Kitz 41, Red and White/Toyo 281A.
    - .2 Threaded Joint Type: NHA-40, Jenkins 810J, Kitz 40, Red and White/Toyo 280A.
- .2 2-½" (65 mm) and larger, flanged ends cast-iron body, solid wedge disc, bronze or stainless steel trim, rising stem, outside screw and yoke.
  - .1 Acceptable Products: Jenkins 404, Kitz 72, Red and White/Toyo 421A/MAS W-10.

.2 Ball (in lieu of gate valves or as specified):

- .1 2" (50 mm) and smaller, brass two piece body, blow-out proof stem, PTFE seats, brass chrome plate ball, lever handle operator, 150 psi (1,034 kPa) rating.
  - .1 Acceptable Products:
    - .1 Solder Joint Type: Red and White/Toyo 5049A, Jenkins-1999, 1979, Kitz 59.
    - .2 Threaded Joint Type: Red and White/Toyo 5044A, Jenkins-1969F, R650, Kitz 58.
    - .3 Push-to-Connect Joint Type or Grooved: Victaulic PL-300.
    - .4 Vic-press joint type series P589 (P569 with stainless steel body).

.3 Butterfly (in lieu of gate valves or as specified):

- .1 2-½" (65 mm) and larger, 200 psi (1,380 kPa) rating, wafer style, threaded lug style cast-iron body, EPDM seat liner, bronze disc, 403 stainless steel stem, 10 position lever lock handle operator on 6" (150 mm) diameter and smaller, handwheel worm gear operator on 8" (200 mm) diameter and larger, for installation between Class 125/150 flanges.
  - .1 Acceptable Products:
    - .1 Wafer Style: Apollo 141, Center Line L200W/G200W (EPDM), Grinnell 7721, Metraflex, MAS-D, Kitz DJ, Toyo 17.
    - .2 Lug Style: Apollo 143, Center Line L200L/G200L (EPDM), Metraflex, MAS-D, Kitz DJ, Toyo 17.
    - .3 With "Victaulic" copper grooved end pipe system, use Victaulic style #608 cast brass body grooved valve with an EPDM encapsulated disk, 300 psi (2,070 kPa) rating, or Shurjoint C300 brass BFV.

.4 With "Victaulic" ductile iron grooved end pipe system, use Victaulic-MasterSeal enamel coated grooved end valve with an EPDM or Fluoroelastometer pressure responsive seat, offset stainless steel stem, and alum-bronze-disk or stainless steel-disk, 300 psi (2,070 kPa) rating or shurjoint SJ300 BFV.

.4 Globe (for throttling, bypass and make-up applications):

.1 2" (50 mm) and smaller, bronze body, bronze or stainless steel trim, 125 psi (860 kPa) rating.

.1 Acceptable Products:

.1 Solder Joint Type with Bronze Bevel Type Disc: NH A51, Kitz 12, Red and White/Toyo 212.

.2 Threaded Joint Type with Composition Type Disc: NH A50, Kitz 03, Red and White/Toyo 220.

.2 2-½" (65 mm) and larger, flanged ends, cast-iron body, bronze or cast-iron bevel-type disc, bronze or stainless steel trim, rising stem, outside screw and yoke, 125 psi (860 kPa) pressure rating.

.1 Acceptable Products: NH T731, Jenkins 2342J, Kitz 76, Red and White/Toyo 400A.

.5 Check (for horizontal installation):

.1 2" (50 mm) and smaller, threaded joint type, bronze body, bronze or stainless steel swing disc holder with Teflon disc, 125 psi (860 kPa) rating.

.1 Acceptable Products: Jenkins 4037, Kitz 04, Red and White/Toyo 236.

.2 2-½" (65 mm) and larger, grooved or flanged ends, ductile or cast-iron body, bronze or ductile/cast-iron swing disc, bronze or stainless steel trim, 125 psi (860 kPa) rating.

.1 Acceptable Products: Victaulic 717PPS, Jenkins 587, Kitz 78, Red and White/Toyo 435A, MAS W-30.

.6 Balance (for domestic hot water recirculation):

.1 1-¼" (32 mm) and smaller, globe lock shield, for maximum system temperature, bronze body and trip, Teflon, polytetrafluoroethylene (PTFE), disc, female by male union connection, 100 psi (690 kPa) rating.

.1 Acceptable Products: Dahl 13012 or 13013 with memory stop, Red and White/Toyo 250LS or 251LS, Tour and Anderson circuit balancing valve.

.2 1-½" (38 mm) and larger, plug type, wrench adjustable stop, for maximum system temperature, semi-steel body, resilient plug seals, EPT or RS 55, maximum 250°F (120°C) operating temperature, 125 psi (860 kPa), threaded end connections for up to 2" (50 mm), flanged end connections on 2-½" (65 mm) and larger.

.1 Acceptable Products: DeZurik 435 with 487 adjustable stop, Homestead Ballcentric, Newman-Hattersley 170M or 171M, or Victaulic / Tour Andersson globe type, oventop.

.7 Vacuum Relief (for hot water tanks installation):

.1 Up to ½" (12 mm), 125 psi (860 kPa) rating.

.1 Acceptable Products: ½" (12 mm) Watts 36A, Cash Acme VR-801.

.2 ¾" (19 mm) and larger, 125 psi (860 kPa) rating.

.1 Acceptable Products: ¾" (19 mm) Watts 36A, Cash Acme VR-801.

.8 Pressure Reducing:

.1 Potable Water System Pressure Reducing Valve:

.1 Provide pilot operated globe type pressure reducing valve with bronze strainer assembly to limit static water pressure to 85 psi (585 kPa) on incoming water line to Plumbing Code requirements. PRV shall be epoxy lined WATTS Model PV-10M with Y strainer to sizes indicated.

.2 Domestic Hot Water Applications: Pressure reducing valve shall be rated to 225°F (107°C) minimum at required pressure.

.2 Acceptable Products:

.1 ¼" (6.0 mm) to ⅜" (9.5 mm), 125 psi (860 kPa) rating: Watts 215, Singer.

.2 ½" (12 mm) to 2" (50 mm), 125 psi (860 kPa) rating: Watts 223, Braukmann, Conbraco, Cash Acme, Singer, Beeco, Zurn ZW 209.

.3 2-½" (65 mm) and larger, 125 psi (860 kPa) rating: BCA 317 PR, Clayton 90 or 90B, Singer 106PR, Beeco, Zurn ZW 209.

.4 All sizes: Cash Acme EB-25 Pressure Regulator.

.9 Pressure Reducing Valve with Integral Low Flow Bypass:

.1 1-½" (38 mm) and larger, 125 psi (860 kPa) rating: Acceptable Products: USB-Z3, Clayton, Singer, Wilkins, Beeco.

.10 Drain Valves and Hose Bibbs:

.1 Hose Bibbs: Lockshield globe type with bronze body and trim suitable for maximum system operating pressure. Acceptable Products: Dahl 2316.

.2 Drain Valves: Ball type with brass body, cap and chain and chrome-plated brass ball. Acceptable Products: Kitz 58CC, Dahl 50430 Series.

.3 Stop and Drain Valves: Emco 10151, RW5046A or Dahl 521 Series.

.11 Solenoid:

.1 Slow closing solenoid valve, forged brass body, Buna "N" disc, stainless steel parts, enclosure to suit environmental conditions, UL and CAS approved, 120 V. Acceptable Products: ASCO

.12 Mixing:

.1 On both upstream hot and cold supplies, in accessible location, provide positive swing check valves and strainers. This requirement in addition to check valve device common to mixing valve. Where required, provide access panel to check valves and strainers. Cabinet type mixing valve to be equal to Moen 15440 or Cash Acme Heatguard 145 Series thermostatic mixing valve complete with valving in stainless steel cabinet.

.1 Acceptable Product: Powers Hydroguard LFLM490 Series.

2.7 Vacuum Breakers

.1 Pressure Type:

.1 CSA approved, mechanically independent, spring loaded poppet type check valve with a downstream spring loaded air inlet valve, with upstream and downstream isolation valves and test cocks. Acceptable Products: Cla-Val 38-VB/AR, Conbraco 4V-500, Febco 765, Watts 800M4FR, Wilkins 720A.

.2 Atmospheric Type:

.1 CSA approved, bronze body, chrome plate finish where exposed. Acceptable Products: Conbraco 38-100, Febco 710/715A, Watts 288A, 288AC, Wilkins 35, Cash Acme V-101 Series.

.3 Vacuum breakers size to match.

2.8 Backflow Preventers

.1 Double check valve assembly (DVA), factory assembled station to CSA B64.5. Acceptable Products: Watts Series 709, Ames 200 Series, CXm F-72, Cla-Val D, D2, Conbraco 40-100, Febco 805, Wilkins 950, MBD-10.

.2 Reducing pressure principle backflow prevention device (RPBP), with inlet and outlet shut-off valves, double check valve assembly, and differential relief outlet and repair/maintenance kit to CSA B64.10-M1984. Acceptable Products: Watts Series 909, Ames 4000 Series, CLA-Val RP, Conbraco 40-200, Febco 860, 867, 835YD, 825, Neptune 575, Wilkins 975, Beeco FRP Series.

2.9 Strainers

.1 Provide 4 to 1 ratio of basket open area to connecting pipe cross-sectional area, ‘Y’ pattern, 304 stainless steel screen.

.2 ¼” (6.0 mm) to 2” (50 mm), threaded ends, bronze body, 150 psi (1,034 kPa) rating.

.1 Acceptable Products: Red and White/Toyo 380, Crane 988-½, Armstrong, Sarco (Canada), Kitz 15, Metraflex Style BSFT.

.3 2-½” (65 mm) and larger, grooved or flanged ends, ductile or cast-iron body, 860 kappa rating.

.1 Acceptable Products: Victaulic Style 732PPS, Red and White/Toyo 381A, Crane 989-½, Armstrong, Sarco (Canada), Kitz 80, Metraflex Style TF-125, MAS W-40, Shurjoint 726Y or Shurjoint 728TEE Strainer.

2.10 Water Hammer Arrestors

.1 Bellows or piston manufactured style with stainless steel casing and welded stainless steel besting bellow if of the bellows style. Site fabricated air chambers are unacceptable. Acceptable Products: Zurn Z-1700 Series bellows style, Jay R. Smith 5000 Series, Amtrol-Mini-Trol, Watts SS-Series, Precision Plumbing Products Inc. 316 piston type, Wade Bellows or Piston Type Shockstops.

2.11 Thermometers and Pressure Gauges

.1 Refer to Section 22 05 22 Thermometers and Pressure Gauges for Plumbing.

2.12 Temperature and Pressure Relief Valves

.1 Design: ASME rated for energy input to system and pressure rating of equipment.

.2 Acceptable Products: Watts, Cash Acme.

2.13 Pipe Joints

.1 Solders and fluxes having lead content and self-cleaning acid type fluxes shall not be used.

.2 Copper to steel or iron and flanged adaptors shall be brass, not copper.

.3 All unions or similar interconnections between dissimilar metals shall be di-electric couplings.

.1 Copper silicon casting conforming to UNS C87850 with grooved and or/threaded ends. UL classified in accordance with NSF-61 for potable water service, and shall meet the low-lead requirements of NSF-372.

.1 Standard of Acceptance: Victaulic Series 647 or Shurjoint DE30-GG.

.2 Acceptable Products: Victaulic or Shurjoint di-electric waterway.

.4 Grooved Joints Lubricants: Lubricate gaskets with products supplied by the coupling manufacturer in accordance with published installation instructions. The lubricant shall be specifically for the gasket elastomer and system media.

2.14 Air Vents

.1 Design: Automatic float type, 150 psi (1,034 kPa) maximum operating pressure.

.2 Acceptable Products: Armstrong 11-AV, Maid-o-Mist 71, Taco 426, Amtrol, Metraflex Style MV-15, Caleffi 5020 MINICAL.

2.15 Hydrants and/or Hose Bibbs: Refer to Schedule on drawings

.1 Acceptable Products: Zurn, Watts, Jay R Smith, Mifab, Wade.

2.16 Trap Seal Primers

1. Acceptable Manufacturers:
   1. Watts, Zurn, JR Smith, Precision Plumbing Products
2. Provide all trap primers with physical air gap fitting at each outlet tube connection
3. Provide electronic type priming device c/w timer and 115V power connection to introduce regulated amount of water into trap at regular timed intervals.
   1. Acceptable Products: Precision Plumbing Products PT-12 or equivalent

4. When only a single fixture requires a trap primer then provide a single electronic type priming device piped to the floor drain requiring trap priming. Priming device to be c/w timer and 115v power connection
   1. Acceptable Products: Precision Plumbing Products Model SMP-500-115V or equivalent.

2.17 Water Heater and Tank (Electric)

.1 Glass-lined, electric hot water heater and tank, ASME construction, CSA listed, rated for 150 psi (1,034 kPa) working pressure.

.2 Plated copper elements, fully automatic controls, manually adjustable thermostat, 120 V control circuit powered by fused transformer.

.3 Extra density, vermin proof, glass fibre insulation with heavy gauge steel jacket finished with baked enamel finish over bonderized undercoat.

.4 Magnesium anode protection, heavy duty magnetic contactors and fuse protection against excessive current flows.

.5 Refer to Schedule on drawings.

.6 Acceptable Products: AO Smith, Ruud, Rheem, State, PVI, Bradford-White.

2.18 Expansion Tank for Domestic Hot Water System

.1 Welded carbon steel expansion tank, ASME construction, stainless steel connection, heavy duty butyl diaphragm, rigid polypropylene liner and integral floor stand, NSF-61 listed for potable water systems.

.2 Refer to Schedule on drawing.

.3 Acceptable Products: Amtrol ST-60V-C Therm-x-trol, State, Sparco, Flexcon.

2.19 Thermostatic Water Controllers

.1 Provide factory tested and assembled high/low flow thermostatic mixing valves complete with check valve, pressure reducing valve, volume control, shutoff valve and stem type thermometer on outlet; strainer stop check on inlet, mounted in lockable cabinet of 16 ga (1.61 mm) prime coated steel. Capacity, model and locations as scheduled.

.2 Field assembled systems will be accepted only where Manufacturer's Representative provides setup services after assembly and certifies in writing that valve has been properly adjusted and assembled. Manufacturers shall provide a seven year warranty against all failures on the thermostatic elements.

.3 For local thermostatic water controller with integral check stops, wall mounting bracket, rough chrome finish, removable cartridge with strainer and thermal motor. Provide one spare cartridge for each valve size on individual units.

.4 Inlet hot temperature to valves will be 140°F (60°C) to 160°F (70°C). Outlet temperature shall be set to 105°F (40°C).

.5 Acceptable Products: Lawler, Leonard, Symmons, Armstrong Digital Water Temperature Control, Cash Acme, Caleffi, Powers, Guardian.

2.20 Recirculation Pumps

.1 Pump between Heater and Tank:

- .1 Bronze body, bronze impeller.
- .2 Spring loaded coupler between motor and pump shaft, drip proof.
- .3 Bronze sleeve type bearing, resilient-mount.
- .4 Refer to Schedule on drawings.
- .5 Aquastat on tank to suit 115V rating.
- .6 Acceptable Products: Bell & Gossett, Armstrong, Taco, Grundfos, Wilo.

.2 Building Recirculation Pumps:

- .1 Bronze body, bronze impeller.
- .2 Spring loaded coupler between motor and pump shaft, drip proof.
- .3 Bronze sleeve type bearing, resilient-mount.
- .4 Refer to Schedule on drawings.
- .5 Acceptable Products: Bell & Gossett, Armstrong, Taco, Grundfos, Wilo.

2.21 Water Meter

.1 Arrange and pay for supply and installation of water meter.

.2 Water meter shall be supplied by Contractor and shall be to Municipal Standards.

.3 Hermetically sealed direct reading centre sweep register, one-piece cast bronze main case, rotating disc measuring chamber with flow control adjustment, magnetically driven, rated for 150 psi (1,034 kPa) service, reading in ft^3 (m^3) and flanged ends conforming to AWWA C700, AWWA C701 or AWWA C702. Acceptable Products: Neptune Trident 8, Rockwell, Hersey.

.4 Provide self-generating remote meter reader to suit municipal requirements. Provide conduit and wire from water meter location to remote reader location.

.5 Provide secondary dry contacts on water meters for connection to building Direct Digital Controls System. Division 25 controls contractor is to provide connection from water meter to building Direct Digital Controls Systems.

.6 Acceptable Products:

- .1 Up to 2" (50 mm): Schlumber Neptune T-10 Meter with ProRead ARB.
- .2 Greater than 2" (50 mm): Neptune Tru/Flo Compound Meter with ProRead ARB, Neptune High Performance Turbine Meter.

Part 3 Execution

3.1 Supply Piping (General)

.1 Upon completion, flush water piping systems with water before installing fixtures to remove any foreign material in piping. Clean plumbing fixtures and equipment and leave in good operating condition.

.2 Provide connections as required, including shutoff valves with unions or flanges to equipment installed by other trades.

.3 Ream pipes and tubes. Clean scale and dirt, inside and outside, before assembly. Remove foreign material from piping.

.4 Clamp cast-iron water pressure pipe at fittings with ¾" (19 mm) 316 stainless steel threaded rods and fasteners complete with required pipe retainer glands, adapters and harnesses to secure pipe sections and fittings together; OR provide proper anchors, thrust blocks and supports throughout.

.5 Reduce horizontal piping with eccentric reducer fittings installed to provide drainage and eliminate air pockets.

.6 Wherever dissimilar metals are joined or supported, provide non-conducting type connections or hangers to prevent galvanic corrosion. Brass adapters and valves are acceptable for pipe connections.

.7 Install piping to allow for expansion and contraction without stressing pipe or connected equipment.

.8 Provide clearance for insulation and access to valves, air vents, drains and unions.

.9 PEX piping is not an acceptable product for any facility water distribution piping

.10 For Victaulic or SHURJOINT grooved joints, pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket seating. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.

.1 Victaulic or SHURJOINT factory trained Representative shall provide on-site training for Contractor's field personnel in the use of grooving tools and installation of grooved joint products. Representative shall periodically visit the jobsite and review Contractor is following best recommended practices in grooved product installation. (Distributor's Representative is not considered qualified to conduct the training or jobsite visit(s).)

.11 When joining grooved ductile to grooved copper a di-electric waterway is necessary. The groove by groove Victaulic style #647 GG di-electric waterway shall be used, or Shurjoint DE30-GG.

3.2 Concealed Supply Piping

.1 Install concealed water supply piping to plumbing fixtures, trim items, equipment, hose bibbs, etc. using cast brass 90° drop ear elbow or drop ear tees, as the piping design dictates.

.2 Provide blocking within the concealed space and the elbows and tees shall be secured to the blocking using brass screws to provide a rigid installation.

.3 Do not install pipe in any part of wall where temperature is less than 9°F (5.5°C) under winter design conditions.

.4 Under no circumstances shall domestic cold water piping be routed in topping or floor slab.

3.3 Plumbing System Acoustical Requirements

.1 Minimum pipe size for suite fixtures, including supplies to faucets, shall be ½" (12 mm).

.2 Ensure no rigid contact between pipes and supporting framing and gypsum wall board.

.3 Do not secure piping to partition which forms part of adjacent suite.

.4 Wrap pipes with minimum ¼" (6.0 mm) thick Rubatex or Armaflex sleeving and secure over insulation using oversized clamps. If piping is insulated, this requirement is waved if clamps mount over insulation. Hard plastic pipe sleeves are not acceptable. An alternate is to provide resilient pipe mounting system such as Acoustoplumb

.5 Carry lavatory in back to back situations separately to waste stack; direct connections from back to back fixtures not acceptable.

.6 Oversize supply, waste and vent pipe penetrations of gypsum wall board by ⅛" (3.2 mm) to ¼" (6.0 mm), pipe centred in hole, gap caulked with silicone sealant and covered with escutcheon. This requirement does not eliminate need for firestopping. Refer to Section 23 05 05 Firestopping for firestop requirements.

.7 Do not allow pipe work to contact gypsum wall board, framing, conduit, electrical or ductwork fans connected to room services.

.8 Ensure water supply lines penetrating floors do not contact structure.

.9 Waste stacks and rainwater leaders shall not touch structure. Provide resilient support at floor penetration with neoprene pad isolators sized for minimum ⅜" (9.5 mm) static deflection. Neoprene pad isolators shall be equal to Mason "Super W". Ensure piping does not touch framing or gypsum wall board.

3.4 Valve Installation

.1 General:

.1 Where possible, disassemble solder end joint valves before soldering.

.2 Where disassembly and the subsequent reassembly are impossible, give special regard to solder jointing. Ensure valve parts are not melted or deformed during soldering.

.2 Shut-Off Valves:

.1 Install shut-off or isolation valves at the following locations:

.1 Where water service enters building.

.2 At base of each building riser.

.3 At each main branch supply point. Provide valve on each outlet leg from tee or cross.

.4 At each single plumbing fixture. Satisfied by provision of fixture stop where called up.

.5 At each piece of equipment.

.6 At points indicated on drawings.

.7 Where required by plumbing code.

.3 Balancing Valves:

.1 Install balancing valves in hot water recirculating branch lines and branch connections to return mains as indicated on drawings.

.4 Pressure Reducing Valves:

.1 Pressure reducing valve stations shall consist of the following:

.1 High-flow or main pressure reducing valve, one pipe size smaller than incoming building service, and shall be provided with strainer, reducer and shut-off valve on inlet side and reducer and shut-off valve on outlet side.

.2 Low-flow pressure reducing valve, 1" (25 mm), and shall be provided with strainer and shut-off valve on inlet side and shut-off valve on outlet side.

.3 Bypass around both pressure reducing valves with normally closed globe valve, which shall be same pipe size as incoming or outflowing building service, and pressure gauge and gauge cock on each side of globe valve. Bypass only PRV; do not bypass water meter or backflow prevention device.

.2 Set main pressure reducing valve at 60 psi (415 kPa) outlet pressure.

.3 Set small flow pressure reducing valve at 5 psi (35 kPa) higher outlet pressure than main pressure reducing valve.

.5 Drain Valves:

.1 Provide drain valves at low points in system.

.2 Install drain valves, ¾" (19 mm) minimum, or line size where piping is smaller than ¾" (19 mm).

.3 Install hose-end adaptor, cap and chain on discharge side of each drain valve or pipe to drain where indicated.

.6 Mixing:

.1 On up-stream hot and cold supplies, in accessible location, provide positive swing check valves and strainers. This requirement in addition to check valve device that is integral to mixing valve or downstream in mixed supply. Provide access panel to check valves and strainers.

3.5 Vacuum Breaker Installation

.1 Install at each fixture or item of equipment where contamination of domestic water system can occur and with CSA B64.10 requirements.

.2 Vacuum breaker installation shall be in accordance with manual “Cross Connection Control Manual” published by Pacific Northwest Section of American Water Works Association.

.3 Atmospheric type vacuum breakers shall be installed at least 12” (300 mm) above flood level rim of fixture.

.4 Provide drainpan with water deflection enclosure on concealed pressure type vacuum breakers with drain line to appropriate drain.

.5 Complete testing of vacuum breakers prior to final acceptance of plumbing systems. Certificate shall be submitted, signed and witnessed that testing was satisfactory.

3.6 Backflow Prevention Station Installation

.1 Install at each fixture or item of equipment where contamination of the water system can occur and in accordance with CSA B64.10 requirements.

.2 Pipe differential relief outlet to drain.

.3 Backflow prevention station shall be in accordance with manual “Cross Connection Control” published in the BC Section of American Water Works Association.

.4 Complete testing of reduced pressure principle backflow prevention devices shall be carried out under this section of work prior to final acceptance of plumbing systems. Certificate shall be submitted signed and witnessed that testing was satisfactory.

3.7 Strainer Installation

.1 Install strainer blow-off connections.

.2 Blow-off connections shall be full drain size and shall include:

.1 Up to 2” (50 mm) - nipple and cap (hot services).

.2 2-½” (65 mm) and larger - nipple, globe valve and nipple (hot services).

.3 All sizes (cold services) - plug blow-off connection only.

3.8 Flanges and Unions

.1 Provide on connections to pumps, reducing valves, control valves, fixtures, and equipment.

.2 Connections up to and including 2” (50 mm) size shall be bronze union, 150 psi (1,034 kPa) rating with ground seat. All larger connections shall be flanged.

.3 Unions not required in installations using grooved mechanical joint couplings. (Couplings shall serve as unions and disconnect points.)

3.9 Pressure Gauges

.1 Install pressure gauge at all pump suction and discharge points at inlet and outlet of all major equipment having more than a 4 psi (25 kPa) pressure drop and at each pressure reducing station inlet and outlet.

3.10 Water Hammer Arrestors

.1 Size in accordance with the Plumbing and Drainage Institute PD1-WH-201 sizing procedures.

.2 Install on branch lines to flush valves, solenoid valves, self-closing faucets, quick closing valves and other equipment incorporating solenoid valves.

.3 Install at the tops of all domestic water vertical risers, and as shown on the drawings.

3.11 Thermometers

.1 Install at domestic hot water storage tank inlet and outlet, and at heat exchanger inlet and outlets.

.2 Locate for ease of readability with sensing elements directly in contact with flowing medium and immediately adjacent to sensing elements.

.3 When installed to sense the water temperature in a pipe, install its sensing element in a non-ferrous, separable well filled with a heat conduction paste. Install the separable well in a form which minimizes the restriction to water flow, if necessary, in a section of oversized pipe.

3.12 Pipe Joints

.1 Install di-electric type couplings or fittings where copper piping and accessories connect to plumbing equipment such as steel storage tanks, pressure reducing stations and ductile iron pipe.

.2 Where water service enters building, terminate at edge of building with Smith Blair standard sleeve coupling having stainless steel nuts and bolts. Bridge excavation with ductile iron pipe.

.3 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.

.4 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.

3.13 Air Vents

.1 Install at high points in domestic hot water recirculation system.

.2 Install on tees. Do not install on horizontal piping or radiused elbows.

.3 Install ½" (12 mm) minimum isolating gate valve ahead of each air vent.

.4 Pipe air vent discharge connections separately to nearest building drain using ¼" (6.0 mm) hard drawn copper.

3.14 Hydrants and/or Hose Bibbs

.1 Provide operating keys to Owner for hose bibbs without attached handle.

.2 Provide isolating shut-off valve upstream of hose bibbs.

.3 Set exterior ground type hose bibb boxes flush and anchor in 18” (450 mm) square x 8” (200 mm) thick concrete collar set at 1” (25 mm) above surrounding grade.

.4 Connect drain ports on floor mount type hose bibbs indirectly to drainage system where such drainage ports are located within confines of building.

.5 Seal around perimeter of hose bibbs with silicone caulk. Where waterproof membrane is present, provide hose bibb with membrane clamp.

3.15 Trap Seal Primer Valves

.1 Provide floor drain trap primers in water closet rooms and other areas connected to sanitary sewer in accordance with Provincial Plumbing Code and as designated on drawings. Pipe material shall be Type L copper, NSF approved, polypropylene tubing or aquaper for buried and in-slab pipe connections.

.2 Locate at locations that are readily accessible by maintenance staff.

.3 Where electronic trap primers are used, the contractor shall include and allow for the complete installation and coordination with the electrical trade.

3.16 Hot Water Tanks and Heaters

.1 Provide temperature and pressure relief valves. Install so that probe properly senses temperature. Pipe relief port full outlet size to drain. Position discharge at drain to prevent splash-over.

.2 Provide vacuum relief valve and check valve on cold water supply.

.3 Provide isolating valves at tank and heater water connections.

.4 Provide corrosion resistant water tight pan under any hot water storage tank and/or hot water heater/storage tank in compliance with **BC Plumbing Code.**

3.17 Recirculation Pumps

.1 Pump between Heater and Tank:

   .1 Install in accordance with Manufacturer’s instruction.

   .2 Provide check valve on recirculation pump discharge and isolation valves up-stream of pump inlet and down-stream of check valve.

   .3 Provide electrical controls connection for the recirculation pump between heater and tank.

3.18 Testing and Inspection

.1 Testing shall consist of hydraulic pressure testing at 200 psi (1,380 kPa) for 8 hours.

.2 Comply with all requirements of Section 22 05 93 Testing, Adjusting and Balancing for Plumbing.

3.19 Flushing and Chlorination of Water Lines

.1 Thoroughly flush water piping until free from scale, sediment and debris as soon as possible after system filled with water.

.2 On completion of laying and testing, all water piping shall be pre-flushed, chlorinated and flushed again in accordance with AWWA C-651.

.3 Retain firm, qualified to supervise and inspect chlorination and flushing procedures and perform chemical biological tests as required.

.4 Mains shall be chlorinated to chlorine residual of not less than 10 ppm after standing for 24 hours. Hypochlorite and water is recommended as disinfectant. AWWA C-651 recommends amount of chlorine required.

.5 Submit to Consultant certificate from testing firm that chlorination and flushing has been successfully completed.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

.1 Interior sanitary waste and vent piping shall be provided as indicated on drawings from plumbing fixtures to the existing sanitary waste piping as indicated on drawings.

.2 Interior storm drainage piping and rainwater leaders shall be provided as indicated on drawings from roof drains, area drains, planter drains and catch basins to the exterior storm building service as indicated on drawings.

.2 Non-functioning existing interior sanitary waste and storm drainage piping shall be removed where access is readily available or capped off and abandoned in place as indicated on drawings.

Part 2 Products

2.1 Interior Drain Waste and Vent Pipe and Fittings

.1 Buried Pipe and Fittings:

.1 Class 4000 cast-iron mechanical joint pipe and fittings with mechanical joint stainless steel couplings to CAN/CSA-B70.

.2 Acrylonitrile-Butadiene-Styrene (ABS) Drain Waste and Vent Pipe Fittings.

.1 Conforming to CAN/CSA-B181.1 or,

~~.1~~.3 Polyvinyl Chloride (PVC) Drain Waste and Vent Pipe and Pipe Fittings conforming to CAN/CSA-B181.2

.2 Above Ground Pipe and Fittings:

.1 Class 4000 cast-iron mechanical joint pipe and fittings with mechanical joint stainless steel couplings to CAN/CSA-B70 up to 8" (200 mm).

.2 DWV copper drainage pipe with cast brass or wrought copper drainage pattern fittings with 50/50 Sn/Pb recessed Solder joints.

.3 IPEX System XFR for storm water servicing only, complete with approved firestopping accessories. Refer to Section 23 05 05 Firestopping for firestop requirements.

.4 IPEX System 15 for storm water servicing only when piping is not exposed. System 15 is not allowed in high rise applications or in return air plenums.

.5 Manufacturer of cast iron piping shall be certified to current standards of ISO-9001, ISO-14001,
OHSAS-18001 Standards, and must be made in North America, with recycled content stated on submission materials.

.1 Acceptable Manufacturers: Bibby Ste-Croix, Tyler Pipe, AB+I.

.6 No HUB couplings shall be certified to the current standard of CSA B602 and 3rd party listed to the current standard of CAN ULC/S102.2.

.1 Acceptable Products: Bibby St-Croix, Anaco, Tyler.

.7 Heavy duty stainless steel couplings shall be composed of a fully corrugated shield, neoprene gaskets and certified to the current standard of CSA B602 and 3rd party listed to the current standard of CAN ULC/S102.2.

.1 Acceptable products: Anaco/Husky HD2000, Tyler Wide Body, Clamp All 125.

.3 Pressurized Sanitary Storm (Force Main) Piping and Fittings

.1 Copper Type K or L hard tempered with solder joint fittings (above grade only).

.2 Schedule 80 PVC (DR12) pipe and pipe fittings complete with solvent joint fittings. Piping and fittings shall meet minimum flame and smoke spread ratings for the building type and construction.

.3 CPVC pipe and fittings complete with solvent joint fittings. All piping and fittings shall meet minimum flame and smoke spread ratings for the building type and construction equal to IPEX DWV System-15.

.4 Additional Requirements:

.1 Cast iron DWV system shall be connected with couplings that are certified to CSA-B-602 and third party listed to current ULC/S102.2 for flame and smoke spread ratings. Heavy-Duty, Shielded, Stainless Steel Couplings composed of a fully corrugated shield, a clamp assembly with a 3/8 inch gear screw tightened to 80 inch pounds, neoprene gaskets and listed to comply with CSA-B60 and Third party listed to current standard of CAN ULC/S102.2 ULC S102.2-10.

.1 Manufacturers: Anaco/Husky HD 2000 (Bibby Ste-Croix) or equal.

.2 Pressure waste piping from pumping stations and other equipment shall be pressure piping and fittings as specified for domestic water.

.3 Plastic (PVC or ABS) piping where used underground shall adapt to approved non-plastic material prior to penetration above the building slab.

.4 Copper to cast-iron joints shall be male brass adaptors to tapped fittings.

.5 Nipples shall be cast-iron or heavy brass.

.5 Acid resistant drain waste and venting.

2.2 Drains

.1 Floor drains connected to the sanitary system shall include trap primer connections from local water supply points at sinks, lavatories and as shown on the drawings.

.2 Provide drains as specified in Hose Bibb and Drain Schedule with lacquered cast-iron body (except as noted otherwise) and clamping collar.

.3 Provide drains by single Manufacturer throughout.

.4 Drains shall be 4" (100 mm) unless noted otherwise. Provide heavy duty H-20 bearing strength drain grates at all locations where vehicles and heavy traffic areas are located (including but not limited to entry vestibules, loading docks and aprons, maintenance garage bays, auto shop bays, metal shop bays, garbage rooms) and as indicated on the drawings.

.5 Roof drains shall include domes, screens, drainage grids, etc. Plastic component parts are not acceptable.

.6 Acceptable Products: Ancon, Enpoco, Jay R. Smith, Zurn, Mifab, Wade, Watts.

2.3 Pressure Waste Valves

.1 Plug type: full port valve, flanged ends, screwed ends are acceptable for valves smaller than 2" (50 mm).

.1 Up to 2" (50 mm) size - Keystone round port Ballcentric valve with flanged ends, Homestead #1512 Ballcentric with flanged ends.

.2 2" (50 mm) and larger - Keystone round port Ballcentric valve with flanged ends, Homestead #1522 Ballcentric with flanged ends.

.2 Check Valves:

.1 3" (75 mm) size and smaller: APCO rubber flapper, Terminal City outside lever and weight, ITT Flygt HDL Model 5087.

.2 4" (100 mm) size and larger: APCO series 6000 cushioned swing check valve complete with oil operated dash point, Terminal City outside lever and weight, ITT Flygt HDL Model 5087.

2.4 **Manholes (Sumps)**

.1 Formed bottom manholes: ASTM C478M, ASTM C478; reinforced precast concrete sections laid on cast-in-place reinforced concrete foundation pad as specified in Division 03

.1 Size 48" (1,200 mm) diameter.

.2 Cover: Standard cast iron with minimum sized pick hole and frame. Use heavy duty cover and frame in vehicular traffic areas.

.3 Steps: ¾" (19 mm) diameter galvanised steel on 16" (400 mm) centres.

.2 Acceptable products: AE Precast, Langely Precast, Fraserway Precast.

Part 3 Execution

3.1 Floor Drains

.1 Install floor drains at low points to provide proper drainage.

.2 Water piping from trap primer to floor drain shall be PEX tubing where cast into concrete and protected in a polyethylene sleeve where buried below slab. Provide Type L copper where exposed within building.

3.2 Roof Drains

.1 Install roof drains at low points on roof to provide proper drainage. Coordinate with roofing Contractor.

.2 Install in accordance with RCABC standards to maintain integrity of roof guarantee.

.3 Install integral expansion joints where roof drains are installed directly above rainwater leaders.

.4 Provide watertight seal in the gap between the flashing, pipe and cap on roof overflow drains to ensure water does not leak into the building interior during an overflow scenario.

.5 Verify style of roof drain with roofing details prior to submitting shop drawings.

3.3 Safes, Flashing and Vent Terminals

.1 Terminate vent terminals minimum of 1” (25 mm) above water level at which roof drainage overflows through roof overflow scuppers or drains.

.2 Cleanouts passing through walls or floors subject to hydrostatic pressure and waterproofed by means other than membrane shall be provided with clamping collars and flashings, tied directly to the cleanout clamping collar.

.3 Supply flashings to cleanouts and drains. Securely fix flashing clamps and extend 12” (300 mm) beyond edge of cast-iron fittings.

.4 Vent flashing minimum 18” (450 mm) x 18” (450 mm) base dimension shall terminate flush with top of 12” (300 mm) high vent pipe and gap between flashing and pipe shall be closed with aluminum cap 3” (75 mm) high. Main flashing shall not be turned over pipe. Vent installation detail to be compliant with RCABC Standard Construction Details

.5 Securely fix all roof drains and tie into roof membrane using membrane clamping collars. Installation to comply with RCABC Standard Construction Details

3.4 Piping

.1 Do not install ABS, PVC or other plastic piping upstream of where high temperature waste is directed.

.2 Do not install piping with glued joints at temperatures below those recommended by solvent Manufacturer.

.3 Refer to Section 23 05 05 Firestopping for firestop requirements.

.4 Joints to be connected with couplings as per Section 2.1.3.

.5 Support horizontal runs and brace at intervals and points as recommended by the Manufacturer and/or local Authority Having Jurisdiction.

.6 Support vertical stacks and assembles and brace as recommended by the Manufacturer and/or local Authority Having Jurisdiction.

3.5 Testing and Inspection

.1 Tests on sanitary and storm systems shall consist of hydraulic pressure testing of 5 ft water column (30 kPa) minimum and 25 ft water column (75 kPa) maximum for 8 hours. Check for proper grade and obstruction with ball test.

.2 Tests on sump pump discharge shall consist of hydraulic pressure testing of 50 psi (1,379 kPa) minimum for 8 hours.

.3 Air test in accordance with Plumbing Code may be used during freezing conditions.

3.6 Catch Basins, Sumps and Manholes

.1 For buried interceptors (all types), include interconnecting pipe installation when provided as part of the assembly by the supplier, and provide concrete pad(s) and hold down straps as indicated on manufacturers literature and installation instructions for buried interceptors. Coordinate with section 03 33 00.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Reference Standards:

.1 Carry out piping system work in accordance with CAN1-B149.1 for natural gas and BC Code Amendments.

1.3 Scope of Work

.1 Connect to utility company's natural gas meter set.

.2 Provide natural gas piping, fittings, valves, pressure regulators, unions, hangers and supports and other components as required for complete installation as indicated on drawings.

.3 Distribute natural gas to natural gas outlets, appliances and equipment that require natural gas service, including boilers, domestic water heaters, natural gas fired air handling units and plant equipment.

.4 Connect natural gas piping to existing natural gas piping at locations indicated on drawings.

.5 Remove unused or redundant natural gas piping throughout renovated or demolished areas of project where access is readily available, or cap off and abandon in place as indicated on drawings.

1.4 Quality Assurance

.1 Submit to Provincial Gas Inspection Department documentation and detailed drawings as required, pay for and obtain permit and approval for natural gas installation prior to commencing work.

.2 Materials and installations shall comply with CAN/CSA B149.1-10 Natural Gas Installation Code and British Columbia Code Amendments.

1.5 Painting and Colour Coding

.1 Painting of natural gas piping, equipment and material installed under this Division of specification shall be included under this Division of work.

.2 Paint exterior piping, including section of piping from gas meter to building entry, piping installed above roof, and piping installed in underground parking garages and exterior pressure regulating valve vent piping.

.3 Painting shall consist of one coat of Rust-Oleum 769 damp proof red primer, one coat of Rust-Oleum 960 zinc chromate and two finish coats of Rust-Oleum 850 yellow enamel paint.

.4 Provide yellow colour coding identification banding of the natural gas indoors piping as required by gas code. Also refer to Section 22 05 53 Identification for Plumbing Piping and Equipment.

1.6 Gas Utility Connection

.1 Arrange and pay for natural gas connection to gas utility’s distribution system. Contractor shall obtain shop drawings for gas fired appliances and equipment and supply gas input load information based on actual equipment being supplied and installed.

.2 Coordinate with gas utility company for natural gas service including installation of meter set located as indicated on drawings.

.3 Connect to gas utility’s natural gas meter set and enter building above grade. Seal space around pipe with backer rod and silicone sealant to provide weatherproof seal and leave neat, finished appearance.

Part 2 Products

2.1 Below Ground Piping

.1 No gas piping shall be installed below building.

.2 Below ground piping outside the building, provide SDR 13.5 polypropylene for up to 6” (150 mm) piping, rated to 50 psi (345 kPa), in accordance with CSA Z-662.

2.2 Above Ground Piping

.1 Schedule 40 seamless carbon steel to ASTM A53 and CSA B-63.

.2 Flexible connections and terminal appliance connections: Tracpipe Stainless Steel Tubing, maximum 3’-3” (1 m) long.

.3 Tracpipe corrugated stainless steel, but must be complete engineered system layout via supplier.

2.3 Fittings

.1 Screwed fittings to 2” (50 mm) diameter shall be malleable iron with beaded ends, Class 150 to ANSI B16.3.

.2 Welded fittings 2-½” (65 mm) and larger shall be forged steel of same weight as connecting pipe. Steel butt weld fittings to ANSI B16.9a. Steel pipe flanges and flanged fittings to ANSI B16.5.

.3 Unions shall be malleable iron with ground joints to ANSI B16.3.

.4 Threadolets or Weldolets Acceptable Products: Grinnell, Anvil, CCTF, Bonny Forge.

.5 Provide di-electric fittings where buried service enters and connects to building piping.

2.4 Joint Materials

.1 Screwed: Thread lubricant or Teflon paste.

.2 Teflon tape is not acceptable.

.3 Flanged: Full faced gasket materials to ANSI B16.20, ANSI B16.21 or ANSI B21.11, flanged steel weld neck, raised face type, carbon steel (ASTM A307) square headed bolts with hexagon nuts to ANSI B18.2.1 and ANSI B18.2.2. Bolt shall be full diameter of bolt holes.

2.5 Manual Isolation Valves

.1 Provincial Gas Department approved and suitable for temperature they are exposed.

.2 Screwed end valves to 2" (50 mm) and flanged end valves 2-½" (65 mm) and larger.

.3 Acceptable Products: Red and White/Toyo 5044A, Kitz 58.

2.6 Pressure Regulating Valves

.1 High tensile iron body with synthetic rubber diaphragm and valve disc.

.2 CSA listed for use in natural gas piping systems.

.3 Acceptable Products: Rockwell, Fischer.

2.7 Gas Valves

.1 NPS 2 and under, screwed.

.2 NPS 2-½ and over, flanged.

.3 Suitable for temperature to which exposed.

.4 Certified by Canadian Gas Association (CGA).

Part 3 Execution

3.1 Pipe Jointing

.1 Install piping in accordance with CSA B149.1-10, Natural Gas and Propane Installation Code.

.2 Cut pipe ends square, utilizing proper pipe cutting tools. Ream pipe ends and clean scale and dirt from inside and outside of pipe, before and after assembly.

.3 Protect openings in piping and equipment by capping or plugging to prevent entry of dirt or debris during construction.

.4 Slope piping down in direction of flow to low points and provide dirt legs with capped ends.

.5 Interior gas piping: Screw or weld up to 2" (50 mm), weld 2-½" (65 mm) and larger.

.6 Interior gas piping located in unvented spaces, in supply or return air ceiling plenums, or operating at 5 psi (35 kPa) pressure or higher; weld all sizes.

.7 Exterior Gas Piping: Weld all sizes except for polyethylene pipe which shall have no joints other than those allowed in CSA B149.1-10, Natural Gas and Propane Installation Code.

.8 Use welding tees to make branch connections, except those less than half diameter of main. Branch connection less than half diameter of main may be made with weldolets or threadolets.

.9 Use eccentric reducers at changes in pipe size, to provide for positive drainage.

.10 Remake leaking joints.

.11 Do not paint di-electric isolating couplings.

.12 Provide pressure regulators and lockable shut-off valves at discharge of gas meter before entry into building.

.13 Provide heat shrink factory extruded polyethylene sleeves over bare metallic pipe at welds.

.14 Joints:

.1 Gas service inside building – screw or weld NPS 2 and under. Weld NPS 2-½ and over.

.2 Gas service in ceiling plenums – weld all sizes.

.3 Gas service outside building – weld all sizes below ground.

3.2 Connections to Equipment, Appliances and Specialty Components

.1 Provide manual isolation valve on each branch line to individual piece of equipment, appliance and gas outlet or specialty component upstream of dirt legs, unions and flanges.

.2 Install unions or flanges on connections to pressure regulators, equipment, appliances and specialty components.

.3 Arrange piping connections to allow access and removal of equipment.

.4 Align and independently support piping connections to prevent piping stresses being transferred to equipment.

3.3 Manual Isolation Valves

.1 Install natural gas manual isolation valves complete with handles at the following locations:

.1 Locations indicated on drawings.

.2 Branch supply line from common meter set.

.3 Service entry to each building immediately prior to entry.

.4 Branch or riser connection from main.

.5 Upstream of pressure regulating valves.

.2 Building isolation valves shall possess locking lugs.

3.4 Seismic Actuated Shut-Off Valves

.1 Install natural gas seismic actuated automatic shut-off valves at service entry point to each building immediately prior to entry.

3.5 Pressure Regulating Valves

.1 Install pressure regulating valves in each equipment room or at each piece of equipment where natural gas supply pressure exceeds low pressure (WC).

.2 Pipe relief vent ports full diameter to atmosphere in accordance with requirements of CSA B149.1-10, Natural Gas and Propane Installation Code.

3.6 Natural Gas Outlets

.1 Provide natural gas outlets at locations indicated on drawings.

3.7 Vent Terminals

.1 Terminate vent outlets to atmosphere at the following minimum lateral distances:

.1 5'-0" (1.5 m) from door, openable window or building opening, including building mechanical exhaust opening and louvres.

.2 10'-0" (3.0 m) from mechanical forced air intake.

.2 Terminate vents with 180° down turn elbows, complete with insect screens.

3.8 Above Ground Exterior Piping

.1 Allow for expansion with suitable anchors, guides and expansion loops to prevent undue stress on system. Rigidly fasten anchors and guides to structural members through roof deck for roof mounted piping. Set roof supports in sheet metal gum pans wrapped into roofing. Coordinate with Roofing Sub-Trade.

.2 Piping shall be provided with approved flexible connectors at point of connection to gas fired equipment.

3.9 Buried Gas Piping Protection

.1 Heat shrink factory extruded polyethylene sleeves over bare pipe at weld.

.2 Employ independent testing agency to test continuity of polyethylene jacket, once piping is installed, using 12,000V Holiday Detector.

.3 Repair breaks in polyethylene jacket with two layers of Polyken tape.

.4 Submit report from testing agency certifying continuity of polyethylene jacket.

.5 Lay jacketed pipe on 6" (150 mm) bed of fresh water washed sand and arrange for 12" (300 mm) of fresh water washed sand over pipe.

3.10 Testing

.1 Pressure test piping in accordance with CSA B149.1-10, Natural Gas and Propane Installation Code.

.2 Examine joints for leaks and remake leaking joints with new materials.

.3 Purge piping after pressure tests in accordance with CSA B149.1-10, Natural Gas and Propane Installation Code.

.4 Submit copies of pressure test reports for piping.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Codes and Standards

.1 Fixtures shall display CSA approval where CSA standard is available.

.2 Plumbing fittings shall be to CAN/CSA B125, Plumbing Fittings.

.3 Plumbing fixtures shall be to CAN/CSA B45, 'General Requirements for Plumbing Fixtures'.

.4 Vitreous china plumbing fixtures shall be to CAN/CSA B45.1, 'Ceramic Plumbing Fixtures'.

.5 Enamelled cast-iron plumbing fixtures shall be to CAN/CSA B45.2, 'Enamelled Cast-iron Plumbing Fixtures'.

.6 Porcelain enamelled steel plumbing fixtures shall be to CAN/CSA B45.3, 'Porcelain Enamelled Steel Plumbing Fixtures'.

.7 Stainless steel plumbing fixtures shall be to CAN/CSA B45.4, 'Stainless Steel Plumbing Fixtures'.

.8 Plastic plumbing fixtures shall be to CAN/CSA B45.5, 'Plastic Plumbing Fixtures'.

1.3 Colour

.1 Vitreous china fixtures shall be white unless otherwise noted.

.2 Stainless steel fixtures shall be satin and/or mirror finish or combination thereof.

.3 Exposed plumbing brass and metal work shall be heavy triple chromium plated.

1.4 Quality

.1 Similar plumbing fixtures shall be by one manufacturer.

 .1 Standard of Acceptance: American Standard, Crane, Kohler, Caroma, Zurn Toto, Moen-Commercial, Sloan.

.2 Plumbing fixture supply brass shall be of one Manufacturer, unless otherwise specified.

 .1 Standard of Acceptance: American Standard, Crane, Kohler, Caroma, Zurn, Toto, Moen-Commercial, Delta-Commercial.

.3 Fixtures shall be free from flaws or blemishes. Surfaces shall be clear, smooth and bright and have dimensional stability.

.4 Plumbing fixtures and trim shall be new, unless otherwise noted.

.5 Visible or exposed parts, trim, supplies traps, tubing, nipples, escutcheons, check valves on diverter supply lines and valves to sanitary fixtures shall be chrome-plated finish, unless otherwise noted.

.6 Fittings shall have heavy duty stems.

.7 Roof drains, floor drains: Standard of Acceptance: J.R. Smith, Zurn, Wade, Watts, Ancon.

Part 2 Products: Refer to schedule on drawings

Part 3 Execution

3.1 Fixture Installation

.1 Connect fixtures complete with specified trim supplied, drains, accessory piping, vented traps, stops or valves, reducers, escutcheons and fittings for proper installation of fixtures and supply fittings.

.2 Provide necessary hangers, supports, brackets, reinforcements, steel back-up plates and floor flanges to set fixtures level and square. Mount fixtures so 200 lb (90 kg) mass will not loosen or distort mounting.

.3 Provide minimum 18 ga (1.27 mm) circular stainless steel shrouds for concealing services dropping to island or bench fixtures from ceiling spaces complete with ceiling and counter flanges. Diameter shall be to accommodate services; however, shrouds shall be same diameter in one room or area.

.4 Provide chrome-plated quarter turn mini ball valves for lavatories, sinks and tank type water closets.

.5 ABS P-traps and waste arms are not permitted.

.6 Water Closets:

- .1 Floor mounted water closets shall be connected to waste utilizing brass or cast-iron floor flanges with mechanical joint connections and wax seals.
- .2 Polished chrome flexible pipe supplied with metal compression rings are acceptable for tank type water closets. Supply shall incorporate ½" (12 mm) inlet x ⅜" (9.5 mm) compression outlet angle stop complete with 12" (300 mm) long flexible riser to fixture. PEX or other plastic supplies are not acceptable.
- .3 Provide 4" (100 mm) drain pipe connections and branch drains from all water closets. Use staggered wye connections at toilet branch drain connections; avoid flat double wye connections.
- .4 Provide extended spud pieces on handicapped water closets to accommodate closed toilet seat being raised.

.7 Lavatories and Sinks:

- .1 Polished chrome flexible pipe supplied with metal compression rings are acceptable. Supply shall incorporate ½" (12 mm) inlet x ⅜" (9.5 mm) compression outlet angle stop complete with 20" (500 mm) long flexible riser to fixture.
- .2 Double waste fittings for lavatories and sinks shall be double sanitary tee.
- .3 Control handles for two handle mixing faucets shall be positioned with cold control on right and hot control on left. Activation by rotating cold control handle clockwise and hot control handle counter clockwise.
- .4 Faucets shall be complete with nuts and tailpieces.
- .5 Provide gaskets and/or sealing washers to prevent entry of water into fixture trim, faucet holes or punchings in millwork.
- .6 Gooseneck spouts shall have clearance of 8" (200 mm) from nozzle tip to countertop, unless otherwise specified.
- .7 Plastic control handles and spouts are unacceptable.

.8 Lavatory and sink P-traps shall be complete with either a cleanout or slip joint connection.

.8 Urinals:

.1 Piping, fittings and P-traps from urinals shall not be copper; vents above urinal rim may be copper.

.2 Urinals shall have individual wastes.

3.2 Fixture Trim Holes or Punchings

.1 Fixture punchings for faucets or other trim shall match holes necessary for specified trim.

.2 Provide fixture and templates to applicable trades for holes and cut outs required in millwork.

3.3 Walls and Floors

.1 Fixtures mounted on glazed tile surfaces shall have ground faces to finished surface.

.2 Plumbing fixtures in contact with walls and floors, shall be sealed with Dow Corning anti-mildew 786 building sealant, made watertight and beaded smooth.

3.4 Water Hammer Arrestors

.1 Provide water hammer arrestors or shock absorbers on fixtures with flush valves and/or quick closing valves or solenoid valves.

3.5 Handicap Fixtures

.1 Water Closets:

.1 Install wall hung water closets designed for handicap use with top of seat 16" (400 mm) to 18" (450 mm) above finished floor.

.2 Install offset on handicap water closet flush valve connection to eliminate interference with grab bar mounting.

.3 Install flush valve so handle is facing transfer or non-grab bar side of water closet.

.4 Install flush valve so that hands free flush is coordinated to flush with the seat cover up.

.2 Lavatories and Sinks:

.1 Provide offset P-traps.

.2 Supplies shall accommodate offset P-trap.

.3 P-traps and waste arms shall be insulated with manufactured insulation kit or ½" (12 mm) of fibreglass insulation and finished with polyvinyl chloride jacket.

.4 Acceptable Manufactured Products: Truebro 'Handi Lav-Guard,' Brocar Products Inc. 'Trap Wrap,' Sexauer 'Handi Lav-Guard' Plumberex 'Handy Shield'.

END OF SECTION

Part 1 General

1.1 Conformance

.1 General Conditions, Supplements and Amendments shall govern this Division (read in conjunction with Instruction to Tenderers / Bidders). This section covers items common to all sections of Mechanical work and is intended to supplement requirements of Division 01. Refer also to Sections 21 05 06 and 22 05 00.

1.2 Work Included

.1 Provide complete, fully tested and operational mechanical systems to meet requirements described herein, in complete accordance with applicable codes and ordinances.

.2 “Provide” shall mean “Supply and Install” products and services specified.

.3 Provide materials, equipment and plant, of specified performance and quality, with current models with published, certified ratings for which replacement parts are readily available.

.4 Provide project management and on-site supervision to undertake administration, meet schedules, ensure performances, and coordination, and establish orderly completion and delivery of fully commissioned installation.

.5 Follow Manufacturer’s recommendations for installation, safety, access for inspection, maintenance and repairs. Provide access to motors, belts, filters and lubricating points. Install equipment to permit maintenance and disassembly with minimum disturbance to connecting piping or duct systems.

.6 Most stringent requirements of this and other mechanical sections shall govern.

.7 Work shall be in accordance with the Drawings and Specifications and their intent, complete with necessary components, including those not normally shown or specified, but required for complete installation.

.8 Provide seismic restraints for required equipment, piping and ductwork.

.9 Connect mechanical services to equipment furnished by Owner or other Sections, including start-up and test.

1.3 Standard of Acceptance

.1 Means that item named and specified by Manufacturer and/or catalogue number forms part of specification and sets standard regarding performance, quality of material and workmanship and when used in conjunction with referenced standard, shall be deemed to supplement standard.

.2 Acceptable product Manufacturers are listed within section where they are specified or in equipment schedules.

.3 Where two or more items of equipment and/or material, of the same type, are required, provide products of single Manufacturer.

.4 Visible Manufacturer’s nameplate shall indicate Manufacturer’s name, model number, serial number, capacity data, electrical characteristics and approval stamps.

.5 Provide new materials and equipment not less than quality specified and of current models with published ratings and available replacement parts. Equipment shall have ULC, CSA or ASME nameplates as required by Authorities having jurisdiction.

.6 Use same brand of Manufacturer throughout, unless otherwise specified, for each specification application of equipment or material.

.7 Replace materials less than specified quality and relocate work incorrectly installed as determined by Consultant.

1.4 Addition of Acceptable Manufacturers

.1 Equipment/material considered to satisfy specification, but of Manufacturer other than those named in section specifying equipment/material may be submitted in writing to Consultant for consideration not later than five working days prior to close of tender or bid depository Sub-Trade tender, whichever is earlier.

.2 Addition of Manufacturer’s names to specifications shall be by addendum only.

.3 Provide complete technical and performance equivalency comparison to specified equipment to show that proposed equipment is equal to, or better than the specified equipment.

1.5 Tender Inquiries

.1 Contractor queries during tender period shall be made in writing to Consultant. Contractor queries will be collected and suitable addenda issued for clarification. No verbal information will be issued by Consultant’s office during tender. Tender queries may be emailed, faxed, mailed, or couriered to Consultant’s office. No telephone questions will be answered.

1.6 Equipment List/Sub-Trades

.1 Unless requested otherwise, submit within seven days of contract award a list naming Sub-Contractors and Manufacturers of equipment to be used.

.2 Equipment list shall be full list of materials intended for installation.

1.7 Detailed Price Breakdown

.1 Provide to Consultant within 30 days of award of Contract, separate materials and labour breakdown. Progress payments shall not be processed until breakdown is received as follows:

- .1 Project start-up costs (shop drawings, permits, etc.).
- .2 Insulation and firestopping.
- .3 Vibration isolation.
- .4 Seismic bracing.
- .5 Plumbing.
- .6 Commissioning.
- .7 Fire protection.
- .8 Hot water heating.
- .9 Sheet metal.
- .10 Controls.
- .11 Verification of control systems.

.12 Balancing of air and water systems.

.13 Equipment and systems testing.

.14 Maintenance Manuals and Record Drawings.

.2 Contractor to provide materials and labour breakdown for each point listed on Consultant's change notice. Contractor also to receive same from affected Sub-Trades and submit their breakdown. Additional information to be provided as per Consultant's request.

1.8 Responsibilities

.1 Responsibility as to Division providing equipment or materials rests solely with General Contractor. Extras shall not be considered based on difference in interpretation of specifications as to which trade provides certain equipment or materials.

.2 Visit site before tendering. Examine local and existing conditions on which work is dependent. No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit site.

.3 Ensure equipment does not transmit noise and/or vibration to other parts of building, as a result of poor installation practice.

.4 Where Contract Documents do not contain sufficient information for proper selection of equipment for bidding, notify Consultant during tendering period.

.5 Examine Consultants' (architectural, code, landscape, structural, civil, electrical, food services) drawings plus Code Consultant's report and work of other trades to ensure work can be carried out. Conflicts or additional work not covered by drawings and specifications shall be brought to attention of Consultant before start of work.

.6 During freezing weather, protect materials such that no harm can be done to installations already in place and/or to materials and equipment on project.

.7 On completion of work, tools and surplus waste materials shall be removed and work left clean and operating correctly.

.8 Advise Consultant of specified equipment, material or installation which violates laws, ordinances or regulations.

1.9 Coordination and Supervision

.1 Employ FULL-TIME superintendent until total completion and defects and deficiencies are rectified. An amount of **$6,000.00** will be included in addition to deficiency holdback at substantial completion to ensure full-time superintendent remains on site until work is certified totally performed.

.2 Check drawings of trades to verify space and headroom limitations for work to be installed. Coordinate work with trades and make changes to facilitate satisfactory installation.

.3 Drawings are diagrammatic and approximately to scale unless detailed otherwise. They are not intended to show structural details or architectural features. Contract Documents establish scope, material and installation quality and are not detailed installation instructions.

.4 Install distribution systems and equipment generally in locations and routes shown, close to building structure avoiding interference with other services or free space.

.5 Work out interference problems on site with other trades and coordinate work before fabricating, or installing any material or equipment. Where necessary, produce interference drawings. Ensure materials and equipment fit into allotted spaces and equipment can be properly serviced and replaced. Extras for improper coordination and removal of equipment to permit remedial work shall not be considered.

.6 When open web structural joists are used, obtain structural shop drawings to ensure adequate space is available for installation of pipes and ductwork.

.7 Coordinate with other divisions including, but not limited to the following:

- .1 Electrical requirements for mechanical equipment and devices requiring electrical power and connection to fire alarm/annunciator panels for mechanical equipment.

.8 Mechanical Contractor shall provide following services:

- .1 Coordinate mechanical work.
- .2 Follow up on material and equipment deliveries, review shop drawings and produce interference drawings.
- .3 Ensure Sub-Trades are installing work properly.
- .4 Ensure interconnecting phases with Mechanical are covered.
- .5 Review cost breakdown, progress claims and cost submissions for mechanical work.
- .6 Resolve and direct responsibility for warranty.
- .7 Provide digital photographs of progress as specified.

1.10 Inspection of Work

.1 Consultant Representative shall review work prior to being concealed. Piping below ground must be reviewed prior to covering.

.2 Work shall be approved by authorities having jurisdiction.

.3 Openings shall be sealed, in particular in fire rated walls and floors. Sealing shall be inspected prior to covering.

1.11 Permits

.1 Obtain required permits and pay fees and comply with Provincial, Municipal and other legal regulations and bylaws applicable to work.

.2 Arrange for inspection of work by authorities having jurisdiction. On completion of work, furnish final unconditional certificates of approval by inspecting authorities.

.3 Contractors and Sub-Contractors responsible for installation of smoke control and sprinkler systems shall be made available to demonstrate sequence of operation and interconnection with other life safety/fire protection systems at coordinated site inspection with Authority Having Jurisdiction for occupancy permit.

1.12 Codes, Regulations and Standards

.1 Mechanical work shall conform to the following codes, regulations and standards, and other codes in effect at time of award of Contract, and any others having jurisdiction. The applicable version of each code and standard shall apply unless otherwise specified in the contract documents:

- .1 Bylaws.
  - .1 Local Building Bylaws.
- .2 Canadian Gas Association.
  - .1 National Standard of Canada CAN/CGA-B149.1 (latest edition). - Natural Gas Installation Code.
- .3 Province of British Columbia
  - .1 BC Safety Authority Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation.
  - .2 BC Building Code.
  - .3 BC Amendment to Canadian Electrical Code.
  - .4 BC Electrical Safety Branch Bulletins.
  - .5 BC Code Amendments, Gas Safety Act and Regulations.
  - .6 BC Industrial Health and Safety Regulations, Workers' Compensation Board of British Columbia.
  - .7 BC Fire Code.
- .4 SMACNA Publications
  - .1 HVAC Duct Construction Standards.
  - .2 Fire, Smoke and Radiation Damper Installation Guide.
  - .3 Guidelines for Seismic Restraints of Mechanical Systems.

.2 Where specifications specifically indicate requirements more onerous than aforementioned codes, these requirements shall be incorporated.

1.13 Warranty

.1 Equipment and systems shall be warrantied for one year. Provide written certifications to Owner. Provide extended warranty certificates on equipment as applicable and specified.

.2 Use of equipment or systems during construction shall not alter warranty period or represent acceptance of work or equipment.

.3 Warranty coverage shall include labour and material to correct defective equipment, workmanship, material and building damage caused by failure of same.

.4 Warranties shall be effective from date of Substantial Completion

1.14 Workmanship

.1 Workmanship shall be in accordance with established practice and standards accepted and recognized by Consultant and Contractor.

.2 Tradesmen engaged in installation of work covered within Mechanical shall be qualified in accordance with requirement of Tradesmen Qualification Act and pertinent licensing requirement required by Ministry of Municipal Affairs.

.3 Note requirements of BCICA Quality Assurance certificate to cover all thermal insulation work.

1.15 Performance Verification of Installed Equipment

.1 Installed mechanical equipment may be subject to performance verification as specified herein if required by Consultant.

.2 When performance verification requested, equipment shall be tested to determine compliance with specified performance requirements.

.3 Consultant will determine by who shall carry out testing. When requested, Contractor shall arrange for services of independent testing agency.

.4 Testing procedures shall be reviewed by Consultant.

.5 Maintain building comfort condition when equipment removed from service or testing purposes.

.6 Promptly provide Consultant with test reports.

.7 Should test results reveal that originally installed equipment meets specified performance requirements, Owner will pay costs resulting from performance verification procedure.

.8 Should test results reveal equipment does not meet specified performance, equipment will be rejected and the following shall apply:

  .1 Remove rejected equipment. Replace with equipment which meets requirements of Contract Documents, including specified performance requirements.
  .2 Replacement equipment may be subject to performance verification as well, using same testing procedures on originally installed equipment.
  .3 Contractor shall pay costs resulting from performance verification procedure.

1.16 Drawings and Measurements

.1 Drawings are diagrammatic and are intended to indicate scope and general arrangement of work and are not detailed installation drawings. Do not scale drawings. Obtain accurate dimensions from Architectural and Structural drawings.

.2 Consult Architectural drawings and details for exact locations of fixtures and equipment. Obtain this information from Consultant where definite locations are not indicated.

.3 Take field measurements where equipment and material dimensions are dependent upon building dimensions.

1.17 Phased Construction

.1 See Architectural specifications and drawings, including instructions to tenderers/bidders, for construction phasing. Make allowances to phase work in accordance with project phasing.

.2 Existing services and existing building must be maintained in operation. Provide and install temporary services as required.

.3 Trades in this Division shall make allowance for implications of having to complete work in new addition before proceeding with work in existing building.

1.18 Sequence of Work

.1 Before interrupting major services, notify Owner and arrange acceptable schedule for interruptions.

.2 Before interrupting services, complete preparatory work as far as possible and have materials on site and prefabricated (where practical) and work continuously to keep length of interruption to minimum.

.3 Include for cost of work that may be required out of regular hours to minimize period of service interruption when connecting into existing systems.

1.19 Building Operation during Construction

.1 In order to minimize operation difficulties for building staff, trades must cooperate with Owner throughout construction period and particularly ensure that noise is minimized.

.2 Convenient access for staff and public to building must be maintained. Minor inconveniences and interruption of services will be tolerated, provided advance notice is given, but Contractor shall to coordinate his work, in consultation with Owner, so operation of facility can be maintained as nearly normal as possible.

1.20 Existing Services

.1 Work shall include relocation of and/or connection to existing equipment, piping and ductwork as indicated and as required. Make good equipment, insulation, piping and ductwork damaged during work. Cap abandoned ductwork and piping at nearest main, cap at roof level for vents, and cap at floor level for drains. Systems shall be restored to match existing standards or as specified.

.2 Arrange work to avoid shut-downs of existing services. Where shut-downs are unavoidable, obtain Owner's approval of timing and work to minimize any interruptions. Interruption of fire services shall be in accordance with local authorities.

.3 Shut-downs, to permit connections, will be carried out by maintenance staff.

.4 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping and ductwork may be required.

.5 Be responsible for any damages to existing systems by work.

.6 Carefully dismantle existing equipment where equipment is turned over to Owner. Do not re-use existing materials and equipment unless specifically indicated.

.7 Balance existing systems extended to addition or disturbed during renovation.

.8 Drawings indicate approximate location of existing hidden or underground facilities where known and applicable. Exact locations shall be confirmed on site. Exercise caution for unknown services.

.9 Calibrate new and existing building control systems affected by work.

.10 Verify location of existing work and structures before fabrication of work. No compensation shall be allowed for extra work caused by failure to verify site conditions.

.11 If existing system are used during construction, provide filters as required to maintain normal system operation. Clean equipment to pre-construction state at completion of work. Provide cleaning of existing equipment that runs during construction to maintain proper operation.

1.21 Shop Drawings

.1 Submit shop drawings in the format and quantity specified in the general conditions for all equipment indicated and proposed for as ACCEPTABLE PRODUCT in the section where they are specified or in the equipment schedules. A comprehensive listing of mechanical equipment and materials complete with the expected submission dates shall be submitted to Consultant within 30 days of contract award. Consultant reserves right to modify list.

.2 Eight sets of shop drawings shall be submitted in photocopied form as discussed with Consultant in accordance with British Columbia MCA format including the following information:

- .1 Cover sheet.
- .2 Physical and dimensional data.
- .3 Service space requirements.
- .4 Electrical requirement data.
- .5 Performance data.
- .6 Manufacturers' specifications.
- .7 Installation instructions.
- .8 Starting instructions.
- .9 Maintenance instructions.
- .10 Operating instructions.

.3 Fan and pump submissions shall include performance curves (charts are not acceptable).

.4 Include radiated, discharge and inlet sound power levels for major pieces of mechanical equipment.

.5 Do not include non-applicable information. Non-applicable information shall be removed entirely or crossed out from shop drawing.

.6 Cover sheet shall include the following information:

- .1 Title, number of pages, Contractor, Supplier, Manufacturer, date of submission.
- .2 Place for Consultant's review stamp 4" (100 mm) x 3" (75 mm)
- .3 Related partied involved in Contractor's pre-submission review (Mechanical and General Contractors).
- .4 Related parties involved in Consultant's review.
- .5 Area allocated for comments.

.7 Maintain one complete copy of reviewed shop drawings on site in indexed 3-ring binder.

.8 Shop drawings not prepared as described above shall not be reviewed by Consultant.

.9 Do not order equipment or materials until shop drawings have been accepted by Consultant.

.10 Related mechanical equipment and materials shall be submitted together. Shop drawings not properly submitted with related equipment shall be held until related shop drawings submitted.

.11 Submit in imperial (SI Metric) units to match those specified.

.12 Consultant's review of shop drawings shall not relieve Contractor from compliance with specified requirements. Installed materials and equipment shall meet specified requirements whether or not shop drawings are reviewed by Consultant.

.13 Shop drawing review by Consultant shall provide the following certification: "Reviewed for general design and compliance with the contract documents. Dimensions and suitability for site condition are the responsibility of the Contractor. Coordinate electrical requirements with the Electrical Contractor. This review of drawing shall not relieve the Contractor from complying with the conditions of the contract documents."

1.22 Duct and Pipe Mounted Control Equipment

.1 The following automatic control equipment will be supplied by Controls Contractor but installed by appropriate trade sections of Mechanical Contract:

- .1 Automatic control valves.
- .2 Temperature control wells.
- .3 Pressure tappings.
- .4 Flow switches.
- .5 Automatic control dampers.
- .6 Static pressure sensors.
- .7 Water check meters.
- .8 Gas check meters.
- .9 BTU meters.

1.23 Temporary Heating

.1 Do not use permanent systems for temporary heat without written permission from Consultant.

.2 Clean and overhaul equipment used during construction. Restore to original working condition. Replace equipment or components not operating properly. Replace mechanical seals in pumps used for temporary heating regardless of condition.

.3 Use of permanent systems for temporary heat shall not modify terms of warranty.

.4 Operate systems under conditions which ensure no permanent damage with safety devices and controls installed and fully operational. Operate water systems with specified water treatment.

.5 Operate fans at design resistance with temporary 60% dust spot efficiency filters installed and filter media on return and exhaust air outlets. Change filters at regular intervals and record type, model and quantity of filters used during construction on LEED® document for EQ credit 3.1. Clean dirty ducts with industrial power vacuum equipment as directed by Consultant.

.6 Provide alarm indicating system failure on systems used for temporary heat.

1.24 Temporary or Trial Usage

.1 Temporary or trial usage by Owner of mechanical equipment supplied under this contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.25 Spare Parts

.1 Provide spare parts as follows:

- .1 One set of packing for each pump.
- .2 One casing joint gasket for each size pump.
- .3 One head gasket for each heat exchanger.
- .4 One glass for each gauge glass installed.
- .5 One set of V-belts for each piece of machinery.
- .6 One filter cartridge for each filter installed (pre- and final filters).

1.26 Project Close-Out Requirements

.1 The project closeout requirements are specifically listed in each section of this specification. Refer to detailed specifications in each section for further, detailed requirements.

1.27 Semi Final Inspection

.1 Perform the following before semi-final field review:

- .1 HVAC systems capable of operation with automatic controls in operation with alarms functional.
- .2 Tests on systems and equipment completed and certificates of approval obtained from Authorities.
- .3 Rough balance of **air** and **water** systems completed.
- .4 Firestopping completed. Refer to Section 23 05 05 Firestopping for firestop requirements.
- .5 Valve tagging completed and equipment, ductwork and piping identified. Escutcheons installed.
- .6 Equipment lubricated in accordance with Manufacturer's data.
- .7 Extended warranty form mailed to Manufacturer and copy provided to Owner.
- .8 Systems chemically cleaned and flushed, strainers cleaned and water treatment initiated. Equipment drains installed. Manufacturer's report on acceptability of treatment obtained.
- .9 Submit sample of Operating and Maintenance Manuals.
- .10 Ensure access doors suitably located and equipment accessible.
- .11 Written report submitted by Manufacturer's Representative on noise and vibration control devices including flexible connections.
- .12 Seismic sway bracing and restraint systems installed.
- .13 Check operation of plumbing systems and fixtures. Ensure fixtures are solidly supported.
- .14 Fan plenums cleaned and permanent filters installed.
- .15 Ensure electrical connections to mechanical equipment are complete and motor rotation correct.
- .16 For packaged, self-contained HVAC equipment, Manufacturer's checkout list completed. Copies forwarded to Consultant and included in Maintenance Manuals.
- .17 Turn all digital photography files over to Consultant with dates of photos and locations taken from.

.18 Provide BCICA Quality Assurance certificate documentation.

1.28 Substantial Completion Requirements

.1 Consultant shall issue checklist for completion by Contractor before Substantial Completion Field Review. Provide written declaration that work is complete. The following items shall be complete before Substantial Completion Field Review:

.1 Piping expansion compensators and flexible connections checked by Supplier – inspection report filed with Commissioning Agent.

.2 Seismic restraints inspected by Suppliers' Professional Engineer and report has been filed with Commissioning Agent. Schedule S Letter of Assurance from Seismic Engineer submitted.

.3 All access doors and panels are in place and not painted closed.

.4 HVAC piping systems have been cleaned, flushed and all final strainer baskets are in place. Provide copy of test reports.

.5 Boiler(s) started and efficiency checks performed by factory trained personnel, with start-up checklists and test sheets submitted and filed with the Commissioning Agent.

.6 Heat Pump start-up sheets and performance check has been done by Suppliers' representative, reports file with Commissioning Agent.

.7 Ductwork has been cleaned, provide letter of verification to Commissioning Agent and this Consultant.

.8 Draft balancing reports have been submitted to this consultant.

.9 Commissioning Checklists for operational readiness and safety checks have been submitted to this Consultant.

.10 Controls pre-operational readiness checklists (end to end checks and sequences of operation) have been verified and submitted to this Consultant.

.11 All control devices have been calibrated and checked for proper operation. Submit report through Commissioning Agent.

.12 Final draft Mechanical Maintenance Manuals have been submitted for review to this Consultant.

.13 Draft Record drawings (marked up whiteprints or ACAD files) have been submitted to this Consultant for review.

.14 The most recent Site Review (inspection) Report has been re-submitted to this Consultant with all outstanding items either crossed off and initialled as "Done", and outstanding items noted with "Time to Complete" or "by others" with a clear statement of who the "others" are and that they have been alerted to perform the rectification of the deficient work.

.15 Confirmation that training sessions have been arranged and set up for the Owners' operating personnel for Controls and Systems Operation.

.16 Refer to requirements in Section 21 05 06 and Section 22 05 00 for plumbing and fire protection systems.

.2 Complete the Substantial Completion Checklist as attached as Appendix A of this section.

1.29 Deficiency Holdbacks and Deficiency Inspections

.1 Work under this Division, which is still outstanding when substantial completion is certified, will be considered deficient and a sum equal to minimum twice the estimated cost of completing that work will be held back.

Part 2 Products

2.1 Operating and Maintenance Manuals

.1 Acceptable Agencies: KD Engineering, Inland Technical Services, Central Interior Air Balancing Ltd., West Rockies Services and RA Bruce and Associates.

.2 Provide services of acceptable agency to prepare proper documentation and instruction to Owner in operation and preventative maintenance of mechanical equipment and systems. Complete and turn over documentation two months before Substantial Completion. Provide proposed table of contents and first draft of General Systems Description to the consultant for review prior to preparing full O&M Binders.

.3 Provide three 8.5" (216 mm) x 11" (280 mm) capacity extension type ACCO Model P5426-E to suit thickness required plastic coated catalogue binders with hot stamped lettering front and spine. One copy of final manuals to remain with Consultant during warranty period. Provide electronic format for Maintenance Manuals, to contain all of the same content as the hard copy. The electronic format shall be arranged in a searchable, segmented format using ADOBE.pdf with both Page Content and Bookmark formatting. Scanned material will not be accepted. Provide the electronic format Maintenance data on CD-ROM disks with labels to match the hard copy format. Where possible and as available, include Maintenance and Operation videos from equipment Suppliers and Manufacturers that demonstrate Maintenance procedures

.4 Each binder shall be indexed with custom made tab dividers (9 point oriole Bristol divider paper stock) with sequentially numbered colour index tabs of laminated Mylar plastic. Tab colours shall be orange for 1.0, 1.1, 1.2, 1.2 … series tabs, green for 2.0, 2.1, 2.2… series tabs, yellow for 3.0, 3.1, 3.2… series tabs, red for 4.0, 4.1… series tabs. The following indexing system shall be used:

 .1 Tab 1.0 - Mechanical Systems: title page with clear plastic protection cover.

 .2 Tab 1.1 - List of Mechanical Drawings: provide list of mechanical drawings.

 .3 Tab 1.2 - Description of Systems: provide description of each system with summer or winter operating variances and controller operating setpoints.

 .4 Tab 1.3 - Operating Division: provide operating description of each major component and how components interface with other components, operation of controls including operational sequences for summer or winter, troubleshooting sequences and safeguards to check if equipment goes offline.

 .5 Tab 1.4 - Maintenance and Lubrication Division: provide preventative maintenance and lubrication schedule for each major component including weekly, monthly, semi-annual an maintenance schedule requirements or pneumatic, electronic and DDC systems.

 .6 Tab 1.5 - List of Equipment Suppliers and Contractors: provide list of equipment suppliers and Contractors, including addresses and telephone numbers. Furnish list of spare parts for each piece of equipment such as bearings, seals v-belts, filters, etc.

.7 Tab 2.0, 2.1, etc. - Certification: provide copies of WHMIS safety data sheets. Include copy of test data, cleaning and chemical treatment program, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed, equipment alignment certificates, copy of valve tag and pipe colour identification schedules and inspection approval certificates for plumbing and natural gas systems.

.8 Tab 3.0, 3.1, etc. - Shop Drawings and Maintenance Bulletins: provide materials received in compliance with Shop Drawings.

.9 Tab 4.0 - Balance Reports: provide copies of balance reports.

.5 Submit documents to Consultant for review before turning over to Owner.

.6 Obtain shop drawing information for Mechanical equipment and include in appropriate section.

2.2 Record Drawings and Digital Photographs

.1 Digital photographs of project shall be taken before covering or concealing underground piping and/or service in walls, concealed ceilings, furring or shafts. Photographs shall be emailed to the Consultant at infocanada@integralgroup.com with the Consultant's job number and project name clearly indicated on the email. Identify each photo with the date and location the photograph was taken from within the same email.

.2 Prior to each FIELD REVIEW, the Contractor shall ensure one set of white prints clearly marked (for Consultant inspection) indicating any changes and deviations from Contract Documents, including any work by change orders and job instructions plus:

.1 Alterations to ductwork, piping, mechanical equipment and associated work.

.2 Inverts of services at key points within building, entering and leaving building and at property line. Dimension to services in relation structure and building, entering and leaving building grid lines for buried services, manholes, catch basins and outside shutoff valves.

.3 Locations of concealed piping, conduit and equipment such as fire dampers, cleanouts, service valves and access doors.

.3 If the marked up white prints are not available for inspection, 5% of the progress payment is automatically deducted.

.4 Before substantial completion, turn marked up white prints over to Consultant. Include a cash allowance of $8,000 for Consultant to transfer site changes to AutoCAD files and provide two sets of white prints marked "Record Drawings" and electronic AutoCAD files on a CD ROM disk to the Owner. The contractor may provide the CAD record drawings at their own cost under this cash allowance in lieu of having the consultant provide the CAD services.

2.3 Access Doors

.1 Acceptance Products: Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.

.2 Supply flush mounted access doors, for installation in ceilings and walls, to permit servicing of mechanical equipment and accessories, inspection of life safety or operating devices, and where specifically indicated.

.3 Unless otherwise noted, access doors shall be minimum: 24” (600 mm) x 24” (600 mm) for body entry, 12” (300 mm) x 12” (300 mm) for hand entry, 8” (200 mm) x 8” (200 mm) for cleanout access. Access doors in building surfaces shall be at least as large as duct access panels accessed through them and shall be oversized when necessary. Size to suit masonry modules when located in masonry wall.

.4 Locate access doors so concealed items are readily accessible for adjustment, operation and maintenance. Locate in service and storage areas wherever possible. Do not locate in paneled, feature or special finish walls, without prior approval of Consultant.

.5 Access doors in fire separations of ¾ hour rating and higher, and firewalls shall have compatible fire rating and ULC label with tamper-proof latch and be self-closing.

.6 Minimum Requirements:

.1 180 degree door swing, mitered rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, steel prime coated.

.2 Plaster or wet wall construction: 14 ga (1.99 mm) bonderized steel flush with wall or ceiling type with concealed flange.

.1 Acceptable Product: Acudor PS-5030.

.3 Masonry or drywall construction: 16 ga (1.61 mm) for 16” (400 mm) x 16” (400 mm) and smaller, 14 ga (1.99 mm) for 18” (450 mm) x 18” (450 mm) and larger bonderized steel face of wall type with exposed flange.

.1 Acceptable Product: Acudor UF-5000.

.4 Tile, ceramic tile, plaster or wet wall construction in washrooms and other special areas: 14 ga (1.98 mm) stainless steel flush with wall or ceiling with concealed flange.

.1 Acceptable Product: Acudor PS-5030 stainless.

.5 Acoustical tile ceiling and similar block materials: 14 ga (1.99 mm) bonderized steel recessed ceiling type.

.1 Acceptable Product: Acudor AP-5010 or AT-5020.

.6 Feature wall construction: Recessed wall type selected to complement and conform with architectural module, treatment, or paneling, size shall conform to adjacent finished areas.

Part 3 Execution

3.1 Concealment

.1 Conceal piping, ductwork and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.

.2 Do not install piping and conduit in outside walls or roof slabs unless specifically indicated. When required, install them inside the building insulation.

3.2 Access

.1 Install work to be readily accessible for adjustment, operation and maintenance. Furnish access doors where required in building surfaces for installation by building trades.

.2 Provide ¾" (19 mm) diameter brass/aluminum/stainless steel number tags or "Allflex" plastic tags with type or service and valve number stamped in black, secured to valve wheel with key chain for all valves. Provide typewritten valve directory giving number, service and location. For valves hidden in suspended ceilings, provide flexible plastic film with permanent pressure-sensitive adhesive type label on the ceiling grid indicating location of valves. Include in Maintenance Manuals and under glass, wall mounted, location determined by Consultant.

3.3 Protection of Work

.1 Protect equipment and materials, stored or in place, from weather, moisture, dust and physical damage.

.2 Mask machine surfaced finishes and edges. Secure covers over equipment openings and open ends of piping, ductwork and conduits, as installation progresses.

.3 Equipment having operating parts bearing on machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.

.4 Refinish damaged or marred factory finish.

.5 Air systems shall have temporary air filters installed before fans are operated. Install new air filters before system acceptance.

3.4 Cutting, Patching, Digging, Canning and Coring

.1 Lay out cutting, patching, digging, canning and coring required to accommodate mechanical services. Coordinate with other Divisions.

.2 Refer to Structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls. Openings through Structural members shall not be made without approval of Consultant.

.3 Be responsible for correct location and sizing of openings required under Mechanical, including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.

.4 Verify location of existing service runs and steel reinforcing within existing concrete floor and walls prior to core drilling and/or cutting. Cost of repairs to existing services and structural components damaged as a result of core drilling and cutting will not be considered.

3.5 Fastening to Building Structure

.1 General:

  .1 Do not use inserts in base material with compressive strength less than 2,000 psi (13,790 kPa).

  .2 Inserts shall have factor of safety of 4.

  .3 Power/powder actuated fastenings and drop-in anchors are not permitted to be used for tensile loading (i.e. suspension of mechanical equipment) or for seismic anchorage and/or restraint.

.2 Types:

  .1 Cast-in-place type:

    .1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.

    .2 Cast-in Anchor: Hilti HCI-MD.

.3 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 8" (200 mm) pipe size.

.4 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 8" (200 mm) pipe size.

.5 Screw concrete insert, Grinnell Fig. 152 for up to 12" (300 mm) pipe size.

.2 Drilled, mechanical expansion type:

.1 Hilti HSL-3 or UCAN LHL heavy duty anchor for using in concrete with compressive strength not less than 2,840 psi (19.6 kPa).

.2 Hilti Kwik-Bolt-3 or UCAN WED stud anchor for concrete (do not use in seismic restraint applications).

.3 Hilti HDI or UCAN IPA drop-in anchor for concrete. Where ever possible, HDI's or drop-in anchors shall be avoided in tension zones of concrete (i.e. underside) due to cracking of concrete and reduct holding value.

.4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.

.5 Hilti Metal-HIT or UCAN Zamac pin bolt (light duty) for concrete and masonry

.3 Drilled, adhesive type:

.1 Hilti HVA or UCAN Adhesive Anchor consisting or anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.

.2 Hilti HY150- MAX-SD or RE500-SD consisting of anchor rod with a two part adhesive system.

.3 For use in concrete housekeeping bases (in vertical downward position) where distance to edge of concrete base could cause weakness if mechanical expansion type anchor were used.

.4 Rod assemblies shall extend minimum 2" (50 mm) into concrete slab below housekeeping bases.

.3 Installation:

.1 Drilling for inserts shall be performed using appropriate tool specifically designed for insert. Diameter and depth of each drilled hole shall be exact dimensions as specified by insert Manufacturer.

.2 Refer to Manufacturer's recommendations for tightening torques to be applied to inserts.

.3 Where specifically called for, drills shall include a dust vacuum system, Hilti DRS Dust Vacuum System.

3.6 Service Penetrations in Rated Fire Separations

.1 Refer to Section 23 05 05 Firestopping for firestop requirements.

3.7 Service Penetrations in Non-Rated Separations

.1 Piping, tubing, ducts, wiring, conduits, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of separation with silicon sealant to prevent passage of smoke and/or transmission of sound.

3.8 Pipe Sleeves

.1 Provide pipe sleeves for piping passing through rated walls and floors. Sleeves shall be concentric with pipe.

.2 Pipes and ducts passing through fire rated separations that have no fire resistance (non-rated separations) do not require sleeve, but insulation at separation shall be wrapped with 24 ga (0.70 mm) thick galvanized sheet steel band for application of flexible caulking compound.

.3 Pipe sleeves for floors and interior walls shall be minimum 24 ga (0.70 mm) thick galvanized sheet steel with lock seam joints.

.4 Pipe sleeves for perimeter walls and foundation walls shall be cast-iron sleeve or Schedule 40 steel pipe with annular fin continuously welded at midpoint and protruding 6" (150 mm) beyond sleeve diameter. Annular fin shall be embedded into centre of wall.

.5 Pipe sleeves for wet or wash down floor areas such as washrooms, janitors rooms, laboratories and mechanical equipment rooms shall be Schedule 40 steel pipe.

.6 Except as otherwise noted, pipe sleeves are not required for holes formed or cored in interior concrete walls or floors.

.7 Pipe sleeves shall extend 2" (50 mm) above floors in unfinished areas and wet areas and ¼" (6.0 mm) above floors in finished areas.

.8 Pipe sleeves shall extend 1" (25 mm) on each side of walls in unfinished areas and ¼" (6.0 mm) in finished areas.

.9 Pipe sleeves shall extend 1" (25 mm) beyond exterior face of building. Caulk with flexible caulking compound.

.10 Sleeve Size: ½" (12 mm) clearance all around, between sleeve and pipe or between sleeve and pipe insulation.

.11 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.

.12 Packing of Sleeves:

.1 Where sleeves pass through foundation walls and perimeter walls, space between sleeve and pipe or between sleeve and pipe insulation shall be caulked with waterproof fire retardant non-hardening mastic.

.2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.9 Escutcheons and Plates

.1 Provide on pipes passing through finished walls, partitions, floors and ceilings.

.2 Plates shall be stamped steel, split type, chrome-plated or stainless steel concealed hinge, complete with springs, suitable for external dimensions of piping insulation. Secure to pipe or finished surface. For pipes passing through suspended ceilings and annulated piping passing through walls, outside diameter shall cover opening or sleeve.

.3 Where pipe sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.

3.10 Equipment Supports

.1 Provide stands and supports for equipment and materials supplied.

.2 Lay out concrete bases and curbs required under Mechanical. Coordinate with Division 3. All concrete work is under Division 3.

.3 Concrete bases shall be minimum 4" (100 mm) thick, or as noted and shall project at least 6" (150 mm) outside bedplate, unless otherwise directed. Bases and curbs shall be keyed to floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases.

.4 Equipment with bedplates shall have metal wedges places under edges of bedplates to raise them 1" (25 mm) above base after levelling. Wedges shall be left permanently in place. Fill space between bedplate and base with non-shrink grout - Embeco or In-Pakt.

.5 Construct equipment supports of structural steel or steel pipe. Securely brace. Employ only welded construction. Bolt mounting plates to structure.

.6 Support ceiling hung equipment with rod hangers and/or structural steel.

3.11 Equipment Installation

.1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to piping and duct systems and without interfering with building structure or other equipment.

.2 Provide means of access for servicing equipment including permanently lubricated bearing.

.3 Pipe equipment drains to floor drains

.4 Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

3.12 Mechanical and Electrical Coordination of Responsibilities

.1 All starters motor control centres, etc., along with input and output power wiring shall be by the Electrical Contractor. This is with the exception of packaged equipment.

.2 Packaged equipment shall have integral starters and only power feeders will be provided. The packaged equipment starters shall be provided by the Mechanical Contractor.

.3 Electrical Contractor shall provide all remote disconnect switches.

.4 All control wiring (including BAS), except fire alarm, shall be provided by the Mechanical Contractor. This also includes Mechanical 120 volt control wiring, and interlock, and control wiring between controls transformers and low voltage terminal equipment, including infrared flushometers and transformers.

.5 Unless specifically noted otherwise, voltage for motors ½ HP and larger shall be 600 V 3-phase, and voltage for motors smaller than ½ HP shall be 120 V single-phase or 208 V 1- or 3-phase.

.6 All multi-speed motors shall be consequent pole, permanent split capacitor type or electronically-commutated motors.

.7 All motors for mechanical equipment shall be by the Mechanical Contractor.

.8 Thermistor protection to be provided on motors 25 HP and larger using approved thermistors as part of the Mechanical Scope of Work.

.9 Thermistors will be provided by Mechanical Contractor.

.10 Electrical Contractor shall provide manual reset devices for motor starters for thermistor interface (only for starters that are provided by Electrical Contractor).

.11 All fire alarm work shall be done by the Electrical Contractor. Electrical Contractor shall provide all relays for interface to control wiring for fan shutdown and fan start-up for air handling units used as part of the smoke control system(s) and any other hard-wired mechanical components connected for fire alarm interlocks.

.12 Electrical Contractor shall wire smoke dampers with end switches to reflect open and closed status.

.13 All end switches shall be provided by the Mechanical Contractor.

.14 Electrical Contractor shall wire EP switches for smoke damper control. Life safety control wiring and relays to interface to general control wiring shall be provided by the Electrical contractor (refer to Mechanical Specification for type of smoke dampers that have been specified).

.15 All relays required for Mechanical Contractor shall be provided by the Mechanical Contractor.

.16 Mechanical Contractor shall provide all pressure switches, supervisory valves, flow switches, dry pipe alarm valves, etc. for interface to fire alarm system. All wiring of these items shall be provided by the Electrical Contractor.

.17 All electric tracing shall be by the Mechanical Contractor with power connections by the Electrical Contractor. All electric tracing shall be 208 V unless specifically noted otherwise. All electric tracing shall be self-limiting type of cable. Mechanical Contractor shall provide loads for the circuits to the Electrical Contractor for connection requirements.

.18 All level switches for sump pumps shall be wired by the Mechanical Contractor.

.19 Variable speed motor drive controllers and motors shall be installed by the Mechanical Contractor, and be complete with load and line side filters/reactors.

- .1 The controller shall be specified with the following characteristics:
  - .1 Line side voltage distortion shall not exceed 3%.
  - .2 Line side current distortion shall not exceed 10%.
  - .3 Line and load sides shall be provided with chokes to prevent any transient or harmonic distortion being backfed into the main power supply. Provide a 5% reactor on the line side and the output shall be provided with an output filter consisting of a reactor and a capacitor.
- .2 Power for the VSD control circuit shall be taken from the line side contactor, but after the line side choke for the drive fault relay.
- .3 Drive BX cabling shall be provided between the VFD and VFD motor.
- .4 Refer to VFD mounting details on drawings which reflects the responsibilities for supply of power and control wiring.

.20 Mechanical Contractor shall provide Transient Voltage Surge Suppressor for all of their microprocessor based equipment, i.e. BAS, etc.

.21 Mechanical Contractor and controls contractor shall provide the Electrical Contractor with locations where power circuits are required for mechanical control systems, i.e. Electronic Devices (trap primers, infrared plumbing trim, etc.) control transformers BAS panels, etc.

.22 Should the Mechanical Contractor change or modify motor sizes or electrically powered mechanical equipment from what is reflected on the Bid Documents during any stage of this project, they shall be responsible to cover all associated electrical costs for the changes, such as revised motor starter and feeds etc.

3.13 Miscellaneous Metal/Metal Fabrications

.1 Be responsible for miscellaneous steel work relative to Mechanical, including, but not limited to:

.1 Support of equipment

.2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork, heat exchangers, hot water storage tanks, expansion tanks, fans and mechanical equipment.

.3 Earthquake resistant devices - refer to Section 23 05 49.

.4 Access platforms, ladders and catwalks.

.5 Pipe anchor and/or support posts.

.6 Ceiling ring bolts - secure to structure or steel supports.

.7 Pipe protection at columns in vehicle and receiving areas.

.2 All steel work shall be primed and undercoat painted ready for finish under Division 9. Refer to drawings for details.

.3 Coordinate with and comply with Section 05 50 00 Metal Fabrications.

3.14 Flashing

.1 Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floors and roofs.

.2 Flash, vent/soil pipes penetrating roofs with aluminum 18" (450 mm) x 18" (450 mm) (base dimension) sheet. Flashing shall terminate flush with top of 12" (300 mm) high vent pipe. Gap between flashing and pipe shall be closed with separate aluminum cap 3" (75 mm) high. Main flashing shall not be turned over pipe. Vent installation to be compliant with RCABC Standard Construction Detail 10.3. For pipes through outside walls turn flange back into wall and caulk.

.3 Flash floor drains over finished areas to floor waterproof membrane. Fasten floor membrane to drain clamp device.

.4 Provide curbs for mechanical roof installations 8" (200 mm) minimum high above roof insulations. Flash and counterflash with galvanized steel or aluminum, made waterproof.

.5 Provide continuous neoprene safes for built-up mop sinks, and shower stalls located above finished rooms. Solder at joints, flash into floor drains and turn up 6" (150 mm) into walls or to top of curbs and caulk into joints.

3.15 Di-Electric Couplings

.1 Provide wherever pipes of dissimilar metals are joined.

.2 Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2.

.3 Provide felt or rubber gaskets to prevent dissimilar metals contact.

.4 Acceptable Products: Capital, Walter Vallet, EPCO.

3.16 Lubrication of Equipment

.1 Lubricate new equipment prior to operating, except sealed bearings, which shall be checked.

.2 Use lubricant recommended by Manufacturer for service.

.3 Extend lubricating connections and sight glasses to outside of housings, where lubricating positions are not readily accessible.

.4 Submit check list, showing that operated equipment has been lubricated prior to and during any temporary heating period and demonstration and instruction period.

3.17 Painting

.1 Finish painting of piping and ductwork shall be carried out by other trades. Refer to Division 9 - Finishes.

.2 Provide factory finish on manufactured items. At completion, touch up damaged surfaces to match original. Do not paint over nameplates.

3.18 Equipment Protection and Clean-Up

.1 Protect equipment and material in storage, on site and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Mechanical equipment stored on site shall be kept in dry, heated and ventilated storage area.

.3 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign material.

.4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.5 Provide, install and maintain 30% efficient temporary filters to return and exhaust air openings from ceiling spaces to prevent air born dust from entering ducts, plenums and coils. Install filters to return air grilles when fans are operated and building is not clean.

3.19 Start-Up

.1 Before starting equipment or systems, provide certificate stating plant is ready for start-up and the following conditions have been met.

  .1 Safety controls installed and fully operational.

  .2 Qualified personnel available to operate plant.

  .3 Permanent electrical connections made to equipment.

  .4 Boilers started up and adjusted by Manufacturer’s Representatives.

  .5 Heat Pumps started up and adjusted by Manufacturer’s Representative.

  .6 Air filters installed.

  .7 Pump and fan drives properly aligned by journeyman millwright.

  .8 Mechanical equipment rooms, including plenums, vacuum cleaned.

3.20 Turnover Seminar for Operating Staff

.1 At completion of project, Mechanical Contractor shall organize and conduct two day seminar to instruct Owner and Representatives in operation and preventative maintenance of equipment and systems.

.2 Provide services of qualified personnel, including Sub-Trades, major equipment suppliers and Consultant to attend seminar and instruct on his equipment or system(s). Seminar shall be chaired by Mechanical Contractor.

.3 Mechanical Contractor shall submit agenda and list of Representatives to Consultant for approval 30 days before seminar. Confirm attendance by written notification to participants, followed by verbal confirmation before seminar date.

.4 At seminar, submit final copies of Record Drawings and Operating and Maintenance Manuals to Owner.

.5 Mechanical Contractor shall submit to Consultant, written follow-up of seminar complete with attendance list and signed acceptance from the operating staff representative indicating they have accepted the demonstrations and instructions. Coordinate with the commissioning agent for project deliverables.

APPENDIX "A'
MECHANICAL CHECKLIST FOR SUBSTANTIAL COMPLETION

Date: ____________________

Project No: ____________________

Project Name: ____________________

Mechanical Contractor: ____________________

Contractor is to initial all items that have been completed and fax or email checklist back to Integral Group (604-687-1802) 48 hours prior to final review. For any items that are not applicable to your project, please mark "N/A" in the right side of the column

1. GENERAL

.6 Maintenance Manuals submitted to Consultant for review. ________

.7 Letter of Completion from control sub-trade forwarded and documentation forwarded. ________

.8 All certification, test and inspection certificates submitted (refer to requirements at the end of this checklist). ________

.9 Record Drawings completed, checked and submitted for mechanical and plumbing. ________

.10 Record Drawings completed, checked and submitted for fire protection. ________

.11 Record Drawings completed, checked and submitted for heat reclaim system. ____

.12 Confirm program for warranty period, including site visits and assistance to Owners for operations and maintenance and controls. Extended warranty forms completed. ____

.13 Performance tests carried out. ________

.14 Cleanup completed (air filters, strainers, etc.). ________

.15 Confirm access to components (valves, dampers, etc.). ________

.16 Thermometers, pressure gauges and filter gauges in place. ________

.17 Flexible connections and isolators free from binding. ________

.18 Painting, identification and valve tagging completed. ________

.19 Equipment lubricated and accessible for maintenance. ________

.20 Balancing completed or nearing completion. ________

.21 Vibration and sound control checked. ________

.22 Insulation repaired and proper finish applied including BCICA Quality Assurance Certificate Submission. ________

.23 Pipe, duct and equipment identification completed. ________

.24 Firestopping completed. ________

.25 "Residential Unit Completion Checklist" completed for each suite (see attached). ____

Part 4 **PLUMBING**

.1 All backflow preventers installed and functioning. ____________

.2 Plumbing fixtures cleaned and water flows adjusted. ____________

.3 Proper access to all cleanouts confirmed. ____________

.4 Confirm that roof and floor drains are located at low points. ____________

.5 Equipment drains taken to hub or funnel drain. ____________

.6 Expansion and contraction provisions satisfactory. ____________

.7 Domestic hot water system functioning properly. ____________

.8 Equipment and units isolated and provided with union or flanges. ____________

.9 Thermometers and gauges installed. ____________

.10 Gas connections to all equipment completed and inspected. ____________

Part 5 **FIRE PROTECTION and life safety SYSTEMS**

.1 Sprinkler systems tested and inspected as per NFPA 13. ____________

.2 Fire protection extinguishers installed. ____________

.3 Spare sprinklers and cabinet provided. ____________

Part 6 **HOT WATER HEATING/HYDRONIC SYSTEMS**

.1 Chemical cleaned piping and treatment charged. ____________

.2 Expansion tank charged. ____________

.3 Terminal units operating. ____________

.4 Radiant panels have clearance for expansion and insulation backing installed. _____

.5 Heating coils operating. ____________

.6 Element fins combed and cleaned. ____________

.7 Pumps running smoothly. ____________

.8 Boiler test fired and results submitted. ____________

Part 7 **CHILLED WATER SYSTEMS**

.1 Chemical cleaned piping, feed pump installed and treatment charged. ____________

.2 Expansion tank charged. ____________

.3 Cooling coils operating. ____________

.4 Pumps running smoothly. ____________

.5 Heat trace and freeze protection installed and tested. ____________

.6 Heat Pump controls tested and operating. ____________

.7 Heat Pump commissioned test and results submitted. ____________

Part 8 **VENTILATION SYSTEMS**

.1 Air handling equipment installed and commissioned. ____________

.2 Equipment controls commissioned and tested. ____________

.3 Ductwork and plenums cleaned. ____________

.4 Air outlets adjusted. ____________

.5 Clean air filters provided. ____________

.6 Ductwork noises eliminated. ____________

.7 Balancing dampers installed. ____________

.8 Fire and smoke dampers installed and tested. ____________

.9 Drive pulley adjusted for design conditions. ____________

.10 Cooling coil condensate drains installed. ____________

Part 9 **ROOFTOP HVAC EQUIPMENT**

.1 Shipping blocks removed. ____________

.2 Sound levels confirmed as satisfactory. ____________

.3 Start-up reports completed. ____________

.4 Controls check out and operate properly. ____________

.5 Seismic attachments complete. ____________

.6 Traps installed on condensate drains. ____________

.7 Thermostats mounted and programmed. ____________

.8 Roof-mounted exhaust fans secured on bases. ____________

Part 10 **DDC/CONTROLS SYSTEMS**

.1 Panel layout sheets complete with point name, point address and wire identification number. One copy attached to each respective panel door. ____________

.2 All points tagged with point name, point address and panel number. ____________

.3 “As-built” control drawings submitted. ____________

.4 “As-built” program flowcharts submitted. ____________

.5 “As-built” ladder wiring diagrams showing all hardware interlocks submitted.__________

.6 Complete Operator’s Manual submitted (including apparatus and Maintenance Manual for all sensors, transducers, solid state relays, etc.). ____________

.7 Turnover seminar and instructions to Owner completed. ____________

CERTIFICATES AND LETTERS OF CERTIFICATION ARE REQUIRED FOR THE FOLLOWING:
[Copies to be faxed to Integral Group (604-687-1802) and included in the Maintenance Manual as per Section 23 05 00.]

.1 Plumbing, piping test certificates (water, sanitary and storm). ____________

.8 Gas piping tests and certifications inspections from Gas Safety Branch and/or gas fitters form letter. ____________

.9 Sprinkler system certification from the Sprinkler Engineer confirming system installation to NFPA 13 with seal. ____________

.10 Contractors Material and Test Certificates for above-ground and below ground piping for sprinkler system. ____________

.11 Verification of proper operation and indication of sprinkler system components on fire alarm panel. ____________

.12 WHMIS requirements completed. ____________

.13 Heating system pressure test certificates of installation. ____________

.14 Cooling system pressure test certificates of installation. ____________

.15 Geoexchange system pressure test certificates of installation. ____________

.16 Report on Chemical Treatment, glycol charging and test results submitted.__________

.17 Backflow preventer test certificates. ____________

.18 Boiler start-up and combustion tests. ____________

.19 Heat Pump start-up ____________

.20 Sealed certification from Seismic Engineer for seismic restraint system. ____________

.21 Megger and capacitance tests on trace cable with verification from supplier for each circuit. ____________

.22 Start-up reports for each piece of refrigeration equipment ____________

.23 Letter of Completion from control sub-trade, including: ____________

.1 Seven day acceptance testing of control system completed.

.2 Control calibration check sheets.

.3 Confirmation of proper control and sequencing of components.

.4 Control system “as-built” with setpoints.

.5 Items under DDC system below.

Date Returned to Integral Group:____

Submitted By:____

Signed By:____

DOCUMENTATION REQUIRED FOR MECHANICAL SUBSTANTIAL COMPLETION

The following documents, or copies of, are to be submitted for release of the substantial completion of the project and release of Integral Group's Schedule C-B. These documents are to be submitted 48 hours prior to the Consultant walkthrough.

The following must be submitted and cannot be accepted as a deficiency:

- Schedule C-B for Sprinklers.
- Schedule C-B for Seismic Restraint and anchorage for Mechanical Equipment.
- Commissioning Report.
- Fire Alarm Verification Report.
- Fire Damper Test Letter from Contractor.
- Municipal/City Plumbing Final Certificate.
- Heat Trace Report for Sprinkler System.
- Provincial Gas Inspection Certificate or sign off letter from gas fitter.
- Firestop Shop Drawings and Material Data Sheet Submission.
- Certificate for Chlorination of Domestic Water Systems.

The following items are to be submitted, but can be held as a deficiency and payment will be withheld until submissions are complete:

- HVAC Air Balancing Report.
- Water Balancing Report of Hydronic Systems
- Shop drawings for all mechanical equipment.
- Refrigeration Contractor Certification Letter.
- Material Test Certificates.
- Warranty Letter from Mechanical Contractor for Warranty period.
- Operation and Maintenance Manuals.
- As-built record drawings.
- Photographs taken during construction and for underground services/concealed piping.
- BCICA Quality Assurance Certificate

END OF SECTION

Part 1 General

1.1 Related Documents

.1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

1.2 Definitions

.1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 General Description of the Work of this Section

Only tested firestop systems shall be used in specific locations as follows:

.1 Penetrations for the passage of duct, piping, and other mechanical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

.2 Repetitive plumbing penetrations in fire-rated floor assemblies. Penetrations exist for the installation of tubs, showers, aerators and other plumbing fixtures.

1.4 Related Work of Other Sections

.1 Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:

- .1 Section 03 30 00 - Cast-In-Place Concrete
- .2 Section 04 05 00 - Masonry Work
- .3 Section 07 84 00 - Firestopping
- .4 Section 09 29 00 - Gypsum Drywall Systems
- .5 Section 21 05 06 - Common Work Results for Fire Protection
- .6 Section 23 05 00 - Common Work Results for HVAC
- .7 Section 23 07 13 - Duct Insulation
- .8 Section 23 07 16 - HVAC Equipment Insulation
- .9 Section 23 07 19 - HVAC Piping Insulation
- .10 Section 22 05 00 - Plumbing

1.5 References

.1 Test Requirements: CAN/ULC-S115-11, "Standard Method of Fire Tests of Through Penetration Fire Stops".

.2 Underwriters Laboratories of Canada (ULC) of Scarborough runs CAN/ULC-S115-11 under their designation of ULC-S115-11 and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.

Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their “Products Certified for Canada (cUL) Directory.

Omega Point Laboratories runs ASTM E-814 and publishes the results annually in their "Omega Point Laboratories Directory"

.3 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

.4 CAN/ULC-S102-M, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 Test Requirements: ASTM G-21, "Standard Test for Determining Resistance of Synthetic Polymeric Materials to Fungi". Materials used under this section must carry a "Level 1" or lower test rating.

.6 All major building codes: NBC, OBC, BCBC, and ABC.

.7 NFPA 101 - Life Safety Code

1.6 Quality Assurance

.1 A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

.2 Firestop System installation must meet requirements of CAN4-S115-M or ULC S-115-M tested assemblies that provide a fire rating as shown in Section 2.03 Clauses J & K below.

.3 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

.4 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

.5 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's firestop custom detail derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Firestop custom detail drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).

1.7 Submittals

.1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 1300.

.2 Manufacturer's engineering judgment identification number and drawing details when no ULC or cUL system is available for an application. Engineer judgment must include both project name and contractor's name who will install firestop system as described in drawing.

.3 Submit material safety data sheets provided with product delivered to job-site.

.4 Submit signed letter from firestopping installation firm on company letterhead certifying penetrations of fire suppression piping through vertical & horizontal rated separations have been firestopped in accordance with ULC-S115.

1.8 Installer Qualifications

.1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

.2 The work is to be installed by a contractor with at least one of the following qualifications:

- .1 FM 4991 Approved Contractor
- .2 UL Approved Contractor
- .3 Hilti Accredited Fire Stop Specialty Contractor (HAFSC)

.3 Installer shall have minimum 3 years of experience with fire stop installation.

1.9 Delivery, Storage, and Handling

.1 Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and ULC or cUL label where applicable.

.2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

.3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.

.4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

.5 Do not use damaged or expired materials.

1.10 Project Conditions

.1 Do not use materials that contain flammable solvents.

.2 Scheduling

- .1 Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
- .2 Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.

.3 Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

.4 Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

.5 During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

Part 2 Products

2.1 Firestopping, General

.1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

.2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

.3 Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

2.2 Acceptable Manufacturers

.1 Subject to compliance with through penetration firestop systems listed in U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory, provide products of the following manufacturers as identified below:

- .1 Hilti (Canada) Corporation, Mississauga, Ontario

  1-800-363-4458/www.ca.hilti.com
- .2 Nuco
- .3 3M
- .4 Tremco
- .5 JV Firestop

.2 Alternatives not listed in Part 2.2.1 will not be accepted.

2.3 Materials

.1 Use only firestop products that have been ULC-S115 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

.2 Pre-Installed firestop devices for use with non-combustible and combustible pipes (closed and open systems) penetrating concrete floors and/or gypsum walls, the following products are acceptable:

- .1 Hilti Cast-In Place Firestop Device (CP 680-P)
  - .1 Add Aerator Adaptor when used in conjunction with aerator system.
- .2 Hilti Tub Box Kit (CP 681) for use with tub installations.
- .3 Hilti Cast-In Place Firestop Device (CP 680-M) for use with non-combustible penetrants.
- .4 Hilti Speed Sleeve (CP 653) for use with cable penetrations.
- .5 Hilti Firestop Drop-In Device (CFS-DID) for use with non-combustible and combustible penetrants.
- .6 Hilti Firestop Block (CFS-BL)
- .7 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.3 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:

.1 Hilti Intumescent Firestop Sealant (FS-ONE MAX)

.2 Hilti Self Leveling Firestop Sealant (CFS-S SIL SL)

.3 Hilti Fire Foam (CP 620)

.4 Hilti Flexible Firestop Sealant (CP 606)

.5 Hilti Elastomeric Firestop Sealant (CFS-S SIL GG)

.6 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.4 Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:

.1 Hilti Elastomeric Firestop Sealant (CFS-S SIL GG)

.2 Hilti Flexible Firestop Sealant (CP 606)

.3 Hilti Intumescent Firestop Sealant (FS-ONE MAX)

.4 Hilti Self Leveling Firestop Sealant (CFS-S SIL SL)

.5 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.5 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:

.1 Hilti Intumescent Firestop Sealant (FS-ONE MAX)

.2 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.6 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems) tested to 50 Pa. differential, the following products are acceptable:

.1 Hilti Firestop Collar (CP 643N)

.2 Hilti Firestop Collar (CP 644)

.3 Hilti Wrap Strips (CP 648E/648S)

.4 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.7 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

.1 Hilti Firestop Mortar (CP 637)

.2 Hilti Firestop Block (CFS-BL)

.3 Hilti Fire Foam (CP 620)

.4 Hilti Firestop Board (CP 675T)

.5 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.8 Non curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:

.1 Hilti Firestop Block (CFS-BL)

.2 Hilti Firestop Board (CP 675T)

.3 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

.9 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:

.1 Hilti FS 657 Fire Block (for walls and floors)

.2 Hilti CP 658T Firestop Plug (for walls and floors)

.3 Hilti CP 680 Cast-In Place Firestop Device (for floors only)

.10 For penetrations through a Fire Separation wall provide a firestop system with a "F" Rating as determined by ULC or cUL as indicated below:

Fire Resistance Rating of Separation	Required ULC or cUL "F" Rating of Firestopping Assembly
30 minutes	20 minutes
45 minutes	45 minutes
1 hour	45 minutes
1.5 hours	1 hour
2 hours	1.5 hours
3 hours	2 hours
4 hours	3 hours

For combustible pipe penetrations through a Fire Separation provide a firestop system with a "F" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

.11 For penetrations through a Fire Wall or horizontal Fire Separation provide a firestop system with a "FT" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

Part 3 Execution

3.1 Preparation

.1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

.1 Verify penetrations are properly sized and in suitable condition for application of materials.

.2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

.3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

.4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

.5 Do not proceed until unsatisfactory conditions have been corrected.

3.2 Coordination

.1 Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

.2 Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.3 Installation

.1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory.

.2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.

- .1 Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
- .2 Consult with mechanical consultant, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
- .3 Protect materials from damage on surfaces subjected to traffic.

3.4 Field Quality Control

.1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

.2 Keep areas of work accessible until inspection by applicable code authorities.

.3 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

.4 Install a warning card that is clearly visible adjacent to all large and medium openings that may be re-penetrated. This card should contain the following information:

- .1 Warning that the opening has been fire stop protected
- .2 Indicate the fire stop system used (ULC or cUL)
- .3 F rating or FT rating
- .4 Fire stop product(s) used
- .5 Person to contact and phone number in case of modification or new penetration of fire stop system

3.5 Adjusting and Cleaning

.1 Remove equipment, materials and debris, leaving area in undamaged, clean condition.

.2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Motors shall be UL listed and CSA certified.

.2 Full Voltage Start Applications:

   .1 All motors shall be in accordance with the National Electrical Manufacturers Association (NEMA) standards, and CSA C390. Motors also shall comply with applicable portions of Canadian Electrical Code.

.3 Variable Frequency Drive and soft start applications:

   .1 Motors shall be in accordance with NEMA standards (MG-1) Part 31 and inverter duty class. Motors also shall comply with applicable portions of Canadian Electrical Code.

   .2 Motors connected to VFDs shall be wound using inverter spike resistant magnet wire capable of 1600V.

.4 Electronic Commutation Motors (ECM) shall be provided in unitary equipment as specified in their respective sections (small fans, pumps, etc.).

.5 Noise level of each motor shall comply with NEMA standards, less than 80 dBA at 39" (1 m).

1.3 Submittals

.1 Submit data of test method used and motor efficiencies with shop drawings.

Part 2 Products

2.1 Electric Motors - General

.1 Provide motors for mechanical equipment as specified.

.2 Unless noted otherwise, provide open drip-proof, ball or roller bearing motors with grease fittings.

.3 Motors shall have standard voltage ratings consistent with project distribution voltages. Motors less than ½ hp (0.37 KW) to be 120 volt, 60 cycle, single phase power. Motors ½ hp (0.37 KW) and larger to be 3 phase power and for scheduled voltage. Confirm electric voltage, phase and starter requirements with electrical specification.

.4 Motors shall be designed and manufactured to operate with ±10% voltage and ±5% frequency variations of the nameplate ratings.

.5 Motors shall be rated for 1.15 service factor in 105°F (40°C) ambient environment.

.6 Motors shall be standard 1750 RPM unless specifically scheduled otherwise.

.7 Provide motors with terminal boxes, suitable for power connections.

.8 Provide screw adjustable bases on belt-connected motors.

.9 Motors shall be of capacitor start type when they may be manually cycled from starting switch, located in finished space.

.10 Lubricate motors exposed to outdoor temperature with lubricants suitable for operation at the lowest temperature indicated by the Climatic Information contained in the National Building Code for the location in which they are installed.

2.2 Electric Motors - Premium Efficient

.1 Motors shall be provided with premium efficiency inverter duty classification with non-wicking leads, class 'B' for ODP motors (pumps only) and class 'F' for TEFC motors insulation (minimum). Provide motor shaft grounding for variable frequency driven motors for all VFD applications.

.1 Premium efficiency open drip-proof motors shall have the following typical full load efficiencies (nominal):

HP	Premium Efficient - Minimum Efficiency (%)		
	3500 RPM 2 Pole	1750 RPM 4 Pole	1150 RPM 6 Pole
1	80.0	85.5	82.5
1.5	84.0	86.5	86.5
2	85.5	86.5	87.5
3	86.5	89.5	88.5
5	91.0	89.5	90.2
7.5	88.5	91.0	92.4
10	90.2	91.7	92.4
15	91.0	93.0	92.4
20	92.5	93.0	92.4

.2 Premium efficiency inverter duty totally enclosed fan cooled motors shall have the following typical load efficiencies (nominal).

HP	Premium Efficient - Minimum Efficiency (%)		
	3500 RPM 2 Pole	1750 RPM 4 Pole	1150 RPM 6 Pole
1	n/a	85.5	81.5
1.5	85.5	85.5	86.5
2	85.5	85.5	87.5
3	87.5	88.5	88.5
5	89.5	89.5	89.5
7.5	91.0	91.7	91.7
10	91.7	91.7	91.7
15	91.7	92.4	91.7
20	92.4	93.0	92.4

.2 ECM Motors (Electronic Commutation Motors) shall be provided for unitary equipment as specified in their respective sections. ECM motors shall be permanently lubricated complete with heavy duty ball bearings to match the device (fan, pump, equipment type) and pre-wired to the specific voltage and phase. Internal motor circuitry shall convert the supplied AC power to the motor DC power to operate the motor. Motor shall be speed controllable down to 20% of rated full speed. Speed shall be controlled by either a Potentiometer dial mounted at the motor, or by a 0-10V signal from controls. Motor shall be a minimum of 85% efficient at all speeds.

2.3 Belt Drives

.1 Provide belt drives to the following requirements:

.1 Steel, cast-iron or aluminum sheaves for motors less than ¾ hp (0.56 KW).

.2 Steel or cast-iron sheaves keyed to shafts, for motors ¾ hp (0.56 KW) and larger.

.3 For motors less than 10 hp (7.5 KW), provide standard adjustable pitch drive sheaves having ±10% range. Use mid-position of range for specified RPM.

.4 For motors 10 hp (7.5 KW) and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.

.2 Match drive and driven sheaves.

.3 V-belts shall conform with the American Belt Manufacturers standards. Multiple belts shall be matched sets.

.4 Not less than 2-belt configuration is required for each drive for motors ¾ hp (0.56 KW) and larger.

.5 Minimum drive rating shall be 150% of nameplate rating of motor. Keep overhung loads within Manufacturer's design requirements on prime mover shafts.

.6 Motor slide rail adjustment baseplate with double draw bolt shall allow for centre line adjustment.

.7 Tension belts to manufactures recommendations before start-up and after 100 hours of operation using calibrated belt tensioning gauge.

.8 Provide one spare set of belts for each piece of equipment with each belt separately identified for the equipment item served.

2.4 Shaft Couplings

.1 Shaft couplings shall be of the pin or jaw neoprene insert type, gear type, or flexing steel insert type and shall allow coupling inserts to be easily removed without disassembly of equipment.

2.5 Guards

.1 Provide removable protective guards on exposed V-belt drives and shaft couplings in accordance with Worker's Compensation Board requirements.

.2 Guards for drives shall have:

.1 18 ga (1.31 mm) expanded metal screen welded to 1" (25 mm) steel angle frame.

.2 16 ga (1.61 mm) thick galvanized sheet metal tops and bottom.

.3 Removable sides(s) for servicing.

.4 1-½" (38 mm) diameter holes on both shaft centres for insertion of tachometer.

.5 Sectionalize if necessary so one man can handle removal.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Fabricate and install belt guards for V-belt drives to permit movement of motors for adjusting belt tension and for belt slap.

.5 Provide removable "U" shaped guards for flexible couplings with 12 ga (2.75 mm) thick galvanized frame and 16 ga (1.61 mm) thick expanded mesh face.

.6 Provide guards on unprotected fan inlets and outlets. Guards to be provided by fan Manufacturer.

.7 Prime coat guards and finish paint to match equipment.

.8 Secure guards to equipment allowing for ease of removal.

Part 3 Execution

3.1 Electric Motors

.1 Unless otherwise noted starters and protection devices will be included under Electrical Division.

.2 Assist Electrical Division to ensure proper connection, correct thermal overload protection and correct motor controls.

.3 Where starters included in this Division as integral part of packaged equipment, they shall contain thermal overload protection.

3.2 Setting and Alignment

.1 Employ journeyman millwright to align V-belt drives and/or shaft coupling drives prior to initial start-up. Millwright shall check that centrifugal fan wheels are properly centered on fan shafts.

.2 Align shaft couplings to within ±0.002” (±0.051 mm) after grouting is complete and piping system is operational.

.3 Align V-belt drives using straight edge.

.4 Submit certificate from millwright, certifying that shaft couplings and V-Belt drives have been aligned and centrifugal fan wheels centered prior to initial start-up and checked again after final system balance adjustment.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Where integrated pump mounted and packaged pump/VFD units are used – refer to Section 23 21 23 Hydronic Pumps.

1.2 Quality Assurance

.1 Variable speed drives (VSD) shall be UL/CSA/NRTL-C certified. Equipment supplied to site without proper certification will be immediately removed from site. Variable speed drives shall comply with the following standards:

- .1 NEMA-250 Enclosures to 1000 V maximum.
- .2 EN 50178 (LVD0.
- .3 EN 61800-3.
- .4 EN 61000-2-1, EN 61000-4-2 (-3, -4, -5, -6)/A2.
- .5 EN 60146-1-1/A1
- .6 IEEE-519
- .7 UL-608C Power Conversion.

.2 VSDs shall be supplied by one Manufacturer.

1.3 Shop Drawings

.1 Provide complete dimensional data, operating data, system setpoints, written detailed sequence of operation and engineering data, including wiring diagrams, electrical schematics, and programming instructions.

.2 Provide drawings showing field installation of electrical, electronic and pneumatic component requirements.

1.4 System Activation

.1 Provide services of qualified technician to set up variable speed motor control system on site. Include minimum of half (½) man day per system to adjust and monitor system operation in conjunction with Balancing Sub-Trace and Controls Sub-Trade and Commissioning Agent.

.2 Provide written start-up report to the Engineer listing operating setpoints, characteristics and identification.

.3 Provide two site inspections during the warranty period to check operation, maintenance and calibration of variable speed drive.

1.5 Power Supply

.1 Variable speed system shall accept 3-phase line voltage as defined in Electrical.

.2 The tolerate supply line voltage deviation for the VSD shall be as follows:

- .1 208 to 240V: Undervoltage Trip 135V, Overvoltage Trip 312V.
- .2 500 to 600V: Undervoltage Trip 325V, Overvoltage Trip 780V.

.3 For 600V networks, the input voltage of the VSD shall be rated for 500V to 600V +/- 10% minimum VSDs rated 575V +/- or less shall not be acceptable.

.4 Input frequency shall be to 60 Hz ±5%. Provide current limiting devices to protect electronics from excessive current.

1.6 DDC Interface

.1 The VFD shall have a TIA-485 port as standard. The standard VSD firmware shall include BACnet and Modbus serial communication protocols. Lonworks shall be available on an under the cover option board.

.2 Provide remote operator interface to accept and transmit 4-20 milliamp, 0-10 VDC and 0-5 VDC signals to and from DDC system to control or monitor the following functions:

.1 Start/stop.

.2 Acceleration of variable speed drive unit.

.3 Deceleration of variable speed drive unit.

.4 Speed of drive.

.5 Failure of unit.

.3 Monitoring shall also be provided by key pad operator on speed drive box complete with auxiliary displays.

1.7 Warranty

.1 VSD shall be warrantied by Manufacturer for period of 36 months from date of commissioning. Warranty shall include parts, labour, travel costs and living expenses incurred by Manufacturer to provide factory authorized on-site service.

Part 2 Products

2.1 Acceptable Manufacturers: ABB, Danfoss, AC Tech, Reliance,

2.2 General Requirements

.1 Provide variable speed drive (VSD) for each fan and pump (or fan and pump set) as specified, complete with integral manual bypass to operate motor if VFD is tripped out or in failure mode.

.2 Variable speed drive shall be of pulse width modulated (PWM) type utilizing transistors and shall have the following minimum specifications:

.1 VSD package shall provide the following minimum protective devices:

.1 208/230 volt systems shall include 5% impedance line and load reactors.

.2 575 volt systems:

.1 Shall include minimum 5% impedance line and load reactors for control of harmonics and LRC Snubber Filter where cable length between VSD and motor exceeds 10’-0” (3.05 m) and LC Sine Wave Output Filter where cable length between VSD and motor exceeds 15’-0” (4.5 m) where connected to NEMA MG1 Part 30 motors.

.2 No output filtering required when connected to NEMA MG1 Part 31 motors.

.2 Provide incoming horsepower rated door interlock at padlockable disconnect switch. Also provide fast acting input line fuses where characteristics are coordinated with drive's electronic protection circuits to not blow under normal output faults such as overcurrent, short circuit or ground fault.

.3 Provide line over and under voltage protection, phase loss protection and phase unbalance protection.

.4 Provide protection against overvoltage on DC bus.

.5 Provide inherent short circuit protection for line to line and line to ground faults. If either fault occurs on output of VSD, VSD shall shut-down without damaging power circuit devices. Controllers utilizing fuses or isolation transformers to provide protection shall not be acceptable.

.6 Provide electronic instantaneous overcurrent protection.

.7 Drive shall have continuous duty service factor of 110% of rated output current with I2t motor overload protection above 100% current.

.8 Minimum efficiency of 97% at maximum load and speed.

.9 Provide two separately adjustable acceleration and deceleration ramps from 1 to 999 seconds (0 to 110% speed).

.10 Provide controller internal thermal protection.

.11 Provide automatic restart after invertor fault trip. Drive shall attempt to restart automatically three times with lock-out after third attempt if restart has not occurred.

.12 Provide rotating motor restart feature complete with soft lock capability during start-up to allow motor/fan unit which has been shut-down or has fault tripped, but is still rotating, to be restarted. VSD shall restart motor at speed at which it is rotating and then re-accelerate to speed called for by speed reference signal.

.13 Provide auto-restart after power outage (provided run enable is maintained).

.14 Provide three frequency reject points with adjustable bandwidth from 0.5 to 9.9 Hz to prevent fan from operating at resonant speed.

.15 Provide automatic/manual signal follower for:

.1 4-20 mA.

.2 0-10 VDC

.3 0-5 VDC.

2.3 Controls: Provide door mounted and microprocessor driven, digital operator control module to allow station operations personnel to set up and monitor drive parameters, observe output speed, load, voltage and time, monitor status and fault information, date and time stamped, as detailed below:

.1 Read-out information shall be displayed with LCD alpha-numeric high resolution display or approved equal. Information being displayed shall be presented in "user friendly" descriptive word format. Use of coded or abbreviated displays shall not be acceptable.

.2 Speed load (power) and output voltage shall be continuously displayed when in run mode. Three display values shall be user selectable from a menu.

.3 Direct keypad entry shall be provided to observe the following parameters:

.1 Maximum speed setting.

.2 Minimum speed setting.

.3 Acceleration rate.

.4 Deceleration rate.

.5 Current limit – monitoring.

.6 Current limit – regenerating.

.7 Up to three pre-set operating speeds.

.8 Up to three frequency reject points to avoid operating at resonant speed points. Centre frequency and band width shall be displayed.

.4 Direct keypad entry shall be provided to initially set or change above noted parameters and only after password entered by authorized personnel.

.5 Provide diagnostics for operator online status information. Each of the following status points shall be indicated by individual LED or digital display

.1 Power on.

.2 Ready.

.3 Run.

.4 Jog.

.5 Motor accelerating.

.6 Motor decelerating.

.7 Direction of rotation (forward or reverse) (if function enabled).

.8 Auto mode (if function enabled).

.9 Manual mode.

.10 Stop.

.11 Low reference (missing or zero speed reference).

.12 External trip (interlocks open).

.13 Power lost.

.6 Provide fault diagnostics to simplify troubleshooting. Each of the following points shall be indicated by individual LED or digital display:

.1 Lockout (fault shut-down after three restart attempts).

.2 Line fault (line over/under voltage, phase loss/unbalance).

.3 Controller over temperature.

.4 I2t motor overload protection.

.5 DC bus overvoltage.

.6 DC bus under voltage.

.7 Auxiliary power supply fault.

.8 Output fault – Phase A.

.9 Output fault – Phase B.

.10 Output fault – Phase C.

.7 Provide keypad accessibility to non-volatile fault history memory which is not operator erasable. Memory shall store the following data for each of ten most recent drive shut-downs:

.1 Fault which caused shut-down.

.2 Output frequency at time of trip.

.3 Output voltage at time of trip.

.4 Output load (power) at time of trip.

.5 Whether load was accelerating or decelerating.

.6 Time and date fault occurred.

.8 Provide the following control functions on door mounted keypad:

.1 Run.

.2 Stop.

.3 Jog (enabled in stop mode only).

.4 Auto/manual (if auto mode is enabled).

.5 Forward/reverse (if function is enabled).

.6 Accelerate (manual mode).

.7 Decelerate (manual mode).

.8 Direct speed set (manual mode).

.9 Provide terminals for interlocking of up to six external interlocks (e.g., Firestat, Freezesat, etc.).

2.4 Harmonics

.1 VSD installations shall meet IEEE 519 harmonics guidelines for control of harmonics. Total harmonic voltage distortion shall be below 5% for normal applications and below 3% for special applications such as airports, at point of common coupling with utility power supply. Calculation to demonstrate compliance shall be included in shop drawing submission. Failure to confirm compliance shall result in rejection of products.

2.5 Manual Bypass

.1 Provide integral 3-contactor manual bypass in NEMA 1 enclosure wired and mounted with VSD to transfer motor from VSD to line power or from line to controller. Bypass circuitry shall be wired to isolate VSD from line. Motor overload protection shall be provided in both drive and bypass mode.

Part 3 Execution

3.1 General

.1 Install equipment in accordance with Manufacturer’s instructions, details and procedure.

.2 In HAND position, power applied to each VSD shall provide soft motor start. In AUTO position, power shall be applied to VSD for soft start only when signal from DDC system allows. Soft start means power consumption shall be fully ramped.

.3 MANUAL/AUTO switch in AUTO positing shall cause motor to accelerate at a rate determined by stability component until speed controller setpoint has been attained.

.4 Loss of power at VSD input terminals or fault conditions shall cause VSD to go into orderly shut-down. Resumption of power shall cause VSD to go into orderly automatic restart sequence and provide soft start for motor.

.5 Short circuit sensed anywhere in motor control loop shall interrupt current flow.

.6 Acceleration and deceleration shall be set during commissioning of DDC system to ensure spurious tripping does not occur during normal operations.

3.2 Start-Up Service

.1 Start-up commissioning service shall include factory and/or authorized service agent, to provide the following:

.2 Verification of contractor wire terminations to VSD and optional circuitry.

.3 Verification of interface wiring to building energy management system.

.4 Measurement of motor voltage and frequency.

.5 Calibration check for minimum speed, maximum speed, acceleration and deceleration rates.

.6 Start-up and verification form to be provided to the Consultant and the Commissioning Agent.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Document and is to be read, interpreted and coordinated with other parts.

1.2 Scope

.1 Flexible pipe connections.

.2 Expansion joints and compensators.

.3 Pipe loops, offset and swing joints.

1.3 Reference Standard

.1 Conform to Standard of "Expansion Joint Manufacturers Association" and Manufacturer's recommendations.

1.4 Shop Drawings

.1 Product data shall include Manufacturer, model number, pressure and temperature rating, axial, lateral and angular movement handled, nominal size and dimensions, details of construction and assembly.

1.5 General Requirements

.1 Examine piping layout and notify Consultant of additional anchors, guides or expansion joints required to adequately protect system, where the on-site pipe rooting and configuration differs from the plans. Engage a specialist supplier or engineer to verify where installation varies from the design.

.2 Make provision for expansion and contraction of pipe work. Piping shall be anchored and supported in such a manner that strain and/or weight does not bear on any apparatus and pipe branch connections. Expansion joints and compensators shall be installed and guided as per Manufacturer's recommendations. Equipment shall be connected with unions or flanges to provide for easy removal. Where piping passes through walls or floor slabs sleeves shall be provided of sufficient size to accommodate expansion and pipe insulation without binding or crushing insulation or preventing expansion of piping.

Part 2 Products

2.1 Flexible Hoses - Braided

.1 Phosphor bronze convoluted bellows with braided bronze sleeve or stainless steel convoluted bellows with braided stainless steel sleeve.

.2 Suitable for system operating temperature and pressure.

.3 Connections:

- .1 NPS 2 and under, screwed connections
- .2 NPS 2-½ and over, flanged connections

.4 Length shall be as recommended by Manufacturer, unless noted otherwise.

.5 Acceptable Products:

.1 Flexonics Flex Con, Flextech Industries, Hydro Flex, Keflex, Vibra-Flo, Metraflex BBCT, Metraflex MLP.

2.2 Flexible Pipe Connectors - Low Temperature

.1 Flexible pipe connectors complete with control rods, manufactured from polyester tire cords and bridge bearing quality neoprene or EPDM, cover and liner to CSA Standard CAN3-S6-M88. Provide flanges, bolts, etc. for outdoor installation.

.2 Twin sphere design with reinforcing ring.

.3 Suitable for a maximum temperature of 105°F (40°C) (chilled and condenser water systems only).

.4 Safety factor for burst and flange pullout shall be a minimum of 3:1

2.3 Flexible Pipe Connections - High Temperatures

.1 Double braided, heat resistant, up to 392°F (200°C) bronze braid, up to 446°F (230°C) stainless steel braid.

.2 Chemically inert and resistant to steam and moisture.

.3 Capacity to absorb 6" (150 mm) with length across flexible portion not less than six diameters.

.4

.5 Acceptable Products:

.1 Anaconda, Flexonics.

2.4 Expansion Compensators

.1 Copper Pipe Expansion Compensator - Low Pressure:

.1 Bronze or stainless steel convoluted bellows.

.2 Suitable for 60 psi (415 kPa) working pressures.

.3 ¾" (19 mm) to 1-¼" (32 mm) diameter, suitable for ½" (12 mm) compression and ¼" (6 mm) extension.

.2 Steel Pipe Expansion Compensator:

.1 Factory assembled unit, with stainless steel or phosphor bronze in carbon steel casing.

.2 Anti-torque groove in casing, internal pipe guide at both ends, full length internal liner.

.3 Suitable for 150 psi (1,034 kPa) operating pressure.

.4 Suitable for 1-½" (38 mm) compression and ¼" (6 mm) extension.

.5 Acceptable Products:

.1 Adsco, Flexonics, Flextech Industries, Hydroflex, Metraflex, Vibra-Flo.

2.5 Anchors

.1 Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

.2 Anchors shall securely attach piping to structural members. Size anchors to accommodate forces due to pipe expansion and weight.

.3 Where bolts secure anchor to structure, weld bolts to plate. Arrange anchors so that bolts are in shear not in tension.

.4 Provide anchors on both sides of expansion devices, as indicated on drawings, and as required to control flexing of the piping system.

2.6 Expansion Loops

.1 Provide expansion loops as required.

.2 Expansion loops shall be of welded construction with long radius elbows. Three legs of expansion loop shall be equal.

.3 For water systems, Victaulic or Shurjoint flexible couplings may be used to accommodate thermal expansion and contraction only with prior written acceptance by the consultant.

2.7 Guides

.1 Pipe alignment guides shall be Hyspan Series 9500 or equal. Size to accommodate pipe insulation.

.2 Acceptable Product: Metraflex Style IV Guides.

Part 3 Execution

3.1 Installation

.1 Install piping systems with due regard and provision for expansion avoiding strain damage to equipment and building. Provide adequate expansion and contraction for piping running horizontally across building expansion joints.

.2 Only major expansion configuration and fittings have been shown on the drawings. Provide required additional compensators, loops and wing connection.

.3 Provide two pipe guides per side of expansion joint or expansion loop so that movement takes place along axis of pipe only.

.4 Install expansion loops, cold sprung 50% of calculated expansion.

.5 Install at least three elbows in branch connections. Where space does not permit 3 elbows, install braided flexible pipe connectors in accordance with Manufacturer's recommendations. Three elbow branch connections shall have sufficient developed length to ensure that excessive stresses are not generated in piping and shall be no less than 36" (914 mm).

3.2 Flexible Hoses - Braided

.1 Install braided flexible hoses where shown on drawings and as flexible connections to designated heating/cooling terminal units.

.2 On screwed connections, install a union on one end.

.3 Do not torque hose.

.4 Ensure braided flexible hoses are not damaged during hydrostatic testing.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

Part 2 Products

2.1 Flow Measure Devices - Liquid

.1 Flow measuring device to be sized to provide a read-out signal between 10 to 40 inches WG (2488 and 9954 PA).

.2 When required minimum straight pipe lengths cannot be provided for in-line devices, use elbow or Venturi type devices.

.3 Each element shall be completed with instrument shut-off valves with finger tight connections and identification tag and chain.

.4 Each element shall be complete with chained metal tag showing element size, location, volume, and differential signals.

.5 Acceptable Products:

- .1 Venturi type - Gerand, Preso.
  - .1 NPS 2 and under: brass screwed.
  - .2 NPS 2-½ and over: cast-iron or steel, flanged, butt-welded or roll grooved couplings where permitted.

.6 Provide direct read-out dial type meter complete with connecting hoses and calibration chart to read measured flow. Flow meter shall be calibrated inches (mm) of water and shall be suitable for water/glycol. Calibrate for water systems and provide correction data for 40% glycol.

- .1 Acceptable Products:
  - .1 Eagle Eye, Gerand, Preso, Western Meter Model SCL101.

2.2 Flow Measuring Devices - Liquid (Electronic Output)

.1 Flow meters shall be manufactured by Annubar, Model No. 1151DP, consisting of flow sensor, transducer, gauges, mounting flange and accessories.

.2 Accuracy shall be ±0.2% of calibrated span and ±1% error per 131°F (55°C). Permanent pressure loss shall not exceed 25% of pressure differential reading. Accuracy shall be consistent to turndown ratio 25 to 1. Flow fitting shall be diamond shape.

.3 Each flow fitting shall be complete with identification tag, conversion chart, quick disconnect gauge fittings and shut-off cocks.

.4 One differential meter shall be complete with hoses, shut-off fittings, bleed valves and carrying case.

.5 Flow meters shall be selected for temperature and pressure of installation. Transducer shall be selected for maximum pressure drop range.

Part 3 Execution

3.1 Flow Measuring Devices - Liquid

.1 Install flow measuring devices in piping circuits to establish operational flow rates. Measuring devices shall be located where shown on drawings.

.2 Install in accordance with Manufacturer’s installation instructions and in correct size of pipe. Reduce pipe size as required.

.3 Install isolating globe, ball or needle valves with ¼” (6 mm) male end SAE flare connection on pressure tapping connections.

.4 Provide and install quick-connect gauge couplings.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

Part 2 Products

2.1 General

.1 Select thermometers and pressure gauges so that their operating range falls in middle half of scale range.

.2 Refer to section 25 05 01 for combination temperature gauges/DDC immersion sensors which may be used in lieu of separate immersion wells for a gauge and a separate immersion well for a DDC sensor.

2.2 Thermometers - Piping

.1 Acceptable Manufacturers:

- .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.

.2 Minimum Requirements:

- .1 Thermometers to be in accordance with Canadian General Standards Board CGSB 14.4 - M88.
- .2 Pipe mounted stem type - mercury actuated, adjustable angle type.
- .3 Refer to flow schematics for location of pipe mounted thermometers and wells.

.3 Case:

- .1 Stem type – Stainless Steel. Case shall be provided with clear glass or heat resistant plastic window.

.4 Scale:

- .1 Stem type - 9" (225 mm) scale length.
- .2 White background with temperature range in black.
- .3 Dual Celsius and Fahrenheit scale.

2.3 Thermometers - Duct/Panel Mounted

.1 Acceptable Manufacturers:

- .1 Moeller, Trerice, Weiss, Weksler, Winters.

.2 Minimum Requirements:

- .1 Thermometers to be in accordance with Canadian General Standards Board CGSB 14-GP-2a.
- .2 Duct mounted dial type - solid liquid filled with remote capillary element.
- .3 Panel mounted dial type (surface) type - vapour filled direct mounting.
- .4 Panel mounted dial type (flush) type - remote liquid filled capillary element.

.3 Case:

.1 Dial type - cast aluminum, black enamel steel or stainless steel with stainless steel or chrome-plated face ring.

.4 Scale:

.1 Dial type - nominal 4-½" (115 mm) unless otherwise indicated.

.2 White background with temperature range in black.

.3 Dual Celsius and Fahrenheit scale.

2.4 Pressure Gauges - Piping

.1 Acceptable Manufacturers:

.1 Marsh, Moeller, Trerice, Weiss, Winters.

.2 Minimum Requirements:

.1 Gauges to be in accordance with ANSI B40.1 Grade "A" level.

.2 4-½" (115 mm) cast aluminum, black steel or stainless steel case, with stainless steel or chrome-plated face ring.

.3 White background with pressure range in black.

.4 Dual kPa and psig scale.

.5 Phosphor bronze bourdon tube, silber brazed tip and socket ¼" (6 mm) NPT lower connection.

.6 Rotary type bushed movement, silicone dampened to prevent pointer oscillation.

.7 Gauges to be registered with Provincial Boiler and Pressure Vessel Safety Branches with CRN number.

.8 ULC listed for use on fire protection systems.

.9 Accuracy shall be 1% off full scale over the middle half of the scale.

.3 Accessories:

.1 Install needle valve ahead of each gauge.

2.5 Test Plugs for Pressure/Temperature

.1 Provide ¼" (6 mm) NPT solid brass test plug fitting complete with brass chain where indicated.

.2 Test plugs shall be capable of receiving either pressure or temperature ⅛" (3.2 mm) OD Dual seal core shall be Nordel suitable for temperature of 350°F (177°C) and shall be rated zero leakage from vacuum to 1,000 psi (6,895 kPa).

.3 Provide 1 master test kit containing 2 test pressure gauge of suitable range, 1 gauge adaptor, ⅛" (3.2 mm) OD probe and 2 stem pocket testing thermometers of suitable range.

.4 Acceptable Products:

.1 Sisco P/T Plugs.

.2 Trerice

2.6 Test Thermometer

.1 Hand over test thermometer in protective case to Owner during Owner's Demonstration and Instruction Period. Provide same make and type as permanently installed thermometers suitable for use with pipe mounted wells. 30°F (0°C) to 140°F (115°C).

.2 Obtain two signed receipts from Owner certifying that test thermometer has been received. Hand one over to Consultant.

2.7 Thermometer Wells

.1 For copper pipe use copper or bronze. For steel pipe use brass, separable socket, ¾ NPT.

.2 Thermowell to be registered with Provincial Boiler and Pressure Vessels Safety Branch with CRN number.

Part 3 Execution

3.1 General

.1 Install thermometers and gauges to be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.

.2 Install engraved lamicoid nameplates as specified in Section 23 05 53 - Identification (identifying medium).

3.2 Thermometers

.1 Install in wells on piping.

.2 Install separable well to minimize restriction to flow and, if necessary, install in section of oversized pipe.

.3 Install wells where indicated for use with test thermometers.

.4 Install in locations as indicated and on inlet and outlet of:

- .1 Heat exchangers.
- .2 Water heating and cooling coils.
- .3 Water boilers.

.5 Use extensions where thermometers are installed through insulation.

3.3 Pressure Gauges

.1 Install the following locations:

- .1 Suction and discharge of pumps.
- .2 Upstream and downstream of PRVs.
- .3 Inlet and outlet of waterside of coils (excluding terminal unit coils) and heat exchangers
- .4 In other locations indicated.

.2 Use extensions where pressure gauges are installed through insulation.

.3 Where single gauge is used to measure multiple points, provide needle valves to isolate each point, including pressure gauge.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 23 05 49 for seismic restraint of piping.

1.2 General

.1 Provide hangers and supports to secure equipment in place, prevent vibration, protect against damage from earthquake, maintain grade, provide for expansion and contraction and accommodate insulation.

.2 Provide insulation protection saddles on insulated piping.

.3 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.

.4 Set inserts in position in advance of concrete work. Use grid system in equipment rooms.

.5 Support from top of structural members. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members, as necessary.

.6 Do not suspend from metal deck.

.7 Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).

Part 2 Products

2.1 Upper Attachments

.1 Concrete:

- .1 Inserts for cast-in-place concrete: galvanized steel wedge. ULC listed for pipe NPS ¾ through NPS 8 - Grinnell/Anvil Fig. 281.
- .2 Carbon steel plate with clevis for surface mount: malleable iron socket with expansion case and bolt. Minimum two expansion cases and bolts for each hanger - Grinnell/Anvil, plate fig. 49, socket fig. 290, expansion case fig. 117.
- .3 Drilled concrete insert shall be Hilti Model HSL or HVA.
  - .1 Acceptable Products: Hubbard Enterprises Holdrite #121LD, #125, #205
- .4 Inserts shall be ICBO approved.
- .5 Power/powder actuated fastenings and drop-in anchors are not permitted to be used for tensile loading (i.e. suspension of mechanical equipment) or for seismic anchorage and/or restraint.

.2 Steel Beam (Bottom Flange):

- .1 Cold piping NPS 2 and under: malleable iron C clamp - Grinnell/Anvil fig. 61.
- .2 Cold piping NPS 2-½ and larger and hot piping: malleable iron beam clamp - Grinnell/Anvil fig. 292, Holdrite #280, Holdrite #261.

.3 Steel Beam (Top):

.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil fig. 61.

.2 Cold piping NPS 2-½ and larger and hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227, Holdrite #261.

.4 Steel Joist (Top Chord):

.1 Cold piping NPS 2 and under: steel washer plate with double locking nuts - Grinnell/Anvil fig. 60.

.2 Cold piping NPS 2-½ and larger and hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron soccer - Grinnell/Anvil: washer plate fig. 60, clevis fig 66, socket fig. 290, Holdrite #261 or #115 with #271 Silencer.

.5 Steel Channel or Angle (Bottom):

.1 Cold piping NPS 2 and under: malleable iron C clamp - Grinnell/Anvil fig. 86.

.2 Cold piping NPS 2-½ and larger and hot piping: universal channel clamp - Grinnell/Anvil fig. 226.

.6 Steel Channel or Angle (Top):

.1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil fig. 61.

.2 Cold piping NPS 2-½ and larger and hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.

2.2 Middle Attachments (Rod)

.1 Carbon steel black (electro-galvanized/cadmium plated for mechanical rooms) continuous threaded road - Grinnell/Anvil fig 146 or Myatt fig. 434.

2.3 Pipe Attachments

.1 Cold piping, steel or cast-iron: hot piping steel, with less than 1" (25 mm) horizontal movement; hot piping, steel, with more than 12" (300 mm) middle attachment (rod) length: adjustable clevis - Grinnell/Anvil fig. 260.

.2 Cold copper piping: hot copper piping with less than 1" (25 mm) horizontal movement; hot copper piping with more than 12" (300 mm) middle attachment (rod) length: adjustable clevis copper plated - Grinnell/Anvil fig. CT-65.

.3 Suspended hot piping, steel and copper, with horizontal movement in excess of 1" (25 mm); hot steel piping with middle attachment (rod) 12" (300 mm) or less pipe roller - Grinnell/Anvil fig. 174 or Grinnell/Anvil fig. 181 up to NPS 6 and Grinnell/Anvil fig. 171 NPS 8 and larger.

.4 Bottom supported hot piping, steel and copper: pipe roller stand - Grinnell/Anvil fig. 271.

.5 Spring hangers; where required to offset expansion on horizontal runs which follow long vertical risers - Grinnell/Anvil fig. 171 single pipe roll hanger with Grinnell/Anvil fig 178.

2.4 Riser Clamps

.1 Steel or cast-iron pipe: black carbon steel - Grinnell Anvil fig. 261 or Myatt fig. 182.

.2 Copper pipe: carbon steel copper finished - Grinnell/Anvil fig. CT-121.

.3 Isolated Clamp – Holdrite #273 with 10 ga bearing plates and pads.

2.5 Saddles and Shields

.1 Cold piping NPS 2 and under: protection shield with pipe insulation under shield with uninterrupted vapour barrier - Kingspan “K Block” - high density insulation.

.2 Cold piping NPS 2-½ and over: protection shield with high density insulation under shield with uninterrupted vapour barrier - Kingspan “K Block” high density insulation.

.3 Hot piping NPS 3 and under: insulation over pipe hanger, Holdrite #270 Isolation Hanger.

.4 Hot piping NPS 4 and over: protective saddle with insulation under saddle - Grinnell/Anvil fig. 160 to 166, Holdrite #71 Isolation Hanger.

2.6 Wall Supports

.1 Horizontal pipe adjacent to wall:

.1 Angle iron wall brackets with specific hangers.

.1 Acceptable Products: Holdrite #261, #280, #255 and #285.

.2 Vertical pipe adjacent to wall:

.1 Exposed pipe wall support for lateral movement restraint - Grinnell/Anvil fig. 262 or 263.

.2 Channel type support - Burndy, Canadian Strut, Cantruss or Unistrut (arrangement to be acceptable to BC Boiler Inspection Department).

2.7 Floor Supports

.1 Horizontal Pipe:

.1 Do not support piping from the floor unless specifically indicated.

.2 Vertical Pipe:

.1 Mid-point of risers between floor slabs - adjustable fabricated steel supports. Refer to Section 23 05 49 Seismic Restraints.

Part 3 Execution

3.1 Hanger Spacing

.1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.

.1 Plumbing piping: most stringent requirements of the Plumbing Code or authority having jurisdiction.

.2 Fire protection: to applicable fire code; toggle hangers are unacceptable.

.3 For Gas Piping refer to Gas Code CAN/CGA-B149.1.

.4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.5 Within 12” (300 mm) of each horizontal elbow, tee, joints, etc.

.6 Provide oversize hangers for cold piping with vapour barrier to accommodate high density insulation and saddle.

.2 Maximum hanger spacing table:

Pipe Size: NPS	**Rod Diameter inches (mm)**	**Maximum Spacing Steel Pipe ft² (m)**	**Maximum Spacing Copper Pipe ft² (m)**
½	⅜" (9.5 mm)	6'-0" (1.8 m)	5'-0" (1.5 m)
¾, 1	⅜" (9.5 mm)	8'-0" (2.4 m)	6'-0" (1.8 m)
1 ¼, 1 ½	⅜" (9.5 mm)	10'-0" (3.0 m)	6'-0" (1.8 m)
2	⅜" (9.5 mm)	10'-0" (3.0 m)	10'-0" (3.0 m)
2 ½, 3, 4	½" (12 mm)	10'-0" (3.0 m)	10'-0" (3.0 m)
5, 6, 8	⅝" (16 mm)	10'-0" (3.0 m)	
10, 12	⅞" (22 mm)	10'-0" (3.0 m)	

3.2 Hanger Installation

.1 Offset hanger so that rod is vertical in operating position.

.2 Adjust hangers to equalize load.

.3 Install hanger to provide minimum ½" (12 mm) clear space between finished covering and adjacent work.

.4 Support vertical piping at every other floor.

.5 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.6 Where practical, support risers piping independently of connected horizontal piping.

.7 Install plastic inserts between steel studs and piping.

.8 For beam clamps, extend hanger rod tight to underside of beam with top bolt and washer.

3.3 Inserts

.1 User inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 4" (100 mm) or ducts over 60" (1,525 mm) wide.

.3 Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square plate and nut above slab, in concealed locations.

.5 Provide test mock up for review.

.6 Provide inserts above heat pumps, pumps and boilers to permit equipment servicing. Provide an eyebolt.

.7 Inserts shall be installed in accordance with Manufacturer's recommendations and in no case closer than 7'-0" (2.1 m) apart.

END OF SECTION

Part 1 General

1.1 Summary

.1 Section includes a complete pipe freeze protection system for above ground water piping consisting of a self-regulating heating cable, connection kits, electronic controller, and installation accessories.

.2 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 References

.1 Reference Standards

- .1 UL515 – Electrical Resistance Heat Tracing for Commercial Applications
- .2 IEEE 515.1-2012 Standard for the Testing, Design, Installation & Maintenance of Electric Resistance Trace Heating for Commercial Applications.
- .3 CSA C22.2 No. 130-03 Requirements for Electrical Resistance Heating Cables & Heating Device Sets
- .4 NFPA70 - National Electrical Code
- .5 C22.1 – Canadian Electrical Code

1.3 Submittals

.1 Product Data

- .1 Heating cable data sheet
- .2 UL, CSA, FM approval certificates for freeze protection for aboveground hydronic lines
- .3 Pipe freeze protection design guide
- .4 System installation and operation manual
- .5 System installation details
- .6 Connection kits and accessories data sheet
- .7 Controller data sheet
- .8 Controller wiring diagram

.2 Shop Drawings

- .1 Provide heat tracing circuit layout drawings indicating power connections, tees, end seal, cable length and circuit cable length.

1.4 Quality assurance

.1 Source Limitations: Obtain all heat tracing system cable & components from a single source from a single manufacturer.

.2 Qualifications

- .1 Manufacturers
  - .1 Manufacturer to show minimum of ten (10) years of experience in manufacturing electric self-regulating heating cables.
  - .2 Manufacturer will be ISO-9001 registered.

.3 Manufacturer to provide products consistent with UL 515, CSA 22.2 No 130-03 and IEEE 515.1 requirements.

.3 Certifications

.1 The system (heating cable, connection kits, and controller) shall be UL Listed, CSA Certified and FM Approved for freeze protection of aboveground hydronic piping.

1.5 Delivery, storage, and handling

.1 Delivery and Acceptance Requirements

.1 Deliver and handle products to prevent their deterioration or damage due to moisture, temperature changes, contaminates or other causes.

.2 Deliver products to site in original, unopened containers or packages with intact and legible manufacturers' labels identifying the following:

.1 Product and Manufacturer

.2 Length/Quantity

.3 Lot Number

.4 Installation and Operation Manual

.5 MSDS (if applicable)

.2 Storage and Handling Requirements

.1 Store the heating cable in a clean, dry location with a temperature range 0°F (-18°C) to 140°F (60°C).

.2 Protect the heating cable from water damage by protecting all cables ends from water ingress.

1.6 Warranty

.1 Manufacturer Warranty

.1 Provide material and system warranty for all goods listed below for two (2) years from date of purchase against faulty workmanship and use of defective materials when such goods are properly installed, operated, and maintained according to product documentation.

.1 Heating Cables, connection kits & accessories

.2 Thermostats, controllers, panels contactors, sensors and accessories

Part 2 Products

2.1 Heat Tracing System

.1 Manufacturers

.1 Basis of Design Manufacturer: Subject to the compliance with requirements, provide Raychem heat tracing products **of Pentair Thermal Building Solutions, Menlo Park 94025, 800-545-6258**;

Email: **thermal.info@pentair.com** Website: **www.pentairthermal.com**

.2 Submit comparable products of one of the following for approval by Mechanical Engineer:

.1 Hevi-Duty, Nelson, Termon, Nuheat

.2 Submit request for substitutions in accordance with Instructions to Bidders and Division 01 General Requirements.

.2 Materials

.1 Heating cables shall be Raychem model XL Trace, self-regulating type heating cables.

.1 The Raychem XL Trace Heating Cables shall be designed for the following voltage/wattage:

.1 208-277VAC – 12 watts/ft @ 50°F -12XL-2-CT

.2 The heating cables shall have a **FLUOROPOLYMER** outer insulating jacket with the following information clearly printed on the cable – cable model #, agency listings, meter marks & batch ID.

.3 The heating cable shall have a modified polyolefin inner jacket and a tinned-copper braid to provide a ground path and enhance the cables ruggedness.

.4 The heating cable shall consist of a continuous core of conductive polymer that is radiation cross-linked, extruded between two (2) 16 AWG nickel-plated copper bus wires.

.5 The heating cable shall be UL part of a UL Listed, CSA Certified and FM Approved system.

.6 Constant wattage cables are not acceptable.

.2 Heating Cable Connection Kits

.1 Heating cable connection kits shall be Raychem model

.1 RayClic

.2 FTC

.2 Contractor shall provide power connections, splices/tees and end seal kits to properly connect & terminate the heating cable circuit along the specified length of above ground water piping.

.3 All splices, tees and crosses shall be installed underneath the pipe insulation with service loops installed to allow for future service of the piping.

.4 Connection kits shall be rated NEMA 4X to prevent water ingress and corrosion. All components shall be UV stabilized.

.5 Connection kits shall be UL Listed or CSA Certified.

.3 Attachment of Heating Cable

.1 Attachment method of heating cable to the piping shall be Raychem model

.1 GT-66 – general purpose, high temperature, glass filament tape for installation @ 40°F and above. Contractor to install heating cable to pipe every 12" by wrapping around the pipe & over the heating cable.

.2 Metal cable ties are not permitted

.4 Identification of Heating Cable System

.1 Contractor shall provide & install Raychem model **ETL "Electric Heat Traced" labels** on exterior of pipe insulation every ten (10) feet on opposite sides of the pipe for the entire length of heat traced piping.

.2 In addition, all splices, tees, crosses and power connections shall be labeled on the exterior of the pipe insulation indicating that presence of a connection kit.

.5 Control

.1 Contractor shall provide **ONE (1) Raychem model C910-485** controller for **each heat tracing circuit** as indicated on heat tracing schedule.

.2 See table below for complete list of required controller capabilities:

Supply Voltage	100VAC to 277VAC		
Enclosure	NEMA4X FRP	Operating Temp Range	-40°F - 140°F
Display	6 character alphanumeric LED		
Control	Relay Type: DP, mechanical	Voltage: 277VAC max	Current: 30 A @ 104°F
Control Algorithms	On/Off	Proportional Ambient Sensing Control for energy saving	
Monitoring			
	Temperature	Low Alarm: 0°F to 180°F	High Alarm: 0°F to 200°F
	Ground Fault	Alarm Range: 20mA - 100mA	Trip Range: 20mA - 100mA
	Current	Low alarm range: .3A to 30A or off	
	Autocycle Test	Interval: 1-240 minutes or 1-240 hours	
Temp Sensor Inputs	Quantity: Two (2)	Type: 100Ω, platinum 3 wire	
Alarm Outputs			
	AC Relay: Isolated solid state triac, SPST, 0.75A max, 100VAC to 277VAC nominal		
	Dry Contact Relay: Pilot duty, 48VAC/DC, 500mA maximum, 10VA max. resistive switching		
	Outputs: Normally Opened or Normally Closed		
Stored Parameters			
	Minimum Temperature	Maximum Temperature	Max. ground fault current
	Maximum Heater current	Contactor cycle count	Time in Use
Alarm Conditions			
	Low & high temperature	Low current	Ground fault alarm & trip
	RTD failure	Loss of programmed values	EMR failure
Communications			
	Protocol: Modbus RTU	Topology: daisy chain	26AWG shielded twisted pair

.6 Temperature Sensors

.1 Contractor shall provide **ONE (1) Raychem model RTD-50CS**, 100Ω, platinum 3 wire RTD for ambient temperature sensing for each C910-485 Heat tracing controller.

.2 Temperature sensor shall be installed as indicated on drawings.

.7 Approval

.1 The complete heat trace system shall be listed by a NRTL for freeze protection of above ground, hydronic piping.

Part 3 Execution

3.1 Examination

.1 Verification of Conditions

.1 Prior to installation of heating cable system, verify that all piping which will be heat trace has passed all hydrostatic/pressure test and is signed off by consultant.

.2 Preinstalling Testing

.1 Prior to installing heating cable on the piping an insulation resistance test shall be performed by the installing contractor to ensure integrity of heating cable as describe in the operation & maintenance manual. Provide written assurance of test and letter to be filed in operation and maintenance manual.

3.2 Preparation

.1 Protection of in-Place Conditions

.1 All heating cable ends shall be protected from moisture ingress until cable is terminated.

.2 Acceptable methods are heat shrinking or installing Rayclic-E end seals.

3.3 Installation

.1 Comply with manufacturer's recommendations in the XL-Trace System Installation and Operation Manual.

.2 Install electric heating cable according to the drawings and the manufacturer's instructions. The installer shall be responsible for providing a complete functional system, installed in accordance with applicable national and local requirements.

.3 Interface with Other Work

.4 Connection of all electrical wiring shall be according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

.5 Grounding of controller shall be according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

.6 Pipe Insulation shall be according to Section 23 07 19 "HVAC Piping Insulation" and is required for a properly operating heat trace system.

3.4 Field Quality Control

.1 Field Tests and Inspections

.1 The following test shall be performed after the heat cable has been installed but before the insulation and after insulating the piping. The results of both sets of test shall be recorded as detailed in the Raychem Pipe Freeze Protection Installation and Maintenance Manual and included in submittals to owner:

.1 Continuity Test

.2 Insulation Resistance – 2500VDC

.3 Capacitance Check – Circuit Length Verification

.4 Power Check

.5 Ground Fault Test

.2 Non-Conforming Work

.1 Any heat tracing circuit which fails the any of the above test must be corrected prior to commissioning or startup of the system.

3.5 System Start-Up

.1 Provide a factory-certified technician or manufacturer's representative for startup & commissioning of the heat tracing system and controller.

.2 Coordinate all controller settings with mechanical engineer prior to programming the controller.

.3 Provide commissioning report in submittals package to consultant for review, and for copy to be placed in the operations and maintenance manual.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Provide vibration isolation on motor driven equipment, piping and ductwork, such that noise transmitted to occupied space by any other path than airborne is less than airborne noise transmitted from mechanical space to occupied space. The following are considered minimum requirements to meet this criterion.

1.2 Regulatory Requirements

.1 Supply isolators and seismic restraints meeting the structural requirements of the **BC Building Code and BC Fire Code**, including Part 4 requirements with respect to seismic snubbers or provide equivalent requirements where integral seismic restraint is provided in isolators/bolting.

.2 Include British Columbia Building Code Section 6.2.1.8.(2). Vibration isolator housings are considered a safety guard with respect to isolated equipment and any contained compressed springs. Include “Fail Safe” Seismic restraint in vibration isolation designed to hold mechanical equipment and springs in place.

1.3 Shop Drawings, Qualifications and Submittals

.1 Anchorage of equipment shall be certified by BC registered professional Structural Engineer who specializes in seismic restraint of resiliently mounted systems. Seismic integral isolation mounts or snubbers shall be Office of Statewide Health and Planning Department - State of California (OSHPD) approved and the associated OSHPD number clearly indicated on seismic device. Where **OSHPD** certification is not available, results of tests consistent with OSHPD procedures and approvals shall be submitted and certified by registered professional Structural Engineer.

.2 Obtain relevant equipment information and provide shop and placement drawings for vibration isolation elements and steel bases for review before materials are ordered.

.3 Provide attachment to both equipment and structure meeting specified forces involved. Attachment details to structure to be reviewed by Structural Consultant for project.

.4 Submit samples of materials required to complete work of this section for inspection and review, as requested.

.5 Post disaster dynamic analysis shall consist of computer printout where equipment has been modeled as single 3-dimensional rigid body composed of several rigidly attached lumped masses. For purpose of analysis at each support, non-linear snubber/air or spring isolator combination may be replaced by single equivalent linear spring which is dependent upon displacement amplitude. System analysis must be conservative and consider six natural modes and associated frequencies. Resultant data shall be combination of modal responses presented in form of most probable value (RMS of six modes) and upperbound value sum of absolute values of six modes.

1.4 General

.1 Provide vibration isolation on motor driven equipment with motors of ½ hp (0.37 KW) and greater (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than ½ hp (0.37 KW), provide vibration isolation grommets at support points.

.2 Provide seismic restraint for equipment including seismic restraint related hardware (bolts and anchors) from point of attachment to equipment to attachment to structure. Required anchors shall be indicated on shop drawings and clearly identified for correct location and to be readily identified after installation. Provide clear instructions for installation. Refer to Section 23 05 49, Seismic Restraints.

.3 Place isolators under equipment so minimum distance between adjacent corner isolators is at least equal to height of centre of gravity of equipment. Include height of centre of gravity on shop drawings. Otherwise, design for increased forces on supports, and submit design calculations with shop drawings for approval.

.4 Ensure isolation systems have a vertical natural frequency less than one third of lowest forcing frequency, unless otherwise unspecified. Use dynamic stiffness correction factors for elastomers and do not exceed 60 durometer.

.5 Isolators and restraining devices, factory supplied with equipment, shall meet requirements of this section. Isolation supplier to check with pump supplier for number and location of isolators and if there is requirement for structural or inertia bases.

.6 Provide concrete inertia bases or structural steel bases, where specified or required by equipment Manufacturer, located between vibrating equipment and vibration isolation elements, unless equipment Manufacturer certifies direct attachment capabilities. Coordinate with Division 3 for provision of concrete work.

.7 Coordinate with Division 3 for provision of housekeeping pads at least 4" (100 mm) high under isolated equipment, or greater thickness where specified. Provide minimum 12" (300 mm) clearance between drilled inserts and edge of housekeeping pads. Housekeeping pads shall be tied to structure with reinforcement to meet Code seismic requirements.

.8 For isolated equipment, design anchors, bolts, isolators and bases to meet Code requirements. For larger isolators, where Code requirement cannot be met by isolator housing, provide Type 6 seismic snubbers or Type 6P where post-disaster requirement is specified.

.9 Use ductile materials in vibration and seismic restraint equipment.

.10 Follow Structural Consultant's instructions for drilled inserts.

.11 Coordinate with Section 23 33 00 "Air Duct Accessories" for ductwork connections to fans or plenums.

.12 Provide flexible connectors between equipment and piping where required by Manufacturers to protect equipment from stress and reduce vibration in piping system. Meet connector Manufacturer's installation requirements as well as equipment Manufacturer's requirements.

.13 Coordinate with Electrical for the provision of a minimum 180° hanging loop of flexible conduit for electrical connections to isolated equipment.

.14 Supply isolators assembled and clearly labelled with instructions for installation by Contractor.

Part 2 Products

2.1 Isolators - General

.1 Supply of vibration isolation equipment by one approved supplied with exception of isolators which are factory installed and are standard equipment with machinery. Confirm with Manufacturer that factory-installed isolators meet seismic requirements.

.2 Select isolators at supplier's optimum recommended loading and do not load beyond limit specified in Manufacturer's literature.

.3 Provide neoprene isolators and components using maximum 60 duro "Bridge bearing quality neoprene," as defined by CSA Standard CAN3-S6-M78. Ensure design of isolation and restraint elements allows adequate clearance to avoid binding.

.4 Design springs "iso-stiff" (kx/ky = 1.0 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.

.5 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for isolation equipment located outdoors or in areas where moisture may cause corrosion.

.6 Elastomeric components in Type 1 and Type 2 isolation products and Type 6 and 6P seismic snubbers shall be bridge bearing neoprene meeting CSA Standard CAN3-S6 and CAN/CSA-S6-88. Durometer shall be defined per ASTM D 675 and within +/- of stated durometer. Minimum tensile strength (2,000 psi (13,790 kPa) for 40 durometer and 2,500 psi (17,240 kPa) for 50 and 60 durometer) and minimum elongation at break point (40 duro = 450%, 50 duro = 400% and 60 duro = 350%) to be per ASTM D 412. Tests for aging shall be per ASTM D 573 where, when tested in a 212°F oven for 70 hours, increase in hardness is no greater than 15%, tensile strength change does not exceed 15% and elongation to break is not reduced by more than 40%. Effects of ozone on product shall be as prescribed by ASTM D 1149 and material will show no cracks when tested. Compression set will be determined by ASTM 395, Method B and 40 duro product shall not exceed 40% and 50 and 60 duro product shall not exceed 25%. Compounding of the neoprene shall be in strict accordance with the Raw Material Supplier's formulation, in order to meet the above noted test procedures.

2.2 Isolators - Type 1, Pads

.1 Neoprene or neoprene/steel/neoprene pad isolators. Select Type 1 pads for minimum $\frac{3}{32}$" (2.5 mm) static deflection or greater. Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing grommets (e.g. use Hilti HVA adhesive set bolts, or equal, with steel washers and lock nuts, adjusted finger tight to hemi-grommets). Size bolt and hemi-grommet for minimum lateral clearance. Use grommets only on light-weight equipment.

.2 Acceptable Products:

- .1 Mason WMW, Super W pads.
- .2 Mason Industries Type HG Hemi-Grommets.
- .3 EAR Grommets.
- .4 Kinetics Noise Control Inc. Type RSP.

2.3 Isolators - Type 2, Rubber Floor Mounts

.1 Rubber/neoprene-in-shear isolators designed to meet specified seismic requirements. Select for 0.15" (4.0 mm) minimum static deflection and bolt to structure. Rubber isolators, provide protection in design of isolator to avoid contact of rubber element to oil in mechanical room.

.2 Acceptable Products:

.1 Mason BR, maximum 50 durometer, Kinetics Noise Control Inc. Type RD, RQ.

2.4 Isolators - Type 4, Hanger Mounts

.1 Spring hangers, complete with ¼" (6.0 mm) thick neoprene cup/bushing sized for 0.05" (1.3 mm) minimum deflection, or neoprene hangers.

.2 Acceptable Products:

.1 Mason HD, HS, Kinetics Noise Control Inc. SH.

2.5 Isolators - Type 6, Seismic Snubbers

.1 Seismic snubbers complete with minimum ⅛" (3.2 mm) neoprene brushing and ¼" (6 mm) air gap. Snubber to act omni-directionally. Ensure bushing can easily be turned by hand after installation.

.2 Acceptable Products:

.1 Manson Z-1225, Kinetics Noise Control Inc. - HS Series.

2.6 Closed Cell Foam Gaskets/Neoprene Grommets - Type 7N

.1 ¾" (19 mm) thick continuous perimeter closed cell foam gasket to isolate base of package equipment, AHUs, exhaust fans, etc. from concrete floors/roof curbs. Select width for nominal 3 psi loading under weight of equipment and allow for 25% compression 3⁄16" (4.8 mm). Increase width of curb using steel shim to accommodate gasket. For light equipment such as exhaust fans, deflection should be a minimum of 0.05" (1.3 mm). Contractor to check fire rating requirements specified for project.

.2 Acceptable Products:

.1 American National Rubber-EPDM-SBR blend SCE 41 type neoprene.

.2 Mason Industries Type HG Hemi-Grommets.

.3 Kinetics Noise Control Inc. Neoprene/EPDM Grommets.

2.7 Pipe Riser Guide/Anchor - Type 8

.1 Telescoping all direction acoustical pipe anchor consisting of two concentric steel tubes separated by 12 mm thick neoprene isolation material. Hot application isolators.

.2 Acceptable Products:

.1 Mason ADA and VSG (H), Metraflex Style IV Guides/PGQ.

.2 Generator exhausts, PRV stations, etc. - CMT VA 50247/25 Cushions, CMT W302 isolators.

2.8 Flexible Connectors - Type 9

.1 Twin sphere flexible connectors with floating flanges complete with grommetted control rods.

.2 Acceptable Products:

.1 Mason MFTNC Connector.

.2 Mason ACC Control Cables.

.3 Unisource Ultra-Sphere U302 EPDM – only for service below 200°F (93°C) and 200 psig (1,380 kPa), up to 12" (300 mm) diameter.

.4 Metraflex Double Cablesphere.

2.9 Concrete Inertia Bases

.1 Concrete inertia bases to be minimum of 1.5 times weight of isolated equipment. Base thickness shall be 1⁄12 of longest dimension of base, but no less than 6" (150 mm). Include with base, steel channel concrete form with required steel reinforcement (as determined by suppliers' Registered Professional Engineer). Provide additional steel as required by sleeves or inserts to receive equipment anchor bolts.

.2 Use height saving brackets in mounting locations to maintain 1-½" (38 mm) clearance below base.

.3 Bases furnished with built-in motor slide rails. Motor location as specified/scheduled.

.4 Acceptable Products:

.1 Mason Type K.

2.10 Steel Bases

.1 Construct structural steel bases sufficiently rigid to keep deflection and misalignment within acceptable limits as determined by equipment Manufacturer.

.2 Use height saving brackets in mounting locations to provide base clearance of 1-½" (38 mm).

.3 Bases furnished with built-in motor slide rails. Motor location as specified/scheduled.

.4 Steel bases supplied as integral part of equipment to be supplied meeting above requirements.

.5 Acceptable Products:

.1 Mason Type WF

Part 3 Execution

3.1 Installation

.1 Execute work in accordance with specifications and in accordance with Manufacturer's instructions.

.2 For equipment mounted on vibration isolators, provide minimum clearance of 2" (50 mm) to other structures, pipe equipment, etc.

.3 Before bolting isolators to structure, start equipment and balance so isolators can be adjusted to correct operating position before installing (seismically rated) anchors and/or welding.

.4 After installation and adjustment of isolators verify deflection under load to ensure loading within specified range and isolation is obtained.

.5 Where hold down bolts for isolators or seismic restraint equipment penetrates roofing membranes provide “gum cups” and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene. Coordinate with Roofing Sub-Contractor.

.6 Use Type 1 pads only where specified.

.7 Under equipment mounted on Type 3 mounts, which do not meet seismic requirement, provide Type 6 seismic snubbers.

.8 Provide Type 4 spring hangers for minimum static deflection of 1” (25 mm) for ceiling hung fans and air handling units, emergency generator exhaust piping and silencers and any other vibrating sources.

.9 Isolate pumps and axial fans rotating at more than 1170 RPM on Type 2 isolators.

.10 Use lowest RPM scheduled for two-speed equipment in determining isolator deflection.

.11 Provide concrete inertia bases on base mounted pumps unless pump Manufacturer certifies inertia base is not required. Only use pedestal support at pump intake pipe where inertia or steel base is large enough to support pedestal. Otherwise support piping using resilient hangers only.

.12 Provide concrete inertia bases on centrifugal fans where specified.

.13 Ensure pumps are installed and aligned so no piping loads are imposed on pump. Pumps and piping should be independently supported and aligned prior to final connection.

.14 Where ductwork, piping or boiler exhaust stacks, etc. connected to, or serving noise generating or vibrating equipment, is routed through walls, floors pipe chases, etc., to avoid contact with structure, future framing, drywall and other finishes which may radiate noise. Use Type 2 and Type 8 mounts. Submit proposed details to meet this requirement.

.15 Make no connections between mechanical room equipment and drywall partitions adjoining occupied spaces. Mount equipment designed for wall mounting on non-critical block work or concrete walls. Connect hangers to concrete structure only. Where structure is steel, connect to major structural beams only, or to structural angles with gussets attached to concrete shear walls. Do not attach to light framing members such as OWSJs. Do not connect to edge of beam flange (e.g. with clips). Weld nut or threaded sleeve to bottom flange at centre, directly below web, to accommodate threaded hanger rod.

.16 Provide Type 8 resilient elements in pipe anchors, where pipe anchors are within 40’-0” (12 m) of vibrating source or if located in pipe chase.

.17 Protect neoprene isolator components from overheating or use Type 8 mounts.

.18 Be responsible for ensuring that flexible duct connections (see Section 23 33 00) are installed with minimum 1-½” (38 mm) metal-to-metal gap. Use flanges to ensure that flexible connectors are clear of airstream.

.19 Isolate variable frequency drive controller using isolators or soft grommets such that structure borne noise transmission to occupied space is less than airborne noise transmission. Controller supplier to provide isolation, including wiring connections, to control flanking noise transmission. Provide isolation meeting seismic requirements.

.20 Provide stabilizing springs limiting movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start-up.

.21 Floor or Pier Mounted Equipment: Isolate floor or pier mounted equipment on Type 3 isolators, unless otherwise specified.

.22 Slab On Grade Mounted Equipment: For equipment mounted on slab on grade use on Type 2 isolators unless otherwise specified.

.23 Pumps: Mount in-line pumps on two Type 2 isolators under each support foot.

.24 Pumps: Isolate 25 hp (18.6 KW) pumps and larger on Type 5 air mounts. For slab on grade installations, isolate pumps on Type 2 mounts.

.25 Rooftop Air Handing Units:

.1 Isolate rooftop air handling units on 2” (50 mm) x 40’-0” (12 m) x ¾” (19 mm) Type 1 neoprene waffle pads. Space waffle pads for nominal 40 psi (276 kPa) under weight of rooftop unit.

.2 Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing pads/gasket. Use Hilti HVA adhesive set bolts, or equal, with steel washers and lock nuts, adjusted finger tight to hemi-grommets. Size bolts and hemi-grommet for minimum lateral clearance.

.3 Where underside of AHU is a return plenum, provide 1” (25 mm) x ¾” (19 mm) thick continuous perimeter, closed cell foam neoprene gasket (Type 7N) between pads.

.4 Isolate equipment within rooftop units in accordance with this section, including fans, compressors, pumps and piping. Ensure structure borne transmission of noise from rooftop unit is less than airborne transmission.

3.2 Inspections

.1 Supplier shall provide assistance to Contractor as necessary during course of installation of isolation equipment.

.2 Supplier shall inspect complete installation after system start-up and establish isolators for each piece of equipment are properly installed and adjusted. Supplier shall submit statutory declaration to Consultant stating complete vibration isolation installation is in accordance with his drawings and instruction and operates to his satisfaction.

3.3 Pipe Isolation Schedule

Pipe Size	Isolated Distance from Equipment
1” (25 mm)	120 diameters (9’-8” (3 m))
2” (50 mm)	90 diameters (14’-8” (4.5 m))
3” (75 mm)	80 diameters (19’-7” (6 m))
4” (100 mm)	75 diameters (24’-6” (7.5 m))
6” (150 mm)	60 diameters (29’-5” (9 m))
8” (200 mm)	60 diameters (19’-4” (12 m))
10” (250 mm)	54 diameters (44’-3” (13.5 m))

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Regulatory Requirements

.1 Restraints shall meet the requirements of the **BC Building Code and BC Fire Code**.

1.3 Seismic Restrain Design and Inspection

.1 Arrange and pay for services of British Columbia registered professional Structural Engineer who specializes in restraint of building elements. This Structural Engineer (Seismic Engineer) shall provide required engineering services related to seismic restraints of non-vibration isolated equipment, ductwork and piping as indicated below.

.2

.3 Seismic Engineer shall provide assistance to Contractor as necessary during course of restraint of equipment, ductwork and piping.

.4 Seismic Engineer shall inspect completed seismic installation and shall submit statutory declaration to Consultant stating that seismic installation is installed in accordance with their drawings and instructions and complies with regulatory requirements. Prior to Substantial completion, Seismic Engineer shall provide Letters of Assurance for mechanical, plumbing and fire protection systems.

1.4 Submittals

.1 Submit shop drawings of restraining devices including details of attachment to structure, either tested in independent testing laboratory or approved by British Columbia Registered Professional Engineer.

.2 Proposed inserts or connections to structure to follow directions of project Structural Consultant.

1.5 Application

.1 Provide cable restraints on isolated equipment and seismic restraint on other equipment, piping and ductwork; all in general accordance with SMACNA Guidelines (see Products).

1.6 Scope of Work

.1 Provide restraint on piping, ductwork, equipment and machinery, which is part of building mechanical service systems to prevent injury or hazard to persons and equipment and retain equipment in normal position in event of earthquake. This specification covers equipment, which is not specifically covered in SMACNA Guidelines.

.2 Provide seismic restraint related hardware, (including bolts and anchors) from point of attachment to equipment through to and including attachment to structure.

.3 When equipment is mounted on concrete housekeeping pads and/or concrete curbs, the anchor bolts shall extend through the pad into structure.

.4 It is responsibility of equipment Manufacturers to design equipment so that strength and anchorage of internal components of equipment exceeds force level used to restrain and anchor unit itself to supporting structure.

.5 Seismic restraints may only be omitted where permitted by SMACNA.

Part 2 Products

2.1 General

.1 Mason Type Seismic Cable Brace (SCB) slack cable restraints.

.2 Restraint systems as indicated in 1998 SMACNA "Seismic Restrain Manual Guidelines for Mechanical Systems" (second edition), Seismic Hazard Level (SHL) A. If lesser restraint is proposed to meet local Code seismic requirements, provide shop drawings of details certified by Seismic Engineer.

Part 3 Execution

3.1 General

.1 It is responsibility of Contractor to ascertain that appropriate size device be selected for each individual piece of equipment.

.2 The following are guidelines for some items not covered in SMACNA but certified shop drawings shall still be submitted. This list does not cover all equipment requiring restraints.

3.2 Air Terminals

.1 Where air terminals are installed in mechanical grid ceilings, provide at least two 12 ASWG galvanized steel wire seismic security bridles per air terminal tied either to the building structure or to ceiling hanger wires.

.2 Attach security bridles at opposite corners of each air terminal and such that the air terminal cannot fall.

.3 Provide necessary brackets for attachment of security bridles to air terminals.

3.3 Radiant Ceiling Panels

.1 Provide 12 ASWG galvanized steel wire seismic security bridles from radiant ceiling panel cross brace to building structure or to ceiling hanger wires at maximum 4'-0" (1.2 m) OC.

3.4 Transfer Ducts, Return-Air Sound Traps, etc.

.1 Provide seismic restraints in accordance with details in SMACNA Guidelines or, alternatively, slack cables may be used.

.2 Non-Isolated Floor Mounted Equipment

.3 Bolt non-isolated equipment and machinery (e.g. floor mounted tanks, heat exchangers, boilers, etc.) to structure. Design anchors and bolts for seismic force applied horizontally through centre of gravity. For equipment, which may be subject to resonances, use nominal 2.0g seismic force.

.4 Isolated Piping and Equipment

.5 Install cables using appropriate grommets, shackles, and other hardware to ensure alignment of restraints and to avoid bending cables at connecting points.

.6 Connect slack cable restraints to ceiling hung equipment such that axial projection of wires pass through centre of gravity of equipment.

.7 Orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), and tie back to ceiling slab at angle not exceeding 45° to slab.

.8 On piping systems, provide transverse slack cable restraints at maximum spacing of 40'-0" (12 m) and longitudinal restraints at 80’-0” (24 m) maximum spacing, or as limited by anchor/slack cable performance. For pipes greater than NPS 10, reduce transverse restraint spacings 20'-0" (6.1 m). Small pipes may be rigidly tied to big pipes for restraint, but not the reverse.

.9 Transverse bracing for one pipe section may also act as longitudinal bracing for pipe connected perpendicular, provided bracing is installed within 24” (600 mm) of elbow or T, and if connected pipe is same or smaller in size. Do not use branch lines to restrain main lines.

.10 Provide flexibility in piping joints or sleeves where pipes pass through building seismic or expansion joints.

.11 At vertical pipe risers, wherever possible, support weight of riser at point above centre of gravity of riser. Provide lateral guides at top and bottom of riser, and intermediate points not to exceed transverse spacings indicated above for horizontal pipes, with guide clearance not exceeding ⅛” (3.2 mm).

.12 Vary adjacent spacing of restraints on piping run by 10% to 30% to avoid coincident resonances.

.13 Install restraints at least 2” (50 mm) clear of other equipment and services.

.14 Adjust restraint cables so they are not visibly slack, or so the flexibility is approximately 1-½” (38 mm) under thumb pressure for 5’-0” (1.5 m) cable length (equivalent ratio for other cable lengths). Adjust clearance at cable strap/spacer piece to not exceed ¼” (6 mm).

.15 Provide transverse and axial restraints as close as possible to vertical bend.

.16 At steel trusses, connect to top chords and follow truss Manufacturer’s instruction.

.17 For post disaster installations, provide vertical rod stiffeners when rod length is great than 50 rod diameters.

.18 Maximum spacing between transverse and longitudinal restrains for piping and duct work shall be 25% less than specified in SMACNA for SHL A.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

.2 References: American National Standards Institute (ANSI) – ASME A13.1 (Rev. 1985) Scheme for the Identification of Piping Systems.

1.2 Equipment Identification

.1 Manufacturer's Nameplates:

- .1 Each piece of manufactured equipment shall have metal nameplate, with raised or recessed letters. Mechanically fasten plate to equipment.
- .2 Manufacturer's nameplates shall indicate Manufacturer's name, equipment model, size, serial number and electrical characteristics and pertinent information for any other service connections.
- .3 Include Underwriters' Laboratories Canada (ULC) or Canadian Standards Association (CSA) registration logos and those of other agencies, as required by respective agencies.
- .4 Nameplates shall be located so they are easily read. Do not insulate or paint over name plates.

.2 System Nameplates:

- .1 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, cooling coil CC-1, pump P-1.
- .2 Identification letters shall be 2" (50 mm) high black letters on white background, sized to suit label or provide laminated plastic plates with black face and white centre of minimum size 3-½" (90 mm) x 1-½" (38 mm) x 3⁄32" (2.5 mm) engraved with ¼" (6.0 mm) high lettering. Use 1" (25 mm) high lettering for major equipment.
- .3 Apply nameplates securely in conspicuous places, on cool surfaces.
- .4 Identify systems, and areas or zones of building being serviced.

1.3 Piping Identification

.1 Piping Identification:

- .1 Each piping system shall be colour coded for identification and labelled with system identification code letters, including temperature and pressure, if applicable, and directional flow arrow in accordance with Pipe Identification Colour Schedule.
- .2 Identifying piping (pipe markers and direction arrows) at the following locations:
  - .1 Adjacent to major valves and where valves are in series at no more than 6'-6" (2.0 m) intervals.
  - .2 At least once in each room and 50'-0" (15 m) maximum spacing in open areas.
  - .3 Gas piping to be identified at 6'-6" (2.0 m) intervals in ceiling plenums.
  - .4 On both sides where piping passes through walls, partitions and floors.

.5 Adjacent to major changes in direction.

.6 At point of entry and leaving each pipe chase and/or confined space and piping accessible at each access opening.

.7 At beginning and end points of each run and at each piece of equipment in each run.

.3 Identification labels may be stencilled. Identification arrows, labels and letters may be vinyl cloth (Brady B500) or vinyl film (Brady B946), with adhesive compatible with surface temperature.

.4 Identification colour bands for primary and secondary colours to indicate the type and degree of hazard shall be applied to overlap a minimum of 6" (150 mm). Ends to be stapled. Bands shall be Brady B550 vinyl cloth tape or Brady B946 vinyl tape, with adhesive compatible with surface temperature.

.5 Identification may consist of semi-radid plastic vinyl labels with surface printing. On pipes larger than 6" (150 mm) diameter total O.D., these labels shall be saddle style, and shall ship complete with 33.5" (850 mm) long nylon cable ties for each label. Standard of acceptance: SMS Coil-Mark (http://www.smillieltd.ca/pdfDocs/Indentification-Systems/Coil-Mark.pdf)

.2 Valve Tags:

.1 Provide valve identification tags and secure them using non-ferrous chain, braided band or plastic band (suitable for temperature). Tags may be of brass, aluminum, metalphoto, lamicoid or fibreglass, stamped or engraved, of 1" (25 mm) minimum diameter. Tags may also be 1-¼" (32 mm) square, two-ply plastic with engraved black characters on white background. Standard of acceptance: SMS valve tags (http://www.smillieltd.ca/pdfDocs/Indentification-Systems/PHSVT.pdf)

.2 Valves to be tagged include:

.1 Valves on main piping circuits.

.2 Valves on major branch lines.

.3 Valves on minor branch lines in horizontal service spaces, vertical service spaces and mechanical equipment rooms.

.4 DO NOT TAG valves on control valve stations, fixture stops, or system drain valves.

.5 Drain valves and hose bibbs on systems containing glycol.

.6 Control valves

.3 Schedule valve numbers using sequential numbering system indicating location, service and the normal position (open or closed). Numbers shall be prefixed by letter "P" or letter "H" indicating valve is on plumbing or heating service.

1.4 Ductwork Identification

.1 Identify plenum access doors with accessed items, e.g. Filter F-1, Supply Fan SF-1, Cooling Coil CC-1.

.2 Stencil on plenum doors, downstream from air filter bank, "Do not open when fan operating."

.3 Identify ductwork in mechanical equipment rooms to denote system and/or zone served and air flow direction arrow.

.4 Identify automatic control dampers concealed in ductwork. Identify "open" and "closed" position of operator arm on outside of duct or duct insulation.

.5 Identification letters shall be 2" (50 mm) high black letters on white background. Flow arrows shall be 2" (50 mm) wide by 6" (150 mm) long black arrows on white background. Stencil over final finish only.

1.5 Ceiling Access Identification

.1 Secure ¼" (6.0 mm) self-adhesive coloured dots (Brady Quik Dots or Avery Data Dots) to ceiling to identify location of access to equipment concealed above ceiling, according to the following schedule:

	Colour
Concealed equipment and cleaning access	Yellow
Control Equipment, including control valves, dampers and sensors	Black
Fire dampers	Red
Fire protection, including sprinkler equipment and drains	Red
Heating/Chilled water, DCW, DHW isolation valves	Green
Pipe mounted equipment, other than fire and sprinkler equipment	Green

.2 When T-bar ceilings are installed, adhere coloured dots to T-bar framing, adjacent to panel to be removed.

1.6 Duct Access Identification

.1 Secure 2" (50 mm) high, Gothic style self-adhesive stick-on letters, (Letrasign or Brady Quick Align) on duct access panels to identify their usage, according to the following schedule:

	Colour	**Letters**
Cleaning and service access	black	C.A.
Controls, including sensors	black	C
Dampers (backdraft, balance and control)	black	D
Fire dampers	red	F.D.
Smoke detectors	red	S.D.

1.7 Tagging Identification

.1 Secure engraved laminated plastic identification tags (black face and white centre) on the following items:

.1 Temperature control instruments, gauges and panels, coordinated with control diagrams identification.

.2 Electrical switchgear supplied under the Mechanical.

.3 Refer also to Controls Sections.

1.8 Identification Schedules

.1 Submit schedules of the following for review prior to framing:

.1 Pipe Identification Colours.

.2 Valves.

.3 Ceiling Access Identification Colours.

.4 Duct Access Identification Colours.

.2 Schedules will be required in each major mechanical room and at least one schedule will be required on each floor having minor mechanical room. Frame schedules under glass in matching frames and hang where directed.

.1 Include one copy of schedules in each operating maintenance manual.

1.9 Pipe Identification Colour Schedule

Service	Identification Lettering	Primary Colour	Secondary Colour
Boiler Blow Off Piping	-	yellow	black
Boiler Blowdown	-	yellow	black
Boiler Feed Water	B.F.W.	yellow	black
Chilled Water Return	CH.W.R.	green	-
Chilled Water Supply	CH.W.S	green	-
Cold Water Service	C.W.	green	-
Fire Combined Standpipes	SPR/S.P.	red	white
Domestic Cold Water	D.C.W.	light blue	-
Domestic H.W. Recirc.	D.H.W.R.	yellow	black
Domestic H.W. Supply	D.H.W.S.	yellow	black
Fire lines W.S.	W.S.	red	white
Fuel oil 2,3,4,5,6	F.O.#	yellow	orange
Glycol Heating Return	GLR - do not drain	orange	black
Glycol Heating Supply	GLS - do not drain	orange	black
Heat Pump Water return	H.P.W.R.	yellow	black
Heat Pump Water supply	H.P.W.S.	yellow	black
Hot Water Return	H.W.R.	yellow	black
Hot Water Supply	H.W.S.	yellow	black
Natural Gas	Gas (Pressure)	yellow	orange
Safety Valve Blowdown	-	yellow	black
Fire Sprinkler lines	SPR	red	white
Fire Sprinkler lines (Dry)	SPR (DRY)	Red	white
Sanitary Drain	SAN	None	None (-)
Plbg Vent	PVent	None	(-)
Storm Drain	Storm	None	(-)

1.10 Pipe Identification Banding Colours

.1 Letters:

.1 ½" (12 mm) high - 1-¼ NPS pipe and smaller.

.2 1" (25 mm) high - 1-½ NPS up to 2-½ NPS pipe.

.3 2" (50 mm) high - 3 NPS and larger pipe.

.2 Bands:

.1 1-½" (38 mm) wide, except arrow bands 2" (50 mm) wide.

.3 Colours:

.1 Horizontally hatched - primary colour.

.2 Vertically hatched - secondary colour.

.3 Black letters and arrows on yellow primary colour.

.4 Background, white letters and arrows or red, blue or green backgrounds.

1.11 Buried Piping Identification/Markers

.1 Metallic Pipe: Provide continuously printed 4” (100 mm) wide x 4 mil thick “Blaze Orange” plastic tape with printing indicating type of service of buried pipe. Place tape at ±12” (300 mm) above buried pipe in backfill.

.2 Non-Metallic Piping: Provide detectable multi-ply tape consisting of aluminum foil core between two (2) layers of 4” (100 mm) x 4 mill thick “Blaze Orange” plastic tape with printing indicating type of service of buried pipe. Place tape at ±12” (300 mm) above buried pipe in backfill lifts.

.3 Where multiple small pipes are buried in a common trench and do not exceed an overall width of 18" (450 mm), install a single tape line marker.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Work Included

.1 Adjust and balance hydronic systems.

.2 Adjust and balance domestic cold water systems, domestic hot water recirculation system and plumbing mixing valves.

.3 Adjust and balance air systems.

.4 Perform acoustic measurements.

.5 Confirm operation of Fire Protection Systems.

1.3 Intent

.1 Perform work as an integral part of contract.

1.4 Quality Assurance

.1 Acceptable TAB Contractors are: MDT Systems, KD Engineering, Western Mechanical Services, Inland Technical Services, Central Interior Air Balancing Ltd and RA Bruce and Associates.

.2 Acceptable TAB firms shall be credentialed by international organizations such as AABC (Associated Air Balance Council) and the NEBB (National Environmental Balancing Bureau). Exceptions to credentialed TAB firms would require submittal to the Consultant for review and approval.

.3 Procedures shall be in accordance with current edition of AABC's National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB's Procedural Standards for TAB Environmental Systems.

.4 Each Balancing TAB Sub-Trade (other than those with proper acceptance) intending to bid for work shall submit the following information not less than seven days before close of Sub-Trade tenders. ANY FIRM THAT DOES NOT COMPLY WILL NOT BE ACCEPTED BY CONSULTANT.

- .1 List previous projects of similar scope with dates projects were executed.
- .2 Outline depth of firm including principals, years of operation, address and phone number.
- .3 List instruments and procedures that will be used on project.
- .4 List name of job site supervisor and provide resume of his/her specific work experience.
- .5 Provide sample of balance report on project of similar scope.

1.5 Submittals

.1 Submit name of proposed TAB firm for approval within **seven** days of contract award.

.2 Include qualifications, including name and qualification of individual certifying reports. Failure to submit name of TAB firm within required time period shall be cause for Consultant to select an alternative firm to carry out work at no change in contract price.

.3 Within 14 days of request, TAB schedules and agenda shall be submitted for approval. TAB work shall not commence until approved.

1.6 Procedures

.1 General: Before starting TAB work, review with Consultant methods and instruments to be used. Include descriptive data, procedure data and sample forms.

.2 Descriptive Data: Review design concepts and general function of each system including associated equipment and operation cycles including BAS Systems sequence of operations. Confirm listing of flow and terminal measurements to be performed and selection points for proposed sound measurements.

.3 Procedure Data: Outline procedures for taking test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

.4 Data sheets required as a minimum are as follows:

- .1 Air System Schematic Diagram
- .2 Air Moving Equipment Test Sheet.
- .3 Exhaust Fan Test Sheet.
- .4 Air Distribution / Outlets Test Sheet
- .5 Air Distribution Duct Traverse Test Sheet
- .6 Air Moving Equipment Static Pressure Profile Test Sheet
- .7 Hydronic System Schematic Diagram
- .8 Circulation Water Pump Data Sheet.
- .9 Hydronic Distribution / Terminal Test Sheet
- .10 Covering comments sheet detailing systems balanced setpoints.

Note: All test sheets shall include a Column detailing achieved results as a % of design.

1.7 Cooperation

.1 TAB firm shall check and report defects or deficiencies that may affect balancing.

.2 Mechanical Contractor shall cooperate with balancing firm to:

- .1 Provide sufficient time before final completion date so that TAB can be accomplished.
- .2 Provide labour and tools to make corrections without delay.
- .3 Place heating ventilating and air conditioning systems and equipment into full operation and continue operation.
- .4 Advise TAB firm of changes made to system during construction.
- .5 Install required test holes complete with removable and replaceable plugs.
- .6 Make necessary revisions to controls, dampers, fan and pump drives and consult with equipment Manufacturers as required to achieve specified systems performance.
- .7 Supply and install dampers as shown and where required to obtain final system balance.

.8 Provide ladders scaffolds, tools and labour to assist work of balancing firm, including removing ceiling tiles and guards and adjusting pulleys and belts, replace when finished.

.9 Control and/or equipment Manufacturer shall work with balancing firm when setting damper linkages and minimum outside air dampers. They shall be available for readjusting of dampers of controls improperly calibrated.

.10 Set pressure regulating valves to operating and code conditions.

.11 Check and set relief and safety valves to code requirements.

.12 Clean strainers. Provide clean air filter immediately before air balancing.

.13 Open fire dampers.

.14 Change variable pitch pulley supplied on 15 hp (11 KW) motors and larger to fixed pulleys after air balance. Provide pulleys.

.15 Provide drive changes required to suit final balance.

1.8 Tests

.1 Give written 24 hour notice of date for tests.

.2 Do not externally insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.

.3 Conduct tests in presence of Consultant. Arrange for Owner's Representative to be present.

.4 Bear costs including retesting and making good.

.5 Refer to Piping Sections for specific test requirements.

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

Part 2 Products

2.1 Instruments

.1 Instruments for TAB of air and hydronic systems shall have been calibrated within six months and verified for accuracy before start of work.

.2 Submit list of equipment to be used for balancing and calibration certificates for each instrument listed.

Part 3 Execution

3.1 General Procedures

.1 TAB to maximum flow deviation from specified values of 10% at terminal devices and -0% +5% at equipment or mean sound level deviation of 20 db. Provide air balancing volumes and settings for all air supply, exhaust and return air ducts and terminals regardless of whether a special air volume tag has been noted on the drawing.

.2 Permanently mark setting on valves, splitters, dampers and other adjustment devices.

.3 Take measurements to verify system TAB has not been disrupted or such disruption has been rectified.

.4 At final field review, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.

.5 At completion, allow minimum two days for Consultant to witness test procedures and conduct tests for each system.

.6 When building is occupied before completion, continue execution of work outside occupied hours.

3.2 Site Visits

.1 Schedule site visits as required with site meetings held by Contractor. After each visit, submit written report to Contractor and Consultant. Site visits shall commence after start of air distribution work and be spread over remaining construction period to start of balancing.

.2 Review of installation shall be made at scheduled visit and any additional dampers or valves required for proper balance shall be reviewed with Consultant and Contractors.

.3 Allow for **4** visits to site to adjust systems for seasonal changes during warranty.

3.3 Acceptance

.1 Mechanical systems shall not be considered ready for final field review until TAB results are acceptable to Consultant.

.2 If found that specified flows cannot be achieved on portions of system, actual conditions shall be reported to Consultant for consideration of correctible action before continuing TAB procedure.

.3 If measured flow at final field review shows deviation of 10% at terminal devices, 5% at equipment or more or mean sound level deviation of 10 db or more from certified report listing, by more than 10% of selected areas, report shall be rejected.

.4 If report rejected, systems shall be re-balanced and certified report submitted at no extra cost.

3.4 TAB Report

.1 Submit draft copies of reports before final acceptance of project. Provide **3** copies of final report for inclusion in Operating and Maintenance Manuals.

.2 Submit with report, fan and pump curves with operating conditions plotted.

.3 Report shall be indexed as follows:

Section 1 Instrumentation and Measurement Procedures.
Section 2 System Data (Designed, Installed and Recorded), test sheet to be systems sequential.
Each system should including the following test sheets:

.1 System Schematics for both air and hydronic systems.

.2 Maintain equipment test sheets.

.3 System distribution (inlet / outlets / valves) test sheets.

.4 Profile pressure test sheets.

.5 Comments sheet noting system setpoints.

Section 3 Drawing.
Section 4 Discussion of Results.
Section 5 Warranty and Certification

3.5 Air System Procedures

.1 Execute air systems balancing for each air system in accordance with AABC and NEBB specifications and as described herein.

.2 Make tests with supply, return and exhaust systems operating and doors and windows closed or in normal operation condition.

.3 Test and adjust blower rpm/speed to design requirements.

.4 Test and record motor full load amps.

.5 Make air quantity measurements in supply and return ducts at each major air handling or rooftop system by pilot tube traverse of entire cross-sectional area. Take minimum of 16 readings on each air handler.

.6 Test and record required and measured system static pressures, filter differential, coil differential and fan total static pressure.

.7 Test and adjust systems for design recirculated airflows rates.

.8 Test and adjust systems for design outdoor air quantities.

.9 Test and record entering air temperatures (DB heating) (DB/WB cooling).

.10 Test and record leaving air temperatures (DB heating) (DB/WB cooling).

.11 Adjust main supply and return ducts to design flow rates.

.12 Adjust zones to design, supply and return flow rates.

.13 Test and adjust each diffuser, grille and register to within 10% of design requirements.

.14 Identify each diffuser, grille and register as to location and area.

.15 Identify and list size, type and Manufacturer of diffusers, grilles, registers and testing equipment. Use Manufacturer's rating on equipment to make required calculations.

.16 Control and/or equipment Manufacturer shall set adjustments of automatically operated dampers to operate as indicated in cooperation with balancing firm.

.17 Adjust diffusers, grilles and registers to minimize drafts.

.18 Provide fire damper drop tests, in association with the sheet metal contractor in accordance with Section 23 33 00.

.19 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

.20 Vary total system airflow rates by adjustments of fan speeds. Vary branch air quantities by damper regulation.

.21 Provide system schematic with required and actual air flow rates at each outlet or inlet. Schematic shall include all fire dampers shown on drawings.

.22 Record installed fan drive assemblies, fan sheaves, motor sheaves and belts.

.23 Record each installed motor Manufacturer.

.24 Final balanced condition of each area shall include testing and adjusting of pressure conditions. Test and record building pressurization levels in variable volume systems throughout full range of fan delivery rates, under both heating and cooling conditions. Test pressure conditions at ground, intermediate and upper levels. Check front doors, exits and elevator shafts for airflow so that exterior conditions do not cause excessive or abnormal pressure conditions. Document abnormal building leakage conditions noted.

.25 Complete TAB to achieve positive building pressure unless otherwise instructed. Positive pressure relative to outside pressure of 0.04" w.g. (10 Pa) minimum and 0.07" w.g. (18 Pa) maximum shall be achieved, measured with negligible outside wind velocity.

3.6 Hydronic System Procedures

.1 Preparation of System - Phase I: Hydronic system shall be prepared for TAB by Mechanical Contractor in the following manner:

.1 Open valves, close bypass valves.

.2 Determine water in system has been treated and is clean.

.3 Check pump rotation.

.4 Confirm expansion tanks are not air bound and system is full of water.

.5 Confirm air vents at high points are installed properly and are operating freely and air is removed from circulation system.

.6 Set temperature controls for full flow.

.7 Check operation of automatic bypass valves.

.8 Check and set operating temperature of equipment to design requirements.

.2 TAB Procedure - Phase II:

.1 Set pumps to proper flow rate.

.2 Proportionally balance flow of water through equipment.

.3 Record leaving water temperatures and return water temperatures and pressure drops through equipment. Reset to design temperatures.

.4 Record water temperature at inlet side of terminals. Note rise or drop of temperatures from source.

.5 Proportionally balance each terminal or in the absence of flow measuring commissioning valves balance each terminal based on temperature differential including a check and confirmation that all auto-flow valves are correctly installed, and are set at the correct flow.

.6 Upon completion of flow readings and adjustments, mark settings and record data.

.7 Coordinate shaving of pump impeller to pump operating condition on pumps larger than 2 hp (1.5 KW).

.3 TAB Procedure - Phase III:

.1 After adjustments to terminals, recheck settings at pumps. Readjust if required.

.2 Read pressure drop through each terminal and set flow rate on call for full flow. Set pressure drop across bypass valve to match terminal full flow pressure drop.

3.7 TAB Data

.1 TAB and equipment data shall be listed in imperial (SI Metric) Units.

.2 Air Handling Equipment Installation Data:

Arrangement, discharge and class.
Motor type, hp (KW), rpm (r/min), voltage, phase cycles and full load amps.
Location and local identification.

.3 Air Handling Equipment Design Data:

Airflow rate (cfm (L/s)).
Static pressure (“ w.g. (Pa)).
Motor hp (KW), rpm (r/min) and amps.
Outside airflow rate (cfm (L/s)).
Fan rpm (r/min).
Fan hp (KW).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).

.4 Air Handling Equipment Recorded Data

Airflow rate (cfm (L/s)).
Static pressure (“ w.g. (Pa)).
Fan rpm (r/min).
Motor operating amps.
Entering and leaving air dry and wet bulb temperatures (°F (°C)).

.5 Duct Air Quantities - Mains, Branches, Outside Air and Exhausts (Minimum and Maximum)

Duct sizes (at traverse normally) (inches (mm)).
Number of pressure readings.
Sum of velocity measurements.
Average velocity (ft/m (m/s)).
Duct recorded airflow rate (cfm (L/s)).
Duct design airflow rate (cfm (L/s)).

.6 Air Inlets and Outlets:

Outlet identification, location and designation.
Application factors.
Design and recorded airflow rates (cfm (L/s)).

.7 Building Pressurization Data

Outside air temperatures (°F (°C)).
Outside wind velocity (ft/m (m/s)).
Building pressures plotted with respect to systems (“ w.g. (Pa)).
Supply air, return air and exhaust airflow rates (cfm (L/s)).
Locations of pressure measuring points, inside and outside building.

.8 Pump Design Data

Water flow rate (USgpm” (L/s)).
Pressure (ft of head (kPa)).
Pump Motor rpm (r/min).
Pump Motor hp (KW)

.9 Pump Installation Data

Size.
Drive type.
Motor type, hp (KW), rpm (r/min), voltage phase, cycles and full load motor amps.

.10 Pump Recorded Data

Discharge and suction pressures (full flow and no flow) (ft of head (kPa)).
Pressure and total dynamic head (ft of head (kPa)).
Water flow rate (from pump curves if metering not provided) (USgpm" (L/s)).
Motor amps.

.11 Expansion Tank Installation Data

Manufacturer, size and capacity (inches (mm)) and USgal (L)).
Pressure reducing valve setting (psi (kPa)).
Pressure relief valve setting (psi (kPa)).

.12 Heating Equipment Design Data

Heat transfer rate (mbh (kw)).
Water flow rate (USgpm" (L/s)).
Entering and leaving water temperatures (°F (°C)).
Water pressure drop (ft of head (kPa)).

.13 Heating Equipment Recorded Data

Element type and identification (location and designation).
Entering and leaving water temperatures (°F (°C)).
Water pressure drop (ft of head (kPa)).
Water flow rate (USgpm" (L/s)).

.14 Heat Exchanger Design Data

Manufacturer, model, and type.
Water flow rates (tube and shell) (USgpm" (L/s)).
Inlet and outlet temperatures (°F (°C)) (tube and shell).

.15 Heat Exchanger Recorded Data

Heated media flow rate (USgpm" (L/s)).
Heating media flow rate (USgpm" (L/s)).
Heated media entering and leaving temperatures (°F (°C)) and pressure drop (ft of head (kPa)).
Heating media entering and leaving temperatures (°F (°C)) and pressure drop (psi (kPa)).

.16 Air Heating and Cooling Equipment Design Data

Heat transfer rate (mbh (kw)).
Water flow rate (USgpm" (L/s)).
Airflow rate (cfm (L/s)).
Water pressure drop across coil (ft of head (kPa)).
Air static pressure drop (" w.g. (Pa)).
Entering and leaving water temperatures (°F (°C)).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).

.17 Air Heating and Cooling Equipment Recorded Data

Element type and identification (location and designation).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
Entering and leaving water temperatures (°F (°C)).
Water pressure drop across coil (ft of head (kPa)).
Water pressure drop across bypass valve (ft of head (kPa)).
Air static pressure drop (" w.g. (Pa)).
Water flow rate (USgpm" (L/s)).
Airflow rate (cfm (L/s)).

Adjusted temperature rise or drop (°F (°C)).

.18 Hydronic Heat Pump Design Data

Manufacturer and Model.
Fan and compressor motor type, hp, rpm, voltage cycle, phase and full load amps.
Water flow rates (USgpm" (L/s)).
Water temperatures entering and leaving (°F (°C)).
Airflow rates (cfm (L/s)).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
Static pressure (" w.g. (Pa)).

.19 Hydronic Heat Pump Recorded Data

Water flow rates (USgpm" (L/s)).
Water temperatures entering and leaving (°F (°C)).
Airflow rates (cfm (L/s)).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
Static pressure (" w.g. (Pa)).

.20 Sound Level Data

Diagram or description of relationship of sound source to measuring instrument.
Overall DB (A) level.
Reading at each octave band frequency from 31.5 Hz to 16 kHz.
NC curves plotted and compared to those recommended by ASHRAE or AABC publications.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 General

.1 Provide external thermal insulation for plenums and ductwork where specified.

.2 Provide internal acoustical insulation for plenums and ductwork where specified.

.3 Journeyman insulation applicators shall supervise the insulation work.

.4 Be responsible for ensuring sufficient space is provided for proper installation of insulation materials.

.5 All insulation shall be in accordance with the latest edition of the "BC Insulation Contractors Association (BCICA) Standards Manual" as reference standard. This project requires the Mechanical Insulation Contractor to provide a BCICA Quality Assurance Certificate (QCA). The Mechanical Insulation Contractor shall register this project with BCICA and shall be in full compliance with the requirements of the QAC Program. Materials must be installed by tradespersons with a Red Seal or TQ Designation in the Heat and Frost Trade as detailed in the QAC Program.

.6 Install insulation with related materials and accessories in accordance with the manufacturer's recommended installation instructions. Where this specification exceeds the BCICA Standards, the Contractor shall meet this specification standard.

1.3 Regulatory Requirements

.1 Flame spread ratings and smoke developed classifications shall be as required by applicable code,
CAN/ULC-102-10 and NFPA 90A. Flame spread rating throughout material shall not exceed 25 and smoke developed shall not exceed 50. Materials shall not flame, smoulder, smoke, or glow at temperatures they are exposed to in service.

.2 Minimum insulation thickness and insulating values shall be in accordance with NECB latest edition or ASHRAE Std 90.1 latest edition or as per the schedule in this specification, whichever is more stringent.

.3 Fibreglass duct wrap shall comply with:

- .1 CAN 4-S102.
- .2 CAN/CGSB-51.5M; Type II (FSK Facing).
- .3 CAN/CBSB-51.11-92.
- .4 CCG Low FS Laminate Cert. #GI-141.
- .5 ULC Listed and classified.
- .6 ASTM C 553; Type I, II III
- .7 ASTM C 795.
- .8 ASTM C 1136; Type II (FSK and PSK facings only)
- .9 ASTM C 1290; Specification for flexible fibrous glass blanket/HVAC ducts.
- .10 ASTM E-84 Surface Burning Characteristics, 25/50 Flame/Smoke.

.11 CAN/ULC – S102-10 “Test for Surface Burning Characteristics of Building Materials”.

.4 Fibreglass insulation board shall comply with:

.1 CAN-4-S102.

.2 CBSB 51-GP-10M.

.3 CGSB 51-GP-52M (facings).

.4 ASTM C 612.

.5 ASTM C 795.

.6 ASTM E-84 Surface Burning Characteristics, 25/50 Flame/Smoke.

.7 CAN/ULC-S102-M88

.8 ASTM C.1136 for Facings

.5 Duct liner (internal lining) shall comply with:

.1 CAN 4-S102.

.2 CAN/CGSB 51.11-92.

.3 ULC listed.

.4 ASTM C 1071; Type I.

.5 NFPA 90A and 90B.

.6 Microbial Growth; ASTM C 1338, G21, G22.

.6 All insulation products shall be formaldehyde-free.

1.4 Qualifications and Samples

.1 Submit Manufacturer documentation (and samples when requested) for materials, applications and finishing methods to establish they satisfy specification and meet applicable code requirements, before commencing work.

1.5 Definitions

.1 “Concealed” means insulated mechanical services in furred spaces, shafts and hung ceilings.

.2 “Exposed” will mean not concealed.

Part 2 Products

2.1 Insulation products shall contain none of the following, Asbestos, Lead, Mercury, Formaldehyde or any related compounds. Insulation products shall be certified UL green guard gold or ‘indoor advantage gold’. Insulation products shall contain 50% or more recycled content and provide verification.

2.2 External Flexible Insulation

.1 External flexible glass fibre insulation with integral vapour barrier:

.1 Minimum density – 1.0 lb/ft^3 (16kg/m^3)

.2 Thermal conductivity at 75°F - 0.024 BTU/hr/ft/°F (24°C - 0.042 W/m/°C).

.3 Acceptable Manufacturers:

.1 Certainteed STD Ductwrap #75 FSK, Manson Alley-Wrap FSK, Owens Corning Soft.R.FSK Ductwrap, Knauf FSK Ductwrap with ECOSE technology, Johns-Manville Micro Lite FSK.

2.3 Duct Liner

.1 Rigid Duct Liner:

.1 Yellow or naturally coloured internal rigid glass fibre acoustical insulation with black sealer coating on one face.

.2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using Type "A" mounting.

.3 Thermal conductivity at 75°F - 0.020 BTU/hr/ft/°F (24°C - 0.035 W/m/°C).

.4 Acceptable Manufacturers:

.1 Certainteed Toughgard 300#, Manson Akousti-Liner R, Knauf Rigid Plenum Liner with ECOSE technology, Johns-Manville Permacoat R300, Owens Corning Quiet-R Rigid Coated Duct Liner.

.2 Flexible Duct Liner:

.1 Yellow or naturally coloured internal flexible glass fibre acoustical insulation with one face faced with non-woven fibreglass mat.

.2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using Type "A" mounting.

.3 Thermal conductivity at 75°F - 0.023 BTU/hr/ft/°F (24°C - 0.040 W/m/°C).

.4 Acceptable Manufacturers:

.1 Certainteed Toughgard Duct Liner 150# or Type 150, Manson Akousti-Liner, Knauf Duct Liner with ECOSE technology, Owens Corning Quiet-R Rotary Duct Liner.

2.4 Accessories

.1 Insulation Adhesive:

.1 Bakelite 230-39, Childers CP-82, CP-56W, Design Polymerics DP2502, Foster 85-20, Polymer Glasstack #25, Robson Ticki-Tuff.

.2 Vapour Barrier Tape (FSK):

.1 Finishing tape to meet flame spread rating and smoke developed classification requirements of applicable code and compatible with facing material, CAN/ULC-S102.

.2 Foil, scrim and kraft paper FSK foil faced retarder tape complying with ASTM 1136 self-adhesive tape.

.3 Vapour Barrier Adhesive:

.1 Bakor 230-21, Childers CP-82, Design Polymerics DP2502, Foster 85-20, 3M 4230.

.4 Insulation Coating Water Based for Indoor Use:

.1 Foster 30-33/30-65; Childers CP 33/35.

.5 Weather Coating - vapour barrier Water Based for Indoor/Outdoor Use:

.1 Knauf expert mastic K1-700ASJ; or K1-705-ASJ; Foster Weathertite 46-50; Childers Vicryl CP-10/11

.6 Reinforcing Membrane:

.1 Glass reinforcing membrane as commercially available.

.7 Seal Coating, Fabric Adhesive and Fabric Coating:

.1 Bakor 120-09, Childers CP-50 AMV1, Design Polymerics DP3050, Foster 30-36/81-42.

2.5 Duct Insulation Schedule and Thickness

.1 External Flexible Insulation with vapour barrier. (Exposed within room which is being served by exposed ducts, do not require external insulation).

Service	Thickness
Cooling and heating supply ducts - where temperature difference between space where duct is located and design air temperature in duct is less than or equal to 40°F (22.2°C).	1” (25 mm)
All cooling and heating supply ducts - where the temperature difference between the space within which the duct is located and the design air temperature in the duct is greater than 40°F (22.2°C).	1-½” (38 mm)
Outdoor air ductwork and plenums (from intake to mixing plenum).	2” (50 mm)
Combustion intake/relief air.	2” (50 mm)
Exhaust air discharge through roof (including sides and bottom of plenum).	2” (50 mm)
Exhaust air ductwork outside the building.	1” (25 mm)
All exhaust air ductwork from the outside wall or roof to 5’-0” (1.5 m) inside building.	1-½” (38 mm)

.2 Internal Flexible Duct Liner

Service	Thickness
All ductwork where indicated by single hatching.	1” (25 mm)
All supply ductwork in the mechanical room (From AHU discharge to duct shaft), or to 3 m beyond fan/mechanical room.	2” (50 mm)

.3 Internal Rigid Duct Liner

Service	Thickness
Built-up site fabricated air handling unit(s). Line sheet metal walls and tops from inlet dampers to discharge dampers. Do not line transverse walls containing coils, filters or fan discharge.	2” (50 mm)
Built-up site fabricated heat recovery exhaust unit(s). Line sheet metal walls and tops.	2” (50 mm)
All outdoor air plenums. Line sheet metal walls and top.	2” (50 mm)

Part 3 Execution

3.1 Application

.1 Apply external insulation to ductwork only after pressure tests have been made and systems accepted.

.2 Apply insulation and insulation finish so finished product is uniform, smooth in finish, with longitudinal seams concealed from view. Apply ductwork insulation materials, accessories and finishes in accordance with Manufacturer's recommendations. Fix and supply duct insulation by staples, washer pins or wire wraps at minimum 24" (600 mm) centres. Use weld-pin washers where duct dimension is larger than 26" (650 mm) high or wide.

.3 Insulation and vapour barrier shall be continuous through non-rated separations.

.4 Grease and fire rated flexible duct insulation shall be applied and installed in accordance with the Manufacturer's instructions.

.5 Insulation and vapour barrier shall be continuous through non-rated separations. Where vapour barrier is indicated, seal joints, seams and penetrations in insulation at hangers, supports, anchors and other projections with vapour-barrier mastic.

- .1 Install insulation continuously through hangers and around anchor attachments.
- .2 For insulation application where vapour barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachments to structure with vapour-barrier mastic.
- .3 Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

.6 Install insulation with non-self-sealing factory-applied jackets as follows:

- .1 Draw jacket tight and smooth.
- .2 Cover circumferential joints with 3" (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4" (100 mm) o.c.
- .3 Overlap jacket longitudinal seams at least 1-½" (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **2" (50 mm)** o.c.
  - .1 For below ambient services, apply vapour-barrier mastic over staples.
  - .2 Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - .3 Where vapor barriers are indicated, apply vapour-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

3.2 Insulation Termination

.1 Terminate insulation short of control and fire dampers so as not to interfere with operation, seal all edges to maintain continuous vapour barrier.

.2 Terminate insulation 24" (600 mm) short of duct mounted electric heating coils.

3.3 Insulation for Cooling Coil Headers and Return Bends

.1 Pack flexible glass fibre insulation around headers and return bends on all cooling coils in built up air handling units and at re-cool coils in terminal ductwork systems to control condensation

3.4 External Flexible Insulation with Vapour Barrier

.1 On rectangular duct work and plenums, over 24" (600 mm) in width, spotweld pins ¼" (6 mm) longer than insulation thickness, one per square foot of duct minimum. If pins are installed in field, capacitor gun shall be used. Impale insulation over pins, and hold in place using metal or nylon clips (washers). Alternatively, use assembly consisting of welded pin with integral head washer welded in place over insulation (Clinched pins not acceptable).

.2 Adhere foil faced vapour barrier tape over butt joints, raw edges, holding washers and other points of penetration of vapour barrier jacket on exposed hot and cold ducts and concealed cold ducts. Provide 16 ga (1.61 mm) wire wrap on 18" (450 mm) centers as additional exterior insulation reinforcing, to snug-tight so insulation is not crushed/compressed.

3.5 Internal Flexible Duct Liner Application

.1 Adhere insulation with insulation adhesive applied to whole of metal surface, with the coating side of insulation exposed to airstream.

.2 Ducts 24" (600 mm) in width and less require no further adhesion.

.3 Duct sides and plenum panels greater than 24" (600 mm) in width shall have metal clips or nylon pins adhered to metal surface at 12" (300 mm) centres to supplement adhesive. (Welding pins may be used provided capacitor type gun is used.) Impale insulation or pins or clips with coated side of insulation exposed to airstream and secured with holding washers. Cover holding washers with reinforcing membrane and insulation coating/sealer.

.4 Seal transverse joints, raw edges, and other points of penetration of coating with reinforcing membrane and insulation coating/sealer.

.5 Seal longitudinal and butt joints with insulation coating sealer.

.6 No raw edges of internal insulation material shall be exposed to moving airstream. Provide 26 ga (0.55 mm) sheet metal nosing at all leading edges of exposed lining to overlap insulation by at least 1" (25 mm) downstream.

.7 Duct size indicated is inside dimension of the insulation. Metal duct sizes shall be increased to allow for internal acoustic insulation thickness.

3.6 Internal Rigid Duct Liner Application

.1 Adhere internal rigid duct liner in same manner as internal flexible duct liner.

.2 Cover plenum wall insulation with galvanized perforated metal sheet having over 50% open area. Protective metal shall be held in place by securing it to projecting pins with washers.

.3 Cover plenum wall insulation with solid galvanized sheet metal for a distance of 48" (1,200 mm) downstream from cooling coils.

.4 Sheet metal and perforated sheet metal is under Section 23 31 00.

3.7 Ductwork Insulation Finished

.1 "Concealed" ductwork insulation, in horizontal and vertical service spaces, will require no further finish.

.2 "Exposed" ductwork insulation, in unfinished floor space will have no further finish.

.3 "Exposed" ductwork insulation in finished floor spaces, mechanical and service rooms, shall be finished with two coats of white, foil-finishing, insulation coating.

.4 "Exposed" duct work insulation outside the building shall have weatherproof finish. Apply one coat of Childers Vicryl CP10/11, or other acceptable water based emulsion mastic, at rate of 1 L/m^2. Embed #10 glass fabric into wet coating. Smooth out wrinkles, lapping ends and edges at least 2" (50 mm). After first coat has achieved initial set, while still damp, apply top finish coating of asphalt emulsion mastic 2 L/m^2 ensuring that reinforcing glass fabric is completely coated. Smooth to uniform finish.

.1 Acceptable products: Foster Weatherite 46-50.

Part 4 Air System Insulation Descriptions

4.1 INDOOR AIR HANDLING EQUIPMENT: AHU-1 and HRV-1

.1 Upstream of Unit (Outdoor Air).

.1 All outdoor air ductwork between the unit and the Outdoor Air inlet shall be: B2 flexible insulation with foil face vapour barrier 50 mm thick, externally applied.

.2 Upstream of Unit (Return Air [AHU] and Exhaust Air [HRV]).

.1 All return/exhaust air ductwork within the mechanical room shall have: C2 rigid duct liner 50 mm thick, internally applied complete with acoustic lagging.

.2 Return/exhaust air ductwork for 3000 mm upstream of unit shall have internal rigid duct liner covered with Galvanized Steel Perforated Cover.

.3 All remaining return air ductwork will not be insulated.

.3 Downstream of Unit (Supply Air).

.1 All supply air ductwork within the mechanical room shall have: C2 rigid duct liner 50 mm thick, internally applied complete with acoustic lagging.

.2 Supply air ductwork up to 1000 mm downstream of air handling equipment shall have internal rigid duct liner covered with Galvanized Steel Perforated Cover.

.3 The remaining supply air ductwork for the entire length up to the control damper or VAV Box inlets shall be: B2 flexible insulation with foil face vapour barrier 25 mm thick, externally applied.

.4 Supply air ductwork for 1000 mm from outlet of VAV box or after control damper shall have: C2 rigid duct liner 50 mm thick, internally applied complete with acoustic lagging.

.5 All remaining supply air ductwork after VAV box or control damper shall be insulated with: B2 flexible insulation with foil face vapour barrier 25 mm thick, externally applied.

.4 Downstream of Unit (Relief Air).

.1 All relief air ductwork between the unit and the Relief Air outlet shall be: B2 flexible insulation with foil face vapour barrier 50 mm thick, externally applied.

4.2 OUTDOOR AIR HANDLING EQUIPMENT: AHU-2 and AHU-3

.1 Upstream of Unit (Return Air).

.1 Return air ductwork outside of the building shall have: 50mm thick, external flexible insulation, externally applied with metal and nylon clips. Provide weatherproof finish complete with aluminum cover over ductwork.

.2 Return air ductwork for 2000 mm prior to inlet of the unit shall have: C2 rigid duct liner 50 mm thick, internally applied complete with acoustic lagging.

.2 Downstream of Unit (Supply Air).

.1 Supply air ductwork outside of the building shall have: 50mm thick, external flexible insulation, externally applied with metal and nylon clips. Provide weatherproof finish complete with aluminum cover over ductwork.

.2 Interior supply air ductwork for 3000 mm from outlet of the unit shall have: C2 rigid duct liner 50 mm thick, internally applied complete with acoustic lagging.

.3 The remaining supply air ductwork for the entire length up to the VAV Box inlets shall be: B2 flexible insulation with foil face vapour barrier 25 mm thick, externally applied.

.4 Supply air ductwork for 1000 mm from outlet of VAV box shall have: C2 rigid duct liner 50 mm thick, internally applied complete with acoustic lagging.

.5 All remaining supply air ductwork after VAV box shall be insulated with: B2 flexible insulation with foil face vapour barrier 25 mm thick, externally applied.

4.3 ROOF MOUNTED EXHAUST AIR FANS

.1 Upstream of Unit (Exhaust Air).

.1 Exhaust air ductwork for 3000 mm upstream of the roof mounted exhaust fan shall be covered in: B2 flexible insulation with foil face vapour barrier 50 mm thick, externally applied.

4.4 INLINE EXHAUST AIR FANS

.1 Upstream of Unit (Exhaust Air).

.1 No insulation required for exhaust air ductwork upstream of fan.

.2 Downstream of Unit (Exhaust Air).

.1 All exhaust air ductwork between the Fan and the Exhaust Air outlet shall be: B2 flexible insulation with foil face vapour barrier 25 mm thick, externally applied.

4.5 INLINE SUPPLY AIR FANS

.1 Upstream of Unit (Outdoor Air).

.1 All exhaust air ductwork between the Fan and the Outdoor Air inlet shall be: B2 flexible insulation with foil face vapour barrier 50 mm thick, externally applied.

.2 Downstream of Unit (Supply Air).

4.6 Supply air ductwork for 3000 mm from inlet of Fan shall have: C2 rigid duct liner 25 mm thick, internally applied complete with acoustic lagging.

~~.5~~.1

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 General

.1 Provide thermal insulation for heating and cooling equipment as indicated and scheduled

.2 Journeyman insulation applicators shall supervise the insulation work. This project required the Mechanical Insulation Contractor to provide a BCICA Quality Assurance Certificate. The Mechanical Insulation Contractor shall registers this project with BCICA and shall be in full compliance with the requirements of the QAC Program. Materials must be installed by tradespersons with a Red Seal or TQ Designation in the Heat and Frost Trade as detailed in the QAC program.

.3 Be responsible for ensuring that sufficient space is provided for proper installation of insulation materials.

.4 All insulations shall be in accordance with the latest edition of “BC Insulation Contractors Association (BCICA) Standards Manual” as reference standard. Conform also to applicable CAN/ULC, CCG, CBSB, ASTM, and NFPA standards. Where this specification exceeds BCICA Standards, the Contractor shall meet or exceed Integral Group specification requirements.

.5 Install insulation and related materials and accessories in accordance with the suppliers and manufacturers recommended installation instructions.

1.3 Regulatory Requirements

.1 Flame spread ratings and smoke developed classifications shall be as required by applicable code and NFPA 90A. Flame spread rating throughout material shall not exceed 25 and smoke developed shall not exceed 50. Materials shall not flame, smoulder, glow, or smoke at temperatures they are exposed to in service.

.2 Minimum insulation thickness and insulating values shall be in accordance with NECB latest edition or ASHRAE Std 90.1 latest edition or as per the schedule in this section, whichever is most stringent.

.3 All insulation products shall be formaldehyde-free.

1.4 Qualifications and Samples

.1 Submit Manufacturer documentation (and samples when requested) for materials, applications and finishing methods to establish they satisfy specification and meet applicable code requirements, before commencing work.

1.5 Quality Assurance

.1 Installer qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.

.2 Surface-Burning Characteristics: For insulation and related materials, UL/ULC Classified per UL723 or meeting ASTM E 84, by testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesives, mastic, tapes and cement material containers, with appropriate markings of applicable testing agency.

  .1 Insulation installed indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

  .2 Insulation installed outdoors: Flame spread index of 75 or less, and smoke-developed index of 150 or less.

.3 Formaldehyde free: Third party certified with UL Environment Validation.

.4 Recycled content: A minimum 50 percent recycled glass content.

.5 Bio soluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).

.6 Low emitting materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of UL Greenguard Gold Certification.

.7 Living building challenge-declare red list free.

1.6 Definitions

.1 "Exposed" equipment shall be considered to be exposed in mechanical and equipment rooms, and where line of sight visibility above "cloud ceilings" exists.

Part 2 Products

2.1 Pre-formed Block and Board Insulation

.1 Mineral Fibre (High Temperature) Rigid:

  .1 Thermal conductivity at 199°F – 0.027 BTU/hr/ft/°F (93° C - 0.046 W/m/°C).

  .2 Acceptable Manufacturers:

    .1 Roxul RHT-80, IIG Min Wool 1200, Thermafibre Industrial Board 8.016 Nominal Density, Knauf-Elevated temperature board with ECOSE technology.

.2 Calcium Silicate (High Temperature) Rigid:

  .1 Thermal conductivity at 199°F – 0.035 BTU/hr/ft/°F (93° C - 0.060 W/m/°C).

  .2 Acceptable Manufacturers:

    .1 IIG Thermo-12 Gold.

.3 Perlite Insulation - High Temperature:

  .1 Without integral jacket.

  .2 Thermal conductivity

  .3 Acceptable Products:

    .1 Sproule WR-1200, Howred Goodtemp

.4 Phenolic Insulation Rigid Board:

.1 With integral FRK jacket.

.2 Thermal conductivity at Flame spread and smoke density does not exceed 25/50 per CAN/ULC S102 with or without integral jacket.

2.2 Flexible Sheet Insulation

.1 Flexible Closed Cell

.1 Thermal conductivity at 199°F – 0.027 BTU/hr/ft/°F (93° C - 0.046 W/m/°C).

.2 Acceptable Manufacturers:

.1 Therma-Cel.

.2 Flexible Foamed Elastomeric

.1 Thermal conductivity at 199°F – 0.027 BTU/hr/ft/°F (93° C - 0.046 W/m/°C).

.2 Acceptable Manufacturers:

.1 F/R Armacell, Aerocell, K-Flex USA.

2.3 Removable Insulation Covers

.1 Flexible mineral fibre or fibre glass fully enclosed on sides and edges with Alpha Maritex #8459-2-8S silicone fibre glass cloth suitable for temperatures involved with stainless steel wire mesh against hot surface, or acceptable equal. All products must conform to ASTM-C1965 and CAN/ULC S102

.2 Insulation covers laced in place with brass/stainless steel hooks and copper/stainless steel wire and be easily removed.

2.4 Accessories

.1 Jacket Fastenings (Multi-Purpose):

.1 Staples (flare type). Galvanized.

.2 Compatible jacket finishing tape.

.2 Corner Beads:

.1 1-½" (38 mm) x 1-½" (38 mm) x 0.015" (0.37 mm) thick galvanized steel or aluminum.

.3 Finish Jacket:

.1 Thermocanvas Jacket:

.1 Fattal's Thermocanvas, Robson Flamex FR Canvas

.2 Metal Jacket:

.1 ITW 24 ga (0.70 mm), Ideal products

.4 Reinforcing Membrane:

.1 Glass reinforcing membrane.

.5 Reinforcing Mesh:

.1 1" (25 mm) square galvanized wire mesh.

.6 Insulating Cement:

.1 Ryder Thermokote MW high temperature, or as commercially available.

.7 Hard Finish Cement:

.1 As commercially available.

.8 Fabric Adhesive:

.1 Bakor 120-18, Childers CP-52, Design Polymeric DP3050, Foster 30-36, Robson White Lag.

.9 Fabric Coating:

.1 Bakor 120-18, Childers CP-52, Design Polymeric DP3050, Foster 30-36, Robson White Lag.

2.5 Acoustic Lagging Material

.1 Acoustic lagging material shall be equal to Vibrasonic Controls VSC-0-10NL-25RP Decoupled Blanket Barrier.

.2 Material shall consist of 1 lb per square foot (0.042 kg/sq.m) Barium impregnated vinyl permanently and continuously affixed to a ¼" (6 mm) 2 lb density open cell polyester foam.

.3 Barrier to have minimum STC of 27 with the following characteristics: 125HZ – 15dB; 250HZ – 19dB; 500 HZ – 21dB; 1000 HZ – 28 dB; 2000 HZ – 33dB; 4000 Hz – 37 dB.

.4 Material to be tested and labelled to meet maximum 25/50 fire rating.

2.6 Equipment Insulation Schedule and Thickness

Equipment	Thickness	Scope
Boiler breeching	4" (100 mm) (2 x 2" (50 mm))	A
Boiler stack (s)	2" (50 mm)	A
Chilled water pump housings	1" (25 mm)	B, D
Deaerator shell and tower	2" (50 mm)	A
Domestic hot water storage tank(s)	2" (50 mm)	A
Domestic cold water meter(s)	1" (25 mm)	B, D
Expansion joints	2" (50 mm)	C
Heat Exchanger(s)	2" (50 mm)	A

SCOPE A: Pre-formed block insulation (high temperature).
SCOPE B: Flexible sheet insulation.
SCOPE C: Removable insulation cover.
SCOPE D: Pre-formed board insulation.

Part 3 Execution

3.1 Application

.1 Apply insulation to equipment only after connections are complete and tests made and systems accepted.

.2 Apply insulation and insulation finish, securing it permanently to surfaces of equipment. Finish work so finished product is uniform in application and smooth in finish with edges protected and sealed.

.3 When more than one layer of insulating material is used to achieve the specified thickness, stagger seams and joints to eliminate leakage paths.

.4 Weld insulation attachment fittings to surfaces, as required, to completely secure block insulation with mechanical wire or strap fastenings. Some pressure vessels will not allow welding to surface, coordinate and confirm with equipment manufacturer.

3.2 Nameplates

.1 Install insulation so that name and registration plates, cleanouts, manholes, inspection opening and gauge and controller tappings are uncovered. Cut back insulation around base of these items at 45° and finish with finishing cement, or mastic finish. When finishing with metal re-covering, provide mitred picture frame flashing, sealed and caulked around edges.

3.3 Insulation - Hot Applications

.1 Apply high temperature insulation block and/or pre-formed/molded pipe insulation and secure firmly to surfaces with mechanical, wire or strap fastenings. Insulation shall be cut, shaped and fitted neatly to contours, without voids.

.2 Insulation on equipment heads shall be fabricated in orange peel sections, and receive ½" (12 mm) trowel coat, dry thickness of insulating hard coat finishing cement, to provide smoothly contoured surface. Cement shall be reinforced with layer of reinforcing mesh or reinforcing membrane.

.3 Apply high temperature mineral fibre rigid insulation to boiler breeching. Exterior application shall be sealed from moisture. Over insulation, apply 22 ga (0.64 mm) thick aluminum. The longitudinal seams shall be located to shed water. Attach with holding strap at 6" (150 mm) on centres. Provide complete aluminum jacket system using parts, accessories and installation procedures of Manufacturer. Seal outdoor jacketing watertight. Overlap seams by minimum of 3" (75 mm). Apply expansion springs on bands where required.

3.4 Insulation - Cold Applications

.1 Apply flexible sheet insulation on cold surfaces. Secure material and longitudinal and butt joints with foam plastic adhesive. Insulation shall be cut, shaped and fitted neatly to contours, without voids.

.2 Secure board insulation on ducts and flat surfaces with adhesive and pins. Seal vapour barrier finish joints with self-adhesive foil tape.

3.5 Block Insulation Finish

.1 Premium Finish (BCICA Premium 2 Standard):

   .1 Over hard finish cement apply thermo canvas jacket using fabric adhesive. Finish fabric jacket with one coat of fabric coating.

.2 Custom Finish:

   .1 No further finish required on hard finish cement.

3.6 Flexible Sheet Finish

.1 Insulated flexible sheet insulation shall be painted with heavy brush coating of foam plastic, white insulation coating.

3.7 Acoustic Lagging Material

.1 Material shall be glued, foam side to all exterior surfaces of heat pumps.

.2 Where access/doors panels are involved, the complete surface area to be treated shall be first cut from a single piece of lagging material, the access area marked out, plus a minimum ½" (12 mm) around perimeter, cut and then glued (foam side to metal) to the door/panel. Do not apply glue to the minimum ½" (12 mm) perimeter overhand section of the material. The main section can then be glued to the main surface being treated. Holes may be punched in the material to allow access to access bolts and material may be cut around hinges and handles.

.3 Glue shall be an inexpensive contact adhesive such as LePages Contact Cement compatible with foam insulation. A liberal coat shall be applied to the metal surface but only a thin coat to the foam side of the lagging material. Put surfaces together **before** adhesive goes tack dry so that it can be manipulated neatly into place.

.4 Use a non-hard setting caulk to caulk panel corners to ensure that the polyester decoupling layer is not visible.

.5 Butt joints may be covered using any fire-rated film/PSA tape.

.6 Where a number of identical units are involved, material shall be die-cut.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 General

.1 Provide thermal insulation on piping, valves, fittings and radiant ceiling panels, as called for and as scheduled. Note items listed that do not require insulation.

.2 Journeyman insulation applicators with red seal or TQ designation in the heat and frost trade shall supervise the insulation work. This project requires the Mechanical Insulation Contractor to provide a BCICA Quality Insurance Certificate (QAC). The Mechanical Insulation Contractor shall register with BCICA and shall be in full compliance with the requirements of the QAC Program. Materials must be installed by tradespersons with a Red Seal or TQ Designation in the Heat and Frost Trade as detailed in the QAC Program.

.3 Be responsible for ensuring sufficient space is provided to allow proper installation of insulation materials.

.4 Minimum insulation thickness and insulating values shall be in accordance with ASHRAE Std 90.1 latest edition or as per the schedule in this section, whichever is most stringent.

.5 Install insulation and related materials and accessories in accordance with the suppliers and manufacturers recommended installation instructions, and BCICA Standards where the specification exceeds BCICA Standards, this specification overrides the BCICA requirements.

1.3 Regulatory Requirements

.1 Flame spread ratings and smoke developed classifications shall be as required by BC Building Code,
CAN/ULC S102 and NFPA 90A. Generally, the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50. Materials shall not flame, smoulder, glow, or smoke at temperature they are exposed to at service.

.2 Minimum insulation thickness and insulating values shall be in accordance with ASHRAE Std 90.1 latest edition or as per the schedule in this section, whichever is most stringent.

.3 Fibreglass pipe insulation shall comply with:

- .1 CAN/ULC S102-M88.
- .2 CCG F1-304 (plain only).
- .3 CBSB 51-GP-9M.
- .4 CGSB 51-GP52M (jacket).
- .5 ASTM C 547, Type I, Type IV.
- .6 STM C 585 – Standard for inner and outer diameters.
- .7 ASTM C 795 – Insulation in contact with austenitic stainless steel.
- .8 ASTM C 1136 (jackets; Type I, II, III, IV).
- .9 ASTM E-84, Surface Burning Characteristics, 25/50 Flame/Smoke.
- .10 CAN/ULC-S102-07 “Test for Surface Burning Characteristics of Building Materials”.

.4 PVC Fittings and Jacketing shall comply with:

.1 CAN/CGSB – 51.53-95

.2 CAN/ULC S102.

.5 All insulation products shall be formaldehyde-free.

1.4 Qualifications and Samples

.1 Submit Manufacturer's documentation (and samples when requested) for materials, applications and finishing methods to establish they satisfy this specification and meet applicable code requirements, before commencing work.

.2 Refer to Section 23 05 05 Firestopping for firestop requirements.

1.5 Quality Assurance

.1 Installer qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.

.2 Surface-Burning Characteristics: For insulation and related materials, UL/ULC Classified per UL723 or meeting ASTM E 84, by testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesives, mastic, tapes and cement material containers, with appropriate markings of applicable testing agency.

.1 Insulation installed indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

.2 Insulation installed outdoors: Flame spread index of 75 or less, and smoke-developed index of 150 or less.

.3 Formaldehyde free: Third party certified with UL Environment Validation.

.4 Recycled content: A minimum 50 percent recycled glass content.

.5 Bio soluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCEB).

.6 Low emitting materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of UL Greenguard Gold Certification.

.7 Living building challenge-declare red list free.

1.6 Definitions

.1 "CONCEALED" means insulated mechanical services in trenches, chases, furred spaces, shafts and hung ceilings.

.2 "EXPOSED" will mean not concealed, to include line of sight elements above 'cloud ceilings'.

.3 Piping inside the building in unheated zones, and on roof or outside the walls.

1.7 Connections to Existing Piping

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

1.8 Heat Traced Piping

.1 Piping subject to freezing is specified to be heat traced. Insulation shall cover heat tracing, allow for oversized insulation as required for heat trace element thickness.

Part 2 Products

2.1 Materials

.1 Products shall not contain lead, mercury or mercury compounds, if possible. They shall be UL Greenguard Gold or Indoor Advantage Gold, if possible.

.2 Products shall be validated by UL/E to be formaldehyde free.

2.2 Pre-Formed Pipe Covering

.1 Mineral Fibre - Low and Medium Temperature:

- .1 Type I (849°F (454°C)) or Type IV (982°F (528°C)); Thermal conductivity at 75°F – 0.019 BTU/hr/ft/°F (24°C – 0.033 W/M/°C)
- .2 Glass mineral wool bonded with a bio-based thermosetting resin.
- .3 UL/ULC classified for Earthwool, FHC 25/50 per ASTM E84 for Redi-Klad. Living building challenge-declare red list free for Rediklad pipe or unjacketed earthwool pipe only.
- .4 Comply with ASTM C585, ASTM C411, ASTM C795 and ASTM C547, Type I and Type IV, **with factory-applied ASJ+-SSL+ or ASJ-SSL**.
- .5 Products shall be validated by UL/E to be formaldehyde free and have an EPD.
- .6 With integral vapour barrier jacked and longitudinal lap.
- .7 Acceptable products: Subject to compliance with requirements, provide Knauf Insulation; **Earthwool 1000 degree pipe insulation with COSE technology** or comparable product by one of the following:
  - .1 Mason Alley K, Owens Corning ASJ/SSL-II, Johns Manville Micro-Lok AP-T Plus.

.2 Mineral Fibre - High Temperature (over 662°F (350°C)):

- .1 With integral vapour barrier jacket and longitudinal lap.
- .2 Thermal conductivity at 199°F – 0.023 BTU/hr/ft/°F (93° C - 0.040 W/m/°C).
- .3 Acceptable Products:
  - .1 Johns Manville Micro-Lok AP-T Plus, Roxul ASJ/SL, ESLIN (Energy Savings Layered Insulation) by Visionary Industrial Insulation.

.3 Flexible Foamed Elastomeric:

- .1 Thermal conductivity at 75°F – 0.023 BTU/hr/ft/°F (24° C - 0.040 W/m/°C).
- .2 Acceptable Products:
  - .1 AP Armacell, Flex USA, Aerocell.

.4 Flexible Closed Cell:

- .1 Thermal conductivity at 75°F – 0.021 BTU/hr/ft/°F (24° C - 0.036 W/m/°C).
- .2 Acceptable Products:
  - .1 Therma-Cel.

2.3 Fire Stopping and Smoke Seal Materials

.1 Refer to Section 23 05 05 Firestopping for firestop requirements.

2.4 Accessories

.1 Insulation Fastenings:

- .1 16 ga (1.61mm) galvanized wire or 16 ga (1.61 mm) thick copper wire as commercially available.

.2 Jacket Fastenings:

- .1 Thermocanvas and All Service:
  - .1 Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacture.
- .2 Metal Jackets
  - .1 Sheet metal screws, pop rivets, bands.
- .3 PVC Jacket and Fitting Covers:
  - .1 PVC self-adhesive tape, plastic pop rivets, bonding cement.

.3 Adhesives:

- .1 Flexible elastomeric and flexible closed cell insulation adhesive:
  - .1 Armstrong 520, Thermacell 1590, Rubatex R-373, Zipcoat 8A.
- .2 Vapour barrier jacket adhesive:
  - .1 Bakelite 230-39, Childers CP-82, Epolux Cadoprene 400, Foster 85-20.
- .3 Fabric adhesive, to insulation pipe covering:
  - .1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, Robson White Lag.

.4 Coatings:

- .1 Vapour barrier coating on reinforcing membrane or on insulating cement:
  - .1 Bakelite 120-09, Childers Chil-Out CP33/Chil-Perm CP35; Epolux Cadalag 336; Foster Vapour out 30-33/Vapor-Fas 30-65.
  - .2 Childers CP-30 (refrigeration suction lines only).
- .2 Flexible elastomeric and flexible closed cell insulation finish coating:
  - .1 Armstrong, Bakelite 120-13, Rubatex, Zipcoat.
  - .2

.5 Finish Jackets:

- .1 Thermocanvas Jacket:
  - .1 Fattal's Thermocanvas, Robson Flamex FR Canvas or Tai-Can Canvas.
- .2 All Service Jacket (with 0.0019" (0.3 mm) minimum thick foil):
  - .1 Fattal's Fat-Lock ASJ, Fibreglass ASJ, Knauf ASJ, Kingspan ASJ, Manson SPT, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ.
- .3 PVC Finishing Jacket (minimum 0.015" (0.38 mm) thick):
  - .1 Proto PVC, Speedline PVC, Zeston PVC.

.4 Aluminum Jacket:

.1 22 ga (0.64 mm) thick corrugated or smooth aluminum jacketing with longitudinal slip joints and 0.0019" (0.3 mm) end laps with factory applied protective liner on interior surface.

.1 ITW, Ideal products or other as commercially available.

.6 Reinforcing Membrane:

.1 Glass reinforcing membrane as commercially available: Foster Mast-A-Fab; Childers Chil-Glas #10; Pittsburgh Corning PC-79

.7 Insulating Cement:

.1 Ryder Thermokote MW high temperature, or as commercially available.

.8 Finishing Cement:

.1 Ryder Thermokote 1 FW.

.9 Pre-Formed Fitting Covers:

.1 Aluminum Fitting Covers:

.1 22 ga (0.64 mm) thick, die shaped components with factory applied protective liner on interior surface.

.1 Childers Ell-Jacs, Ideal Weatherjacs, Shield-Ells or other as commercially available.

.2 PVC Fitting Covers:

.1 0.02" (0.50 mm) thick pre-moulded one-piece covers.

.1 Childers, Proto PVC, Speedline PVC, Zeston PVC, Fattal PVC.

.10 Pre-Formed Insulation Fittings:

.1 Shur-Fit, Moulded Acoustic Production or from insulation fabricators.

2.5 Scope of Insulation

.1 Heating Piping, Fittings and Valves:

.1 Insulate the following systems, unless otherwise noted:

.1 Hot water heating supply and return piping.

.2 Boiler feed water piping.

.3 Glycol heating supply and return piping.

.4 Geo-exchange source side metal piping and components inside the building.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Piping located within perimeter heating enclosures.

.2 Relief piping.

.3 Drain lines.

.4 Small branch risers to terminal heating elements just above floor level, from 6" (150 mm) below floor slab up to heating element.

.5 Flexible interconnections between ceiling radiant heating panels.

.6 Condenser water piping inside building.

.7 HDPE plastic geo-exchange piping inside the building.

.3 Insulate the following valves and fittings if pipe is insulated using pre-formed fitting insulation sections:

.1 Elbows, tees, reducers.

.2 Valve bodies on the valves and check valves, over NPS 2-½” (65 mm)

.3 Flanges.

.4 Strainers.

.4 The following hot pipe fittings that operate at greater than 140°F (60°C) shall be coated with Thermalite - SG as per Manufacturer’s specification to prevent skin burns:

.1 Valves, NPS 2-½” (65 mm) and smaller.

.2 Valve bonnets.

.3 Unions.

.4 Drip legs.

.5 Flexible connections.

.6 Expansion Joints.

.7 Check valve covers.

.2 Chilled water piping, refrigerant piping, fittings and valves:

.1 Insulate and vapour seal the following systems, unless otherwise noted:

.1 Chilled water supply and return, including pump bodies, valve bodies and meters.

.2 Refrigerant suction piping for product refrigeration.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Drain lines for sumps 60°F (15.6°C) and over.

.3 Insulate and vapour seal the following fittings, if pipe is insulated:

.1 Elbows, tees, reducers.

.2 Valves, (bodies and bonnets) except check valve covers.

.3 Strainers.

.4 Flanges

.5 Unions

.6 Chilled water pump bodies.

.3 Plumbing pipes, fire protection pipes, fittings, valves:

.1 Insulate the following systems, unless otherwise noted:

.1 Domestic cold water system including meter body and including traps on handicapped lavatories.

.2 Domestic hot water supply and recirculation piping.

.3 Rainwater leaders and cast-iron fittings for the full length from the roof drain body to connection to below grade storm sewer, using preformed fibreglass pipe insulation complete with continuous vapour barrier.

.4 All drains, lines, stacks, fire standpipes and sprinkler mains in unheated areas (insulation shall cover heat tracing cables).

.5 Water valves, flanges, PRVs strainers, check valves.

.6 Sprinkler/standpipe system from domestic water connection point to 16'-0" (5.0 m) downstream or to inlet alarm valve, whichever is less, using preformed fiberglass pipe insulation complete with continuous vapour barrier.

.7 Interior irrigation/hose bibb supply piping.

.2 DO NOT insulate the following, unless otherwise noted:

.1 Piping used exclusively for fire protection (unless in unheated spaces).

.2 Soil stacks, vents, etc.

.3 All special service piping, e.g. gas, compressed air, etc.

.4 Unions.

.5 Flexible connections or expansion joints (unless noted on drawings).

.6 Check valve covers.

.7 Strainer leg and basket covers.

.8 Flexible fixture connections.

.4 Pipe penetrations through walls and floors:

.1 Material for stuffing, sealing and caulking of pipe penetrations shall be supplied and installed under this section.

2.6 Pipe Insulation Schedule and Thickness Table – inches (mm)

.1 'Inside' means within the heated building envelope. Everywhere else is considered outside and unheated space.

		NOMINAL PIPE SIZE (NPS)				
Service	**Design Operating Temperature**	**Runouts 2 and less (note 1)**	**1 and less**	**1-¼ to 2**	**2-½ to 4**	**5 and larger**
Chilled Water	≥41°F (≥5°C)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)
Hot Water/Glycol Heating	105°F (40°C) - 140°F (60°C)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-½" (38 mm)
	141°F (60°C)- 200°F (93°C)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-½" (38 mm)	1-½" (38 mm)
Hot Water/Glycol Heating	201°F (94°C)- 250°F (120°C)	1" (25 mm)	1-½" (38 mm)	1-½" (38 mm)	2" (50 mm)	2" (50 mm)
Heat Pump Water (inside building) (including all geo-exchange piping within building)	15°F (-10°C) min to 55°F (13°C) max	1" (25 mm)	1" (25 mm)	1-½" (38 mm)	1-½" (38 mm)	1-½" (38 mm)
Heat Pump Water (outside building) (where exposed and not buried)	30°F (-1°C) to 90°F (32°C)	1" (25 mm)	1-½" (38 mm)	1-½" (38 mm)	1-½" (38 mm)	1-½" (38 mm)
Domestic Cold Water	Below 65°F (18°C)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)
Domestic Hot Water	105°F (40°C) - 160°F (70°C)	1" (25 mm)	1" (25 mm)	1" (25 mm)	1-½" (38 mm)	1-½" (38 mm)

		NOMINAL PIPE SIZE (NPS)				
Service	**Design Operating Temperature**	**Runouts 2 and less (note 1)**	**1 and less**	**1-¼ to 2**	**2-½ to 4**	**5 and larger**
Self-Regulated Heat Traced Piping	105°F (40°C) - 140°F (60°C)	1" (25 mm)	1-½" (38 mm)	2" (50 mm)	2" (50 mm)	2" (50 mm)
Buried and Exterior Rainwater Storm Drainage	90°F (32.2°C)	None	None	None	None	None
Above Grade Interior Rainwater Storm Drainage	Below 65°F (18°C)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)

Note 1: Runouts to individual terminal units not to exceed 6'-0" (1.8 m) in length.
Note 2: All piping forming part of the HVAC and plumbing systems and located outside the building envelope shall be insulated. At a minimum of 2x thickness above. (This includes all/any unheated spaces within the building).

Part 3 Execution

3.1 Application

.1 Apply insulation to piping only after tests have been made and systems accepted.

.2 Apply insulation and insulation finish so finished product is smooth in finish, with the longitudinal seams concealed from view. Apply piping insulation materials, accessories and finishes in accordance with Manufacturer's recommendations. Pre-formed pipe fitting insulation sections shall be used on all elbows, tees and pipe joint/flange fittings. Where pre-formed insulation sections cannot be used or sourced, insulate to BCICA standards, including oversize insulation at mechanical pipe joints.

.3 On piping NPS 2-½ and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than length of shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports. Provide oversize Clevis hangers as required. See Section 23 05 29.

.4 Insulation and vapour barrier shall be continuous through both rated and non-rated separations.

.5 Provide sealed bevelled cut-outs at all ball valve handles to allow free movement of handle without tearing insulation.

.6 Provide high density insulation and shields at all riser clamps/seismic sway bracing connection locations for all cold piping with continuous vapour barrier.

3.2 Insulation Termination Points

.1 Terminate insulation 3" (75 mm) back from all uninsulated fittings to provide working clearance and terminate insulation at 90° and finish with reinforced scrim cloth vapour barrier mastic system. Cover onto pipe and over the insulation vapour barrier. On concealed hot services terminate insulation 3" (75 mm) back from uninsulated fittings, cut off at 90° and apply reinforce scrim cloth and breather mastic systems. The use of pre-formed PVC end caps and pre-formed PVC fittings are also acceptable.

.2 Cut back insulation at 45° and finish with silicone caulking sealant around base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.

3.3 Vertical Risers

.1 On vertical pipe over 3" (75 mm) provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 15'-0" (4.5 m) centres.

3.4 Hot Application 80°F (26.7°C) and Over

.1 Piping:

.1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling flap, with spreading staples at 3" (75 mm) centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.

.2 Install strips of vapour barrier jacket over butt joints and secure with reinforcing tape and mastic.

.2 Fittings:

.1 Insulate fittings, to thickness of adjacent pipe insulation, with sections of pipe insulation mitred to fit tightly, or with pre-formed insulation fittings (Shur-Fit) or from insulation fabricator.

.3 Valves, Strainers:

.1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks to thickness of adjacent pipe insulation or insulate with pre-formed insulation fittings (Shur-Fit) or from insulation fabricator. Drains, blow-off plugs and caps shall be left uncovered.

.4 Flanges and Victaulic Fittings:

.1 Do not insulate flanges on condenser/heat pump water piping inside building.

.2 Insulate flanges on condenser/heat pump water piping outside building.

.3 Insulate flanges with oversized pipe insulation or mitred blocks to thickness of adjacent pipe insulation. Insulation to overlap adjoining insulation at least 3" (75 mm).

3.5 Cold Application 50°F (10°C) and Less

.1 Piping:

.1 Install low/medium temperature pipe insulation with integral vapour barrier jacket to pipe and hold in place by securing jacket flap. Seal flaps with vapour barrier adhesive. Pipe insulation with integral self-sealing vapour barrier jacket does not require additional fastening.

.2 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50% for insulation OD 12" (300 mm) and above apply strip on 10" (250 mm) centres for additional securement.

.3 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50% for insulation OD 12" (300 mm) and above apply strip on 10" (250 mm) centres for additional securement. (Note: accessory items such as, but not limited to, thermometers, probes, actuators, etc. shall be insulated and sealed. Hangers shall be insulated from where they carry the pie to the point of attachment to the structure).

.2 Fittings:

.1 Insulate fittings to thickness of adjacent pipe insulation with section of pipe insulation mitred to fit tightly, or pre-formed insulation fittings (Shur-Fit), apply reinforcing membrane embedded barrier coating and apply finish vapour barrier coating.

.2 Alternatively insulate fittings with tightly placed flexible insulation and apply vapour barrier, and apply pre-moulded 20/50 rated PVC fitting covers. Apply vapour-barrier adhesive and tape on joints and overlaps of PVC covers.

.3 All heat traced sanitary, storm and drainage piping, to cold pipe insulation thickness schedule.

.3 Valves, Strainers:

.1 Insulate pump bodies, valve bodies, bonnets and strainers with fitted pipe insulation to the same thickness as the pipe insulation, or mitred blocks to thickness of adjacent pipe insulation, apply reinforcing membrane embedded in barrier coating. Alternately, insulate with pre-formed insulation fittings (Shur-fit) covered with reinforcing membrane, stapled in place and covered with barrier coating. Drains, blow-off plugs and caps shall be left uncovered.

.4 Unions, Flange and Victaulic Fittings:

.1 Insulate cold unions and flanges with oversized pipe insulation or mitred blocks to thickness of adjacent pipe covering, apply reinforcing membrane embedded in barrier coating and final coating of vapour barrier mastic.

3.6 Anti-Sweat Coating

.1 Coat with anti-sweat coating - “No Sweat” by Robson Thermal Mfg. Ltd. or approved alternate, the following uninsulated cold surfaces:

.1 Connect surfaces of thermometers, pressure gauges, flow switches, controllers, etc.

.2 The coating thickness shall be recommended by coating Manufacturer for system operation conditions.

3.7 Pipe Insulation Finishes

.1 “Concealed” insulation in horizontal and vertical service spaces will require no further finish.

.2 “Concealed” pipe insulation in damp locations, e.g. pipe trenches, shall have vapour barrier jacket, vapour sealed.

.3 “Exposed” flexible insulation shall be painted with heavy brush coating of foam plastic white insulation coating.

.4 “Exposed” insulation inside building shall be finished as follows:

.1 Premium Finish (PVC Covers) PF-3 BCICA Standard:

.1 Over factory applied integral all-service type jacket on pipe insulation, apply PVC jacket.

.2 Over insulated fittings apply PVC fitting covers. Over insulated valve bodies, valves bonnets, strainers and flanges apply purchased PVC covers or field fabricate from PVC sheeting secured with solvent bonding cement.

.2 Premium Finish with Canvas Wrap: BCICA PF-2 standard finish fabric with two coats of fabric coating. Canvas re-covering shall be applied with a minimum overlap of 1" (25 mm), and finished with two coats of flexible fabric paint, white.

.3 Economy Finish:

.1 Apply pipe insulation with integral all-service type jacket. Cover longitudinal and circumferential joints with jacket finishing tape neatly applied. Alternately, secure jacketing longitudinal joint using integral self-sealing lap. Cover circumferential joints with jacket finishing butt strips. Over wrap strips by 50%. For insulation OD 12" (300 mm) apply trips on 10" (250 mm) centres for additional securement. PVC 0.02" (0.50 mm) thick should not be used as vapour barrier alone. Should have 'ASJ' or mastic system under it. Over insulation on short pipe runs and piping adjacent to fittings, valves, etc., jacket to be field applied.

.2 Over insulated fittings apply tack coat of vapour barrier mastic and embed reinforcing membrane and cover with same mastic. Over insulated valve bodies, valve bonnets, strainers and flanges, apply all-service jacketing using necessary fastenings and jacket finishing tape and with reinforced mastic system on irregular surfaced.

.5 "Exposed" outdoor insulation shall be finished as follows to BCICA PF-4 Standard:

.1 Insulation shall have vapour barrier jacket.

.2 Over pipe insulation jacket apply aluminum weather protecting jacket. The longitudinal seam shall be located to shed water. Secure the jacket using necessary metal banding on approximately 10" (250 mm) centres and at the overlaps. Screws are not permitted on cold operating systems.

.3 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges, apply metal jacket or pre-formed metal fittings to provide complete jacket system. Secure with necessary fastenings.

.4 Seal outdoor jacketing watertight.

3.8 Refrigeration Suction Piping Outside Building

.1 Install flexible foamed elastomeric or flexible closed cell pre-formed piping insulation. Secure longitudinal and butt joints with adhesive. Insulate fittings and components. To obtain the specified thickness, apply in layers with staggered joints.

.2 Finish with flexible elastomeric or flexible closed cell insulation coating.

.3 Re-cover all outdoor exposed closed cell foam insulation with aluminum jacket.

3.9 Fire Stopping and Smoke Seals

.1 Refer to Section 23 05 05 Fire Stopping for firestop requirements.

3.10 Insulation Packing of Pipe Sleeves

.1 Tightly pack space between pipe sleeves and pipe or between pipe sleeve and pipe insulation with mineral wool insulation - Thermal Ceramics "Cerafibre" or Carborundum "Fibrefrax" to full depth of sleeve to prevent transmission of sound and/or passage of smoke.

3.11 Insulation for Radiant Ceiling Panels

.1 Provide and install 3" (75 mm) thick 34 lb/ft³ (12 kg/m³) flexible glass fibre insulation on top of hot water ceiling radiant heating panels. Insulation shall be faced on both sides with FSK (Foil, Scrim, Kraft) facing (similar to Manson C and I ceiling wrap) and edges sealed with insulation coating/sealer. Foil side facing down on top of radiant panel.

.2 Application:

.1 Cut insulation to fit dimension of back of panel and lay insulation on top of panel.

.2 Insulation shall extend from edge to edge.

.3 Insulation shall cover small piping located directly above the panel

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Commissioning shall be executed in accordance with intent of ASHRAE Guideline 1.1 – 2007 "HVAC and R Technical Requirements for the Commissioning Process".

.2 Acceptable Commissioning Agents: MDT Systems, KD Engineering, Airmec, MMM Group – Commissioning Division.

1.3 General

.1 Be responsible for the performance and commissioning of equipment supplied in Mechanical. Commissioning is process of advancing installation static completion to full working order in accordance with contract documents and design intent. It is activation of completed installation.

.2 In consultation with General Contractor, ensure sufficient time is allowed and fully identified on construction schedule for proper commissioning of mechanical systems.

.3 Due to phased nature of construction, it will be necessary to commission, test, balance and demonstrate Phase 1 work prior to commencing Phase 2 work so that Airport can relocate departments and create working space for Phase 2 work to proceed.

Part 2 Products: Not Used

Part 3 Execution

3.1 Commissioning and Demonstration

.1 Submit schedule for commissioning phase of work. Schedule shall show:

- .1 Equipment start-up schedule.
- .2 Submission dates for documents required prior to substantial completion.
- .3 Timing of various phases of commissioning, testing, balancing and demonstration process.

.2 Commissioning is concluded when air and water systems have been balanced and installation is in working order and acceptable for use. Work will include the following:

- .1 Balancing of air systems as specified in Section 23 05 93.
- .2 Balancing of liquid systems as specified in Section 23 05 93.
- .3 Adjust vibration isolators and earthquake restraints for optimum performance.
- .4 Verification and certifications of sealing of HVAC penetrations through fire separations (rated and non-rated) and sound separations.
- .5 Verification of water tightness of roof and exterior wall penetrations.
- .6 Verification that coil drain pans operate.

.7 Set up automatic control valves/dampers and automatic temperature control devices.

.8 Testing and debugging of DDC System.

.9 Set up and test alarm and protective devices.

.10 Power failure test with emergency generator start-up.

.11 BAS Trend Logging of temperature and humidity in specified areas.

.3 At conclusion of commissioning, demonstrate operation of systems to Consultant and to Owner’s Operating Staff. For demonstration and instruction to Operating Staff requirements, refer to following clause and Controls Systems Specification.

.4 The verification process shall include the demonstration of the following:

.1 Ease of access provided for servicing coils, motors, drives, fusible link fire dampers, smoke dampers, control dampers and damper operators.

.2 Location of and opening and closing of access panels.

.3 Operation of automatic controls dampers and automatic temperature control devices.

.4 Operation of alarm and protective devices.

.5 Proper response of air valves to thermostats and volume adjustment controls.

.6 Operability of randomly selected fire dampers.

.7 Noise level from typical air valves under extreme operating conditions.

.8 Operation of equipment and systems under each mode of operating, and failure, including:

.1 DDC control features.

.2 Boilers and associated gas systems.

.3 Heat pumps.

.4 Heat recovery systems.

.5 Heat exchangers

.6 Pumps.

.7 Unit heaters.

.8 Fans.

.9 Coils.

.10 Tanks - domestic hot water and expansion.

.9 Energy meters for natural gas sub-metering, hydronic energy meters, water sub-meters, and electrical sub-meters to be tested, calibrated and verified in accordance with the Manufacturer’s requirements and Government of Canada Weights and Measures Requirements.

.5 At completion of the commissioning, testing, balancing and demonstration, submit the following to Consultant:

.1 Letter certifying that work specified is complete, clean and operating in accordance with specification and drawings.

.2 Completed copies of commissioning check sheets, copies of start-up reports from specialty Contractors and Vendors and functional performance test sheets.

.3 Record drawings as specified.

.4 BC Boiler Inspection Department approval of boiler, pressure vessels and pressure piping installation.

.5 Fire Commissioner's approval of fuel oil installations.

.6 BC Gas Inspection Department approval of boiler and gas firing.

.7 List of alarm and protective devices tested, with the final operating settings.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 23 05 49 for required seismic restraint of piping.

1.2 Reference Standards

.1 Carry out piping system work in accordance with ASME/ANSI B31.9 code and CSA B51.

.2 Grooved joint piping components shall conform to CSA B242 code.

1.3 Regulatory Requirements

.1 Components, products and fabrication techniques shall be provided in compliance with Regulations and Requirements of Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

.2 Installation, repair or alternations to pressure piping systems shall be performed by licensed Contractors Welders, certified for work in accordance with Regulations and Requirements of Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

.3 Field welding to be in accordance with procedures of CSA-W117.2 and current edition of ASME/ANSI B31.1 or B31.9 Code.

1.4 System Pressure Ratings

.1 Pipe Fittings:

- .1 Piping system 125 psi (860 kPa) or less operating pressure – 125 psi (860 kPa) rating.
- .2 Piping systems 126 psi (870 kPa) to 250 psi (1,725 kPa) operating pressure – 250 psi (1,725 kPa) rating.

.2 Valves:

- .1 Suitable for maximum system operating temperature and pressure.
- .2 Triple duty valves at pump stations are prohibited.

1.5 Shop Drawings

.1 Submit detailed shop drawings of valves in accordance with Section 23 05 00. Shop drawings shall indicate make, model, location, type, size and pressure rating and Provincial CRN number.

.2 Grooved joint couplings and fittings shall be shown on drawing and product submittals, and shall be specifically identified with the applicable style or series designation.

Part 2 Products

2.1 General

.1 Products shall be registered with regulatory authority in accordance with CSA B51.

2.2 Pipe

.1 Steel Pipe:

- .1 To NPS 10, Schedule 40 to ASTM A53 Grade B or NPS ¾ to NPS 2 to ASTM A795, Schedule 5, suitable for Pressfit.
- .2 To NPS 12 and over, ⅜" (9.5 mm) wall thickness to ASTM A53 Grade B.
- .3 For the following system:
  - .1 Hot water heating.
  - .2 Glycol heating.
  - .3 Chilled water.
  - .4 Chemical feed.
  - .5 Heat pump water.
  - .6 Relief valve vents.
  - .7 Pressure drains.

.2 Stainless Steel Pipe: To NPS 2, Schedule 10S to ASTM A312, Type 304/304L, suitable for and approved for use with Vic-Press 304™.

.3 Copper Pipe: to ASTM B88M-86, Type K, or L hard drawn copper tubing.

- .1 Type L, hard drawn:
  - .1 Pressure drains (to NPS 2).
  - .2 Domestic hot water pre-heat.
- .2 Type L hard drawn may be used as an alternative to steel piping for the following systems:
  - .1 Hot water heating.
  - .2 Chilled water.
- .3 Type K, hard drawn:
  - .1 Air vent overflow

.4 PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8" (200 mm) and larger or ASTM D2241, SDR 21 or 26:

- .1 Fittings: ASTM D2466 or ASTM D2467, PVC.
- .2 Joints: ASTM D2855, solvent weld.

2.3 Pipe Joints – Steel Piping

.1 NPS 2 and under: screwed fittings, except where otherwise noted, with Teflon tape and RectorSeal Teflon paste or pipe dope, Pressfit in applicable applications.

.2 NPS 2-½ and over: welding fittings and flanges to CSA W47.1.

.3 Flanges: raised face, steel weld neck, lap or back-welded slip on type. Use flat face for attachment to case iron valves.

.4 Victaulic Vic-Press fittings with grade “E” EPDM O-rings may be used on closed-circuit hot water heating up to 230°F (110°C) working temperature, and 200 psig working pressure, glycol heating, chilled water, heat pump water, condenser water-closed circuit systems.

.5 Victaulic couplings or SHURJOINT brand to CSA B242-M1980 may be used on hot water heating, chilled water and heat pump water systems. Use lubricant supplied by Manufacturer and coat gasket. Grade “EHP” gasket for temperature range -30°F (-34°C) to 250°F (120°C) or “EPDM” gasket for temperature range -30°F (-34°C) to 230°F (110°C). Couplings shall consist of two ductile iron housing segments conforming to ASTM A536 Grade 65-45-12.

.1 Rigid Type to NPS 12: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

.1 NPS 2 through NPS12: Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to 250°F (120°C). Victaulic Style 107N.

.2 Victaulic Zero-Flex Style 07, Shurjoint Z07.

.2 Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of flexible connector provided it meets vibration isolation requirements. The couplings shall be placed in close proximity to the source of the vibration. Victaulic Style 77 or Installation-Ready Style 177.

.3 NPS 14 and Larger: Victaulic AGS two-segment coupling series with lead-in chamfer on housing key and wide width FlushSeal® gasket.

.1 Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07, Shurjoint Z07.

.2 Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77, Shurjoint 7707, 7705.

.4 Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 741 / W741, Shurjoint 7041.

.1 For connections to Class 300 flanged components in sizes through NPS 12, Victaulic Style 743, Shurjoint 7403.

.6 Flange Bolts and Nuts, carbon steel: to ANSI B18.2.1 and ANSI B18.2.2.

.7 Flange Gaskets:

.1 Up to 125 psi (860 kPa) system pressure – non-asbestos gaskets for mating surfaces.

.2 Over 125 psi (860 kPa) system pressure – stainless steel spiral wound non-asbestos gaskets.

2.4 Pipe Fittings – Steel Pipe

.1 Pipe fittings, screwed, flanged or welded:

.1 Cast-iron pipe flanges: Class 125 to ANSI B16.1.

.2 Cast-iron screwed fittings: Class 125 to ANSI B16.3.

.3 Steel pipe flanges and flanged fittings: to ANSI B16.5.

.4 Steel butt-welding fittings: to ANSI B16.9a.

.5 Unions, malleable iron ground joint type: Class 150 to ANSI B16.3

.2 Fittings for roll grooved piping: Ductile iron to ASTM A536; wrought steel to ASTM A234 Grade WPB; or factory fabricated from steel pipe conforming to ASTM A53.

.1 All grooved joint couplings, fittings, valves, and specialties shall be Victaulic or Shurjoint.

.2 Grooving tools shall be of the same Manufacturer as the grooved components.

.3 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

2.5 Pipe Joints – Stainless Steel Pipe

.1 Victaulic Vic-Press 304™ fittings with HNBR O-rings may be used on hot water heating up to 210°F (98°C) working temperature, domestic water, glycol heating, chilled water, heat pump water, condenser water-closed circuit systems. Vic-Press system shall be rated to 500 psi (3,450 kPa).

2.6 Pipe Joints – Copper Pipe

.1 All sizes soldered or brazed as specified in Part 3 Execution of this Section.

.2 NPS 2 to NPS 8 – Victaulic Style 607H installation-ready rigid copper couplings or Shurjoint C305 with offsetting angle-pattern bolt pads and grade “EHP” gasket for temperature range -30°F (-34°C) to 250°F (120°C) may be used on hot water heating, heat pump, chilled water, and condenser water systems.

.1 Couplings shall be manufactured to copper-tube dimensions. (Flaring of tube or fitting ends to accommodate alternate sized couplings is not permitted.)

2.7 Pipe Fittings – Copper Pipe

.1 Cast bronze: to ANSI B16.18.

.2 Wrought copper bronze: to ANSI B16.22.

.3 Roll grooved (non-flared) fittings by Victaulic, or Shurjoint.

2.8 Flanges – Copper Pipe

.1 Brass or bronze: to ANSI B16.15.

.2 Cast-iron: to ANSI B16.4.

.3 Victaulic Style 641 Flange Adapter, or Shurjoint C341.

2.9 Valves General

.1 Valves shall be of one Manufacturer.

.2 Provide valves with Manufacturer’s name and pressure rating clearly marked on outside of body. Valves shall be suitable for service used.

.3 All castings used for valve bodies shall be date stamped for quality assurance and traceability.

.4 Valves shall have current Provincial CRN number.

.5 Include lock shield handles where shown or noted.

.6 Provide valves located over 7'-0" (2.1 m) from floor in equipment room areas with chain operated sheaves. Extend chains to 6'-0" (1.8 m) above floor and hook to clips arranged to clear walking aisles.

.7 Use non-rising stem valves where there is insufficient clearance for stem to rise.

.8 Butterfly valves installed to permit removal of equipment, shall be threaded full lug type or grooved. Wafer type if additional pair of flanges is installed. The stem on butterfly valves shall be offset from the disc centerline to provide full 360-degree circumferential seating.

2.10 Gate Valves

.1 NPS 2 and Under, Screwed:

- .1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.
- .2 Acceptable Products:
  - .1 125 psi (860 kPa) – Crane 1700, Kitz 24, Nibco T-134, Toyo 293.

.2 NPS 2 and Under, Soldered:

- .1 Bronze body, rising stem, solid wedge disc, screwed bonnet.
- .2 Acceptable Products:
  - .1 200 psi (1,380 kPa) WOG – Crane 1700S, Kitz 44, Nibco S-134, Toyo 299.

.3 NPS 2-½ and Over, Flanged:

- .1 Cast-iron body, rising stem, OS and Y, solid wedge disc, bronze trim, bolted bonnet.
- .2 Acceptable Products:
  - .1 125 psi (860 kPa) – Crane 465-½, Kitz 72, Nibco F-617-0, Toyo 421A.

2.11 Globe Valves

.1 NPS 2 and Under, Screwed:

- .1 Bronze body, rising stem, renewable composition or bronze disc, union bonnet.
- .2 Acceptable Products:
  - .1 125 psi (860 kPa) – Crane 1703, Kitz 03, Nibco T-235-Y, Toyo 220.

.2 NPS 2 and Under, Soldered:

- .1 Bronze body, rising stem, renewable composition or bronze disc, screwed bonnet.
- .2 Acceptable Products:
  - .1 200 psi (1,380 kPa) W.O.G. – Crane 1703S, Kitz 10, Nibco WD-2100 or LD-2100, MAS-D Series, Toyo 212.

2.12 Butterfly Valves

.1 NPS 2-½ and Over:

- .1 Cast-iron and ductile iron body with ductile iron plated or bronze disc, stainless steel stem and extended neck to clear minimum of 2" (50 mm) thick insulation.
- .2 Threaded full lug type or wafer type (with or without integral flanges).
- .3 Resilient EPT or EPDM seat.

.4 Operators (unless otherwise specified in Controls Section):

.1 NPS 8 and under – lever handle with minimum 10 position ratchet and disc position indicator.

.2 NPS 10 and over – worm gear operator.

.5 Acceptable Products:

.1 150 psi (2,070 kPa) WOG – Crane, Demco, Keystone, Kitz, Kurimoto, Toyo, Nibco WD-2100 or LD-2100, MA Stewart 'D' Series, RWV 918 Series.

.2 NPS 2 and Over – Steel Roll Grooved Piping:

.1 Ductile iron body.

.2 Disc:

.1 Electroless nickel or PPS coated ductile iron.

.2 Aluminum bronze.

.3 Stainless steel.

.3 Seal:

.1 NPS 12 and Smaller: Pressure-responsive Grade 'E' – EPDM.

.2 NPS 14 and Larger: Disc-mounted Grade 'E' – EPDM.

.4 Stainless steel stem. (Stem shall be offset from the disc centreline to provide full 360-degree circumferential seating.)

.5 Grooved ends.

.6 Operators (unless otherwise specified in the Controls Section):

.1 NPS 8 and under – lever handle with minimum 10 position ratchet and disc position indicator.

.2 NPS 10 and over – worm gear operator.

.7 Acceptable Products:

.1 300 psi (2,070 kPa) WOG –

.1 NPS 12 and Smaller: Victaulic MasterSeal™, Shurjoint SJ300N.

.2 NPS 14 and Larger: Victaulic AGS-Vic300, Shurjoint SJ300N.

.3 NPS 2-½ through NPS 6 – Copper roll grooved (non-flared) piping:

.1 Cast brass body.

.2 Disc: Ductile iron encapsulated with Grade 'E' EPDM Seat or Alim-Bronze.

.3 Stem: Integrally cast to the disc, stainless steel.

.4 Copper-tube dimensioned grooved ends.

.5 Operator: lever handle with minimum 10 position ratchet and disc position indicator.

.6 Acceptable Products:

.1 300 psi (4,140 kPa) WOG – Victaulic Series 608N, Shurjoint SJ300BFV.

2.13 Ball Valves

.1 NPS 2 and Under, Screwed:

.1 Forged brass or bronze body, double O-Ring design or Teflon packing, threaded cap, chrome plated solid bronze ball, PTFE seats, blow-out proof stem.

.2 Ball valves for isolation service shall have large/full port.

.3 Ball valves for balancing service shall have reduced port and memory stop valve handle.

.4 Acceptable Products:

.1 600 psi (4,140 kPa) WOG – Crane F9202, Grinnell 3700, Kitz 58, Nibco T-585-70, Toyo 5044A.

.2 Victaulic Series P589 / P569 shall be used in when Vic-Press 304™ / Pressfit® fittings are used.

.3 Red-White 5020 EZ Press for Type K or L copper when Pressfit fittings are used.

.2 NPS 2 and Under, Soldered:

.1 Forged brass or bronze body, double O-Ring design or Teflon packing, threaded cap, chrome plated solid bronze ball, PTFE seats.

.2 Ball valves for isolation service shall have large/full port.

.3 Ball valves for balancing service shall have reduced port and memory stop valve handle.

.4 Acceptable Products:

.1 500 psi (3,450 kPa) WOG – Crane F9222, Grinnell 3700SJ, Kitz 59, Nibco S-585-70, Toyo 5049A.

2.14 Balance Fittings and Valves

.1 NPS 1-¼ and Under:

.1 Bronze body and bronze trim, rising stem, renewable composition disc, globe type with memory stop, Lockshield, male union connections, angle and straight type.

.2 Acceptable Products:

.1 100 psi (690 kPa) – Dahl 13000-M series, Toyo 250 or 251, Caleffi.

.2 NPS 1-½ and Over:

.1 Screwed connections up to NPS 2.

.2 Flanged connections NPS 2-½ and over.

.3 Cast-iron body, non-lubricated eccentric plug with resilient coating EPT or RS 55, suitable for 250°F (120°C) operating temperature, stainless steel bearings, adjustable memory stop, plug type suitable for wrench adjustment.

.4 Acceptable Products:

.1 175 psi (1,210 kPa) WOG – DeZurik 400, Keystone Ballcentric, Caleffi.

.3 NPS 3 and Over:

.1 Victaulic Vic-Plug Valve Series 377.

.2 Xylem Circuit Setter.

.3 Armstrong CEV.

.4 Victaulic – Tour & Andersson – STAD, STAF and STAG.

.5 Wheatley G.S.

.6 Oventrop

2.15 Automatic Flow Control Valves

.1 General: Devices shall automatically control required flow quantity between differential pressure ranges of 0 psi (0 kPa) to 45 psi (310 kPa) (pressure independent type auto-flow valves).

.2 NPS 2 and Smaller:

.1 Body forged brass ASTM B283 600 WOG, 250°F (120°C).

.2 Return from coil: (downstream side of Temperature Control Valve) Combination assembly including:

.1 Body fitted with ball shut-off valve, hard chrome-plated, Teflon Ball Seals and EPDM or Viton O-Rings.

.2 Flow Cartridge shall be accessible non-clogging piston type with + 5% accuracy.

.3 Two P/T Plugs, union for accepting temperature control valve (by Controls Contractor).

.3 Return from Coil: (upstream side of Temperature Control Valve) Combination assembly including:

.1 Full port union with manual air vent and P/T test plug.

.4 Supply to coil: Combination assembly including:

.1 Ball valve, strainer P/T test plug and blow down drain valve.

.3 NPS 2-½ and Larger:

.1 Body epoxy coated ductile iron ASTM A536 250 psi (1,725 kPa) 250°F (120°C).

.2 Flow cartridges 304 SS moving parts in brass housing, 2 psi (14 kPa) to 45 psi (310 kPa), 25 USgpm" (1.9 L/s) to 2,280 USgpm" (144 L/s).

.3 P/T Plugs, thermometer well and drain.

.4 Provide dual hose temperature/pressure meter kit with flow conversion chart and carrying case.

.5 Acceptable Products: Nexus, Griswold, Victaulic Series 76V/76G, Caleffi; Oventrop; Cocon-Q; RWV 9900 Series.

2.16 Circuit Balancing Valves

.1 NPS 2 and under: D2R Brass (Ametal) copper alloy body, screwed, 'Y' pattern globe.

.2 NPS 2-½ and over: Ductile-iron body, flanged or grooved, 'Y' pattern globe.

.3 Maximum pressure 250 psi (1,725 kPa) and maximum temperature 250°F (120°C). To be selected and sized for a nominal pressure drop of 5 ft (1.5 m) head, typically one pipe size smaller than piping size.

.4 Calibrated balancing valve with memory, positive shut-off, inlet and outlet pressure measuring connections with integral shut-offs and drains.

.5 Calibration charts and adjustment tools to be included.

.6 Provide differential pressure meter kit of same brand and Manufacture as balancing valves suitable for direct read-out complete with connection hoses suitable for system pressure. Meter to remain with Owner after installation.

.7 Acceptable Products:

.1 Bell and Gossett – Circuit Setter

.2 ESBE – Circuit Setter

.3 Victaulic / Tour and Andersson – STAD, STAF, and STAG

.4 Armstrong – CBV

.5 Wheatley – GS

.6 Nexus

.7 Caleffi

.8 RWV 9500 and 9520 Series

.8 Packaged coil components consisting of required coil valving, strainers, unions, hoses, etc., may be supplied. Victaulic Koil-Kit Series 799 or 79V, with Series 78U Union Port Fitting, Series 78Y Strainer/Ball Valve, Series 78T Union/Ball Valve, required 24" (600 mm) long braided hoses, and Series 793/794 Differential Pressure Controllers. The coil packaged shall be provided with a meter to be left with the Owner after installation. Acceptable product: Oventrop coil kit, with dynamic, Cocon-Q, or hydro-control balancing valve with Y-Strainer, ball valve and union fitting; RWV Coil Kit.

2.17 Swing Check Valves

.1 NPS 2 and under, screwed:

.1 Bronze body, bronze swing disc, screw in cap, regrindable seat.

.2 Acceptable Products:

.1 125 psi (860 kPa) – Crane 1707, Grinnell 3300, Kitz 22, Newman Hattersley 60, Nibco T-413-B, Toyo 236.

.2 NPS 2 and Under, Soldered:

.1 Bronze body, bronze swing disc, screw in cap, regrindable.

.2 Acceptable Products:

.1 Class 200 psi (1,380 kPa) WOG – Crane 1707S, Grinnell 3300SJ, Kitz 23, Newman Hattersley 61, Nibco-S-413-B, Toyo 237.

.3 NPS 1-½ and Over, Grooved:

.1 Ductile iron body, Grade 'E' – EPDM seat, stainless steel swing disc, coupled cap.

.2 Acceptable Products:

.1 Class 300 psi (2,070 kPa) CWP – Victaulic Style 712, Mueller Steam, Shurjoint SJ900.

.4 NPS 2-½ and Over, Flanged:

.1 Cast-iron body, renewable or regrindable seat, bronze swing disc, bolted cap.

.2 Acceptable Products:

.1 Class 125 psi (860 kPa) – Crane 373, Grinnell 6300A, Kitz 78, Newman Hattersley 731, Nibco F-918, Toyo 435A.

2.18 Silent Check Valves (Spring Type)

.1 NPS 2 and Under, Screwed:

.1 Bronze body, bronze trim, stainless steel spring, (heavy duty spring in vertical down flow application).

.2 Acceptable Products:

.1 Class 125 psi (860 kPa) – Conbraco 61-500, Durabla, Grinnell 3600, Muessco 203BP, Mueller Steam.

.2 NPS 2-½ and Over:

.1 Cast steel, wafer style bronze trim, stainless steel spring (heavy duty spring in vertical down flow application).

.2 Cast ductile iron, grooved end type, stainless steel spring and shaft, for use in horizontal or vertical applications.

.3 Acceptable Products:

.1 125 psi (860 kPa) – Apco, Centerline, Durabla, Duo-Chek II, Grinnell CV817, Nibco W-910, M & G, Victaulic 716, 779, Shurjoint SJ900.

.2 300 psi (2,070 kPa) with Grooved Ends: Victaulic 716, or 779 with venturi taps.

.1 For sizes NPS 14 and over, Class 230 psi (1,586 kPa) with AGS grooved ends, Victaulic Series W715.

2.19 Needle Valves

.1 Bronze body, screwed, globe type with cadmium plated steel stem.

.2 Acceptable Products: Class 400 psi (2,760 kPa) – Crane 88/89, RP and C 60-100.

.3 Application: Install needle valves where petcocks or manual vents are indicated.

2.20 Radiator Valves

.1 Screwed bronze body with bronze trim, wheel handle, rising stem, renewable composition disc, male union connections, angle and straight type.

.2 Acceptable Products: Class 100 psi (690 kPa) – Dahl 11041 or 11042, Dunham Bush 200B or 246B, Kitz 100 series, Sarco Type R or RP, Toyo 252 or 253, Oventrop.

2.21 Drain Valves

.1 Globe type, bronze body with bronze trim and composition disc.

.2 Acceptable Products: Crane 1703, Dahl 2343, Kitz 03, Newman Hattersley 13, Nibco T-235-Y, Toyo 220, Caleffi.

2.22 Hose Bibbs for Hydronic System Service

.1 Brass ball valve with forged brass cap and chain, NPS ¾ male, threaded hose end, Lockshield in public areas. Working pressure 250 psi (1,725 kPa) to 250°F (120 °C).

.2 Acceptable Products: Crane F9202CC, Dahl #50-430, Kitz 58CC, Red-White/Toyo 5046.

2.23 Low-Loss Headers (Hydraulic Separators)

.1 Low loss headers (hydraulic separators) shall be equal to Viessmann models 80/20 and 400/200 to suit flow. Acceptable products: Caleffi Hydro Cal.

2.24 Chilled Water Piping, Buried

.1 Steel Pipe: ASTM A53, Schedule 40 wall for sizes up to 12" (300 mm) and over, black with factory applied AWWA C105 polyethylene jacket, and minimum 2" (50 mm) of factory applied rigid expanded foam insulation.

.1 Fittings: ASTM A234, forged steel welding type.

.2 Joints: AWS D1.1, welded.

.3 Casing: Polyurethane insulation with high density polyethylene jacket and heat shrink sleeves.

.4 Standard of Acceptance: Logstor Rohr, Perma-Pipe: Xtru-Therm.

.2 Copper Tubing: ASTM B88, Type **K** annealed.

.1 Fittings: ASME B16.22, wrought copper.

.2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430°F to 535°F (220°C to 280°C)

.3 Casing: Polyurethane insulation with high density polyethylene jacket and heat shrink sleeves.

.3 Ductile Iron Pipe: AWWA C151.

.1 Fittings: AWWA C110, ductile iron, standard thickness.

.2 Joints: AWWA C111, rubber gasket with ¾" (19 mm) diameter rods.

.4 PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8" (200 mm) and larger, or ASTM D2241, SDR 21 or 26.

.1 Fittings: ASTM D2466, or ASTM D2467, PVC.

.2 Joints: ASTM D2855, solvent weld.

Part 3 Execution

3.1 Piping

.1 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly. Remove welding slag or other foreign material from piping.

.2 During construction, protect openings in piping and equipment, by capping or plugging to prevent entry of dirt.

.3 Screw, weld or groove (unless otherwise specified) piping systems up to NPS 2.

.4 Weld or groove (unless otherwise specified) all piping systems NPS 2-½ and over.

.5 Install piping to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.

.6 Avoid piping in exterior walls unless otherwise directed. If required, install this piping protected from outside by building insulation and vapour barrier.

.7 Maintain minimum of 1" (25 mm) space between adjacent flanges or pipe insulation, whichever has larger diameter.

.8 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.9 Saddle type branch fittings may be used on mains, if branch line is half size or smaller than main. Whole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle. Use correct hole saw size for Victaulic 920 Mechanical tees, Shurjoint 7721, 7722 tees.

.10 If welding, use long radius elbows.

.11 Install thermometer wells and immersion sensor wells specified under Controls Section. Where wells restrict flow in small diameter pipes (NPS 1-½ and smaller) install section of oversized pipe at least NPS 2.

.12 Remake leaking joints using new materials, do not caulk or cement leaking threaded joints.

.13 Use eccentric reducers at pipe size changes, flush on top side, to permit positive venting and drainage.

.14 Do not use thread protection couplings, close nipples, running nipples or street elbows.

.15 Install di-electric type unions or flanges or Victaulic Style 47 Clearflow Di-electric Waterways to "OPEN" type systems, where copper piping connects to steel. E.g. Domestic hot water tanks, acceptable product: Shurjoint DE30-GG.

.16 Avoid locating water and drain piping over electrical equipment. Where unavoidable, provide galvanized drip pans under such pipe and weld piping and fittings. Provide drain and piping from drip pans to floor drain.

.17 Bull head tees shall not be used for converging flows.

3.2 Pipe Grading

.1 Grade piping to provide positive drainage and venting. Slope as follows:

.1 Supply mains and branches – up in direction of flow, minimum 1:480

.2 Return mains and branches – down in direction of flow, minimum 1:480

.3 Reverse return supply and return mains – up in direction of flow, minimum 1:480

.4 Grade horizontal drainage and vent piping down in direction of flow, 2% minimum.

.5 On closed system, equip low points with ¾" (19 mm) drain valves. Provide at high points on lines and equipment connections, collecting chambers and high capacity float operated air vents.

3.3 Grooved Joint Piping Systems

.1 Grooved joints shall be installed in accordance with Manufacturer's latest published installation instructions.

.2 Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.

.3 Gaskets shall be elastomer grade suitable for intended service, and be molded and produced by coupling Manufacturer.

.4 Grooved coupling Manufacturer's factory trained Representative shall provide on-site training for Contractor's field personnel in use of grooving tools and installation of grooved joint products.

.5 Representative shall periodically visit jobsite and review Contractor is following best recommended practices in grooved product installation. (Distributor's Representative is not considered qualified to conduct training or jobsite visit(s).)

3.4 Soldering and Brazing

.1 Pressure fluid systems – with chemical treatment (heating, chilled and condenser water) BRAZE with silver base brazing alloy, 1000°F (538°C) melting point.

.2 Pressure fluid systems – without chemical treatment, (heat recovery, domestic water) SOLDER with 95/5 tin-antimony.

.3 Non-pressure systems, (drains) SOLDER with 50/50 tin lead.

.4 Piping connections to radiant ceiling panels, SOLDER with 95/5 tin-antimony.

3.5 Connections to Equipment and to Existing Piping

.1 Install unions, grooved couplings or flanges at connections to equipment and specialty components and at connecting points to existing systems which, for reasons of separation for testing, will require to be blind flanged or capped. Where dissimilar pipe and terminal connections are made the entire connected assembly shall be warrantied by the contractor.

.2 Unions are not required in installations using grooved mechanical joint couplings. (Couplings shall serve as unions and disconnect points.)

.3 Install removable sections of pipe with 12" (300 mm) spool pieces on suction side of end suction pumps and where required for ease of maintenance.

.4 Connect to equipment in accordance with Manufacturer's instruction unless otherwise noted.

.5 Arrange piping connections to allow ease of access and for removal of equipment.

.6 Align and independently support piping connections adjacent to equipment to prevent piping stresses being transferred.

.7 Do not reduce equipment connection sizes by bushing.

.8 Branch connections to existing steel piping may be made using double strap service saddles – Smith Blair #313 or Dresser #91.

.9 Connections to existing copper piping systems may be made using mechanical type couplings (flair or union types) if compatible with existing system operating and test pressures and temperatures.

3.6 Drain Connections

.1 Pipe discharge from liquid relief valves, liquid safety valves, high capacity air vents, equipment blowdown, water columns, overflows and piping system drains to nearest building drain. Install brass, bronze or copper receiving funnel on drain where shown.

.2 Drains for drain pans shall be DWV copper ASTM B306 1-¼" (32 mm) minimum size.

.3 Drain and vent piping shall be of same material as piping system connected, except where otherwise specified.

.4 Where item being drained is under pressure, provide deep seal trap.

3.7 Expansion of Piping

.1 Install piping systems with due regard and provision for expansion, avoiding strain or damage to equipment and building. Provide adequate expansion and contraction for piping running across building expansion joints.

.2 Only major expansion configuration and fittings have been indicated on drawings. Provide required additional compensators, loops and swing connections.

.3 Where expansion loops are required, use Victaulic Style 177 and 77 or Shurjoint 7705, 7707 couplings on the loops in accordance with Victaulic instructions and as approved by the Engineer is acceptable.

.4 Provide anchors, where shown. Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B3.31.

.5 Expansion loops shall be welded construction with long radius elbows.

.6 Install expansion loops, cold sprung 50% of calculated expansion.

.7 Install at least three elbows in branch connections. Where space does not permit, install braided flexible pipe connectors in accordance with Manufacturer's recommendations. Three elbow branch connections shall have sufficient developed length to ensure excessive stresses are not generated in piping and in no case less than 36" (914 mm).

3.8 Valves

.1 Install valves with stems upright or angled 45° above horizontal unless approved otherwise.

.2 Install control valves with stems upright unless approved otherwise and with adequate clearance for removal of actuators.

.3 Use gate valves or ball valves NPS 2 and under to shut-off branch takeoffs and to isolate equipment.

.4 Butterfly valves may be used as alternative to gate valves on glycol heating, hot water heating, chilled water and heat pump systems.

.5 Use globe valves to control flow in circuits except where balancing cocks are specifically specified.

.6 Use plug type globe valves in control valve bypass connections.

.7 Use plug cocks for balance valves in water return branch mains and branch connections to return mains and for shut-off and balancing on glycol circuits.

.8 Install balance fittings or valves in return piping connections to each terminal heating and cooling unit, e.g. Radiators, unit heaters, fan coil units, heating and cooling coils. All balancing valves shall be sized on a nominal pressure drop of at least 5 ft (1.5 m) water column, typically one pipe size smaller than line size.

.9 Install radiator valves in supply connections to each convection heating element.

.10 Provide isolation valves in systems such that floor by floor for horizontal systems, risers in vertical system and zone areas on large horizontal system can be isolated.

.11 Provide valves upstream of meters, gauges, automatic air vents, Flowtrex/Triple duty valves etc. for isolation purposes.

.12 Use swing check valves, in horizontal and vertical upflow pipes and on discharge of pumps. Spring loaded water check valves shall be located 8 pipe diameters downstream of pumps or elbows.

.13 Use silent check valves where specifically shown in vertical pipes with downward flow.

3.9 Drain Valves and Hose Bibbs

.1 Install drain valves and hose bibbs at each low point in piping system and at specific drain locations indicated on drawings.

.2 Install NPS ¾ hose bibbs at downfed terminal heating and/or cooling units.

.3 Install NPS 1-½ or NPS ¾ on line sizes less than NPS 1-½ drain valves/hose bibbs at low points in piping systems to facilitate draining.

.4 Install drain valves in lieu of hose bibbs for systems operating at over 200°F (93°C).

.5 Install hose end adaptor on discharge side of each drain valve or pipe to drain, where indicated.

.6 Use NPS 1-½ fire hose and connect to discharge side of drain valves to flush piping system during pipe cleaning process.

.7 Install caps, with chains, on hose end adaptors, in public areas.

3.10 Piping Tests

.1 Notify Consultant and Inspection Authority Having Jurisdiction, 48 hours in advance of intended test dates.

.2 Before testing piping, isolate equipment, which cannot withstand test pressure. Where dissimilar pipe and terminal equipment are connected, the dissimilar pipe connections shall be pressure tested prior to final component installation.

.3 Do not insulate, backfill or conceal until tests have been completed and approved by inspection authorities.

.4 Examine systems under test for leaks.

.5 Joints shall remain dry during test. General sweating around weld shall be reason for rejection.

.6 Remake leaking connections and joints.

.7 Tests shall be limited to new piping and terminal units only.

.8 New connections to existing piping shall be warranted.

.9 Initial Hydrostatic test:

.1 150% of working pressure, but not less than 125 psi (860 kPa) for 1 working day.

.10 Final Hydrostatic test:

.1 150% of working pressure, after piping connections to equipment are complete, maintain until entire piping system has been inspected.

3.11 Flushing and Cleaning

.1 Flushing and cleaning shall commence after piping tests are completed.

.2 Install temporary bypass connections around heat pump units before commencing chemical cleaning.

.3 Chemically clean the following piping systems as recommended by approved professional chemical cleaning and treatment agency who shall supervise work:

.1 Heating hot water system(s).
.2 Glycol heating system(s).
.3 Chilled water system(s).
.4 Heat pump water system(s).

.4 Flush out traces of chemical with clean water after chemical cleaning is complete.

.5 Install final connections to heat pump units after flushing is complete.

.6 Remove, clean and reinstall strainer baskets.

.7 Submit report signed by principal of Agency, which certifies cleaning has been satisfactorily completed.

3.12 Chemical Treatment

.1 Chemically treat water systems in accordance with Section 23 25 00.

3.13 Testing and Balancing

.1 Balance piping systems in accordance with requirements of Section 23 05 93.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Reference Standards

.1 Provision of specialty components shall be in accordance with ANSI/ASME B31 Codes for Building Services Piping.

1.3 Regulatory Requirements

.1 Water specialty components shall be provided in compliance with Regulations and Requirements of Province of British Columbia "Power Engineers Boiler and Pressure Vessel Safety Act and Regulations".

1.4 System Pressure Ratings

.1 Piping systems 125 psi (860 kPa) or less operating pressure - 125 psi (860 kPa) rating.

.2 Piping systems 126 psi (870 kPa) to 250 psi (1,725 kPa) operating pressure – 250 psi (1,725 kPa) rating.

Part 2 Products

2.1 Air Vents Automatic – High Capacity Type

.1 Non-Serviceable Type:

- .1 Casing and internal parts suitable for system operating pressure and temperature.
- .2 Metal construction with outlet threaded to accept vent tubing connection.
- .3 Automatic float type.
- .4 Shraeder type venting valve.
- .5 Acceptable Products:
  - .1 50 psi (345 kPa) maximum operating pressure – Armstrong AW, Dole 75, Maid-O-Mist 6, Taco 426, Watson McDaniel AE 1800, Caleffi.
  - .2 75 psi (517 kPa) maximum operating pressure – Armstrong AW, Dole 75, Maid-O-Mist 6, Taco 426, Watson McDaniel AE 1800, Caleffi.
  - .3 150 psi (1,034 kPa) maximum operating pressure – Armstrong AW, Maid-O-Mist 6, Taco 426, Watson McDaniel AE 1800, Caleffi.

2.2 Air Vents Manual – High Capacity

.1 Globe Type:

- .1 Bronze Body, union bonnet, screwed, 450 Brinell hardened stainless steel trim and plug type disc.

.2 Acceptable Products:

- .1 Class 125 psi (860 kPa) – Crane 14-½ LP, Jenkins 2032, Lunkenheimer 73-PS, Toyo 214.

.2 Class 200 psi (1,380 kPa) – Crane 212P, Jenkins 2050, Lunkenheimer 73-PS, Toyo 214.

2.3 Air Vents Manual – Radiator Type

.1 Needle Type:

.1 Bronze or steel body, screwed, needle valve.

.2 Manual key operator.

.3 125 psi (860 kPa) maximum operating pressure and 250°F (120°C) maximum operating temperature.

.4 Acceptable Products:

.1 Maid-O-Mist 816, Caleffi.

.2 Hydroscopic Type:

.1 Bronze or steel body, screwed hydroscopic discs.

.2 Manual screwdriver or key operator.

.3 Acceptable Products:

.1 50 psi (345 kPa) maximum operating pressure – Maid-O-Mist 72, Taco 417, Caleffi.

.2 75 psi (517 kPa) maximum operating pressure – Maid-O-Mist 72, Taco 417, Caleffi.

2.4 Air Separators

.1 Provide centrifugal, type with 125 psi (860 kPa) WSP steel tank, galvanized steel ¼" (6 mm) perforated strainer, perforated stainless steel air collector tube and drain connection.

.2 Provide air and dirt separators including blow-down valve, skim valve, and automatic air vent. The separator must utilize an internal medium to aid in the separation of air and dirt entrained in the system. The separator must be constructed in accordance with the latest revision of the ASME Boiler and Pressure Vessel Code and stamped for the working pressure of the system.

.3 Acceptable Manufacturers:

.1 Armstrong, Spirotherm, Taco, Spirotech, Caleffi.

2.5 Expansion Tanks – Diaphragm Type

.1 Expansion tanks with working pressure to 30 psi (207 kPa) and less than 24" (600 mm) in diameter.

.1 Steel construction with sealed-in elastomer diaphragm suitable for up to 240°F (116°C).

.2 Welding performed by certified, qualified welders.

.3 Factory tested hydraulically to 75 psi (517 kPa).

.4 Identification plate showing:

.1 Manufacturer's name.

.2 Expansion tank operating pressure, 30 psi (207 kPa).

.3 Hydraulic test pressure 75 psi (517 kPa).

.4 Date of manufacture.

.5 Pre-charge via air charging valve to 12 psi (83 kPa).

.6 Saddles for horizontal installation or base mount for vertical installation.

.7 Acceptable Products: Watts, Amtrol/Extrol, Bell+Gossett (Xylem), Taco, Zilmet.

.2 Expansion tanks with working pressure exceeding 30 psi (207 kPa) or with diameter exceeding 24" (600 mm).

.1 Steel construction with sealed-in elastomer diaphragm suitable for up to 240°F (116°C).

.2 Manufactured in accordance with requirements of ASME Section VIII, Pressure Vessels, Division 1, 125 psi (860 kPa) pressure rated.

.3 Identification showing:

.1 Manufacturer's name:

.2 Capacity in litres.

.3 Hydraulic test pressure.

.4 Working pressure.

.5 Code stamping and ASME registered design.

.4 Air pre-charged via air charging valve to 12 psi (83 kPa).

.5 Saddles for horizontal installation or base amount for vertical installation.

.6 Acceptable Products: Watts, Amtrol/Extrol, Bell+Gossett (Xylem), Taco, Flexcon.

2.6 Flexible Hose Assemblies

.1 Scope: For connection to air valve reheat coils, fan coil units etc.

.2 EPDM rubber inner core, installation or base mount for vertical installation.

.3 End connections are male solid NPT one end and male swivel NPT on the other end.

.4 Suitable for hot water applications up to 230°F (110°C).

.5 Acceptable Products: Unisource Manufacturing Inc. H-P Flex, Metraflex Elastoflex/SST.

2.7 Flexible Hoses – Heat Pumps

.1 Multi-purpose air/water hose.

.2 Suitable for 250 psi (1,725 kPa) at 212°F (100°C).

.3 Black EPDM tube with orange cover.

.4 Brass, iron pipe thread hose couplings. Secure couplings to hose with stainless steel worm drive clamps.

.5 Minimum length 24" (600 mm).

2.8 Pressure Reducing Station – Cold Water

.1 Screwed, bronze or cast-iron body, suitable to 200 psi (1,380 kPa), composition seat.

.2 Each reducing station to include:

.1 Gate valve, strainer, union, pressure reducing valve, union gate valve.

.2 Bypass with globe valve.

.3 ¾" (19 mm) relief valve.

.3 Acceptable Products: Cashco, Watts, Cash Acme.

2.9 Pressure Relief Valves – Water

.1 Screwed, bronze body or cast-iron body with expanded outlet.

.2 ASME rated.

.3 Acceptable Products:

  .1 Bronze body: Watts 174A, NPS ¾ to NPS 2, Cash Acme F-30 or F-82.

  .2 Iron body: Watts 740, NPS ¾ x 1 to NPS 2 x 2-½, Cash Acme F-95.

2.10 Pressure Relief Valves – Pump Bypass

.1 Hydraulically operated, single seated globe valve, controlled by a direct acting spring valve and diaphragm pilot valve.

.2 Main and Pilot Valve - cast-iron body, stainless steel seat and reinforced synthetic rubber diaphragm.

.3 Suitable for system operating temperature and pressure.

.4 Connections:

  .1 NPS 2 and under, screwed.

  .2 NPS 2-½ and over, flanged.

.5 Refer to drawings and/or schedules for flow rates (min., normal, max.) and relief pressure range or setpoint.

.6 Acceptable Products:

  .1 Singer Model 106-RPS.

2.11 Pressure Relief Valves - Pump Bypass

.1 Differential pressure overflow valve to control pump pressure.

.2 Screwed, bronze body with stainless steel spring.

.3 Acceptable Products:

  .1 Braukmann DU 146.

2.12 Strainers

.1 NPS 2 and under: bronze body, screwed connections.

.2 NPS 2-½ and over: cast-iron body, flanged connections.

.3 NPS 2 and over: Y or T type strainer with grooved ends with ductile iron body or factory fabricated steel body.

.4 Suitable for maximum system operating pressure. Where system pressure exceeds 125 psi (860 kPa), use 250 psi (1,725 kPa) strainer bodies.

.5 Basket Screen:

  .1 Bronze, stainless steel or monel perforated screen.

  .2 225 holes/in² (35 holes/cm2), 3⁄64" (1.2 mm) diameter perforations, 36% open area.

.6 Acceptable Products:

.1 Armstrong, Metraflex, Muesco, Spirax/Sarco, Toyo, Victaulic Series 730, 732 or W730 for all grooved end strainers, Shurjoint 726Y, 728T.

2.13 Suction Guide

.1 Integrated long radius elbow, strainer and suction entrance guide vanes.

.2 Suitable for 150 psi (1,034 kPa) and 250°F (120°C).

.3 Cast ductile iron body, stainless steel strainer, stainless steel guide vanes

.4 Connections:

.1 NPS 2 and under, screwed.

.2 NPS 2-½ and over, flanged or grooved.

.5 Select for system flow rate and allowable pressure drop.

.6 Acceptable Products:

.1 Armstrong Suction Guide, Bell and Gossett Suction Diffusers, Mech-Line, Taco Suction Diffuser, Victaulic 731 / W731 Series Suction Diffuser, Metraflex Suction Guide, Shurjoint 725G Grooved End.

Part 3 Execution

3.1 Air Vents – Automatic – High Capacity Type

.1 Install automatic high capacity air vents at each high point in piping system and where indicated on drawings.

.2 Install on tees and not on horizontal pipe runs or elbows.

.3 Install ½" (12 mm) minimum isolating gate valve ahead of each air vent, unless air vent has integral shut-off valve.

.4 Pipe air vent discharge connections (except for glycol) separately to nearest building drain using ¼" (6 mm) hard drawn copper tube. Label ends with permanent labels.

.5 Pipe air vent discharge connections (except for glycol) separately to water-tight solder jointed 16 ga (1.61 mm) copper drain pan, using ¼" (6 mm) hard drawn copper tube where exposed and soft copper where concealed. Label ends with permanent labels.

.6 Pipe air vent discharge connections from glycol circuit, separately back to glycol mixing tank, using ¼" (6 mm) hard drawn copper tube.

3.2 Air Vents – Manual – High Capacity

.1 Install manual air vents at high points in piping systems and where indicated on drawings.

.2 Install on tees and not on horizontal pipe runs or elbows.

.3 Install isolating gate valve ahead of each vent valve.

.4 Pipe air vent discharge connections to nearest building drain.

3.3 Air Vents Manual Radiator Type

.1 Install manual/automatic low capacity air vents on return side of each water heating/cooling terminal element installed above connection to main piping.

.2 Fit air vent on top of air collecting chamber of NPS ¾" (19 mm) pipe, 6" (150 mm) high.

.3 Arrange air vents so screwdriver slots or key opening are easily accessible.

.4 Drill access holes through radiation enclosures, where necessary.

.5 DO NOT USE on glycol systems.

3.4 Air Separator

.1 Provide on suction side of system circulation pump.

3.5 Air Scoop

.1 Provide on suction side of system circulation pump.

3.6 Combination Balance/Check Valves

.1 Install combination stop/balance/check valves on discharge of centrifugal pumps as indicated on drawings and/or where scheduled.

.2 Install in accordance with Manufacturer's recommendations.

.3 Minimum 5 pipe diameters from pump connections.

3.7 Expansion Tank – Diaphragm Type

.1 Install expansion/contraction tanks at each location indicated on drawings and as scheduled.

.2 Install gate valve in system connection.

.3 Install globe valve in tank drain connection.

3.8 Flexible Hoses Heat Pumps

.1 Install flexible hoses on supply and return loop water connections to each heat pump.

.2 Install union on one end.

.3 Use flexible hoses to bypass heat pumps during pipe cleaning.

3.9 Flexible Pipe Connectors

.1 Install convoluted and arched pipe connectors, for misalignment connections, where indicated on drawings or required.

.2 Install in accordance with Manufacturer's recommendations.

.3 Three Victaulic Style 77 or Shurjoint 7705, 7707 flexible couplings may be used in lieu of flexible connectors for vibration attenuation and stress relive. The couplings shall be placed in close proximity to the source of the vibration.

3.10 Pressure Reducing Stations – Cold Water

.1 Install water make-up stations for each hot water, chilled water and other closed water systems where indicated on drawings.

.2 Pipe relief valve to drain.

3.11 Pressure Relief Valves – Water

.1 Install pressure relief valve(s) on each heat exchanger to prevent over pressuring.

.2 Select relief valves to relieve full heat input of heat supply side.

.3 Pipe relief valve to drain.

.4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.12 Pressure Relief Valves – Pump Bypass

.1 Install pressure relief valves to relieve flow from supply main to return main where indicated on drawings.

3.13 Separator – Liquids/Solids

.1 Provide straight run at inlet and outlet connections of at least 5 pipe diameters.

.2 Install spool piece at outlet to permit internal service access.

3.14 Strainers

.1 Install pipe line strainers where indicated on drawings.

.2 Provide isolation valves on either side of strainer to permit cleaning without draining system.

.3 Blowdown connections:

- .1 Strainers, NPS 2" (50 mm) and under – hot services: nipple and cap.
- .2 Strainers, NPS 2-½" (65 mm) and over – hot services: nipple, globe valve and nipple.
- .3 Strainers, all sizes – cold services: plug.

3.15 Suction Guide

.1 Install suction guides on suction of centrifugal pumps, where indicated on drawings and where scheduled in accordance with Manufacturer's recommendations.

.2 "Start-up" strainer baskets must be removed prior to commissioning of systems.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Separate Price

.1 Provide a base price for work in this section based on using all HDPE piping for closed loops, headers and collection piping. Note that HDPE is NOT an oxygen barrier material and requires the use of non-ferrous and/or stainless steel components in the source side system.

1.3 General

.1 Geoexchange Contractor shall provide complete Ground Source Heat Exchanger (GSHX), as indicated on drawings, to couple with heat pump HVAC system specified elsewhere, including the following:

- .1 Borehole drilling and grout
- .2 Ground loop heat exchange piping downstream of supply and return distribution manifolds located in above-ground mechanical room.
- .3 Dewatering and treatment/removal of slurry related to borehole drilling, and excavation and backfill required for horizontal header piping. Coordinate site-specific scope requirements with the General Contractor.
- .4 Freeze protection ~~to 14°F (-10°C)~~ using 25% propylene glycol based antifreeze solution.
- .5 Flushing, purging, testing of GSHX piping including temporary circulator pumps.
- .6 Supervision and field engineering required for the complete and proper function of the ground-source heat exchanger.
- .7 Protection of geoexchange piping.
- .8 Cooperation during the overall HVAC system commissioning phase.

.2 The Mechanical Contractor shall be responsible for:

- .1 Supply and return distribution manifolds located in above-ground mechanical room, including isolation and balancing/flow control valves as shown on drawings
- .2 Permanent hydronic pumps.
- .3 HVAC water treatment for above-ground systems.
- .4 Cooperation with the Geoexchange Contractor to coordinate minimum clearances to mechanical services, depth-of-bury of all underground piping, and location and ordered arrangement of header piping “stub ups” to geoexchange manifolds.
- .5 Overall balancing and commissioning of completed heat pump/HVAC system.

.3 Coordinate sequencing of borehole drilling, excavation, trenching, and backfill with General Contractor. Include proposed drilling and installation schedule with tender submission.

.4 Coordinate sequencing of manifold installation, flushing, purging, testing, system fill, system balancing, and commissioning with the Mechanical Contractor.

1.4 References

.1 AHRI 330 Ground Source Closed-Loop Heat Pump Systems.

.2 ASHRAE Ground-Source Heat Pumps: Design of Geothermal Systems for Commercial and Institutional Buildings (Textbook by Kavanaugh and Rafferty)

.3 ASTM D2513 – Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

.4 ASTM D3350 – Standard Specification for Polyethylene Plastics, Pipe and Fittings Materials.

.5 ASTM F1055 – Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing

.6 ASTM F2080 – Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Cross-Linked Polyethylene (PEX) Pipe

.7 EN 1555-3 – Plastic piping systems for the supply of gaseous fuels. Polyethylene (PE). Fittings

.8 CSA B137.1 – HDPE Piping

.9 CSA C448 – Design and Installation of Earth Energy Systems, All Sections

.10 IGSHPA Closed-Loop / Ground Source Heat Pump Systems, Design and Installation Standards

.11 ISO 9001 – Quality Management Systems - Requirements

.12 Commissioning and installation of heat pumps to CAN/CSA 13256-1-01 and CAN/CSA 13256-2-01

.13 Provincial Ministry of Environment Regulations related to vertical borehole and wall drilling.

1.5 Quality Assurance

.1 Manufacturer's Qualifications:

- .1 Firms must be regularly engaged in manufacture of GSHX products and tools of types, materials, and sizes required; their products in satisfactory use in similar service for not less than 5 years.
- .2 All components shall be supplied by one manufacturer.
- .3 Pipe shall be manufactured in a facility whose quality management system is ISO 9001 certified.
- .4 Pipe and fittings shall be IGSHPA approved.

.2 Installer's Qualifications:

- .1 Installation shall be performed by qualified laborers trained in the procedures of ground loop heat exchange systems. Installer shall have either IGSHPA or Geothermal Service Contractor (GSC) certification. Installers shall have at least two years of successful installation experience with GSHX work similar to that required for this project.
- .2 Only acceptable method for joining pipe to be buried is heat fusion process. GSHX fabricators must have completed heat fusion certification course under direct supervision of certified heat fusion trainer.

.3 Codes and Standards:

.1 Installation shall comply with AHRI 330 Ground Source Closed-Loop Heat Pump Systems.

.2 Comply with local and provincial ordinances, and most recent editions of GSHPA Standards and CSA C447-94, and as here in after specified.

.4 Delivery, Storage, and Handling

.1 Deliver and store piping and equipment with labeling intact, in a safe, dry, enclosed, well-ventilated, under-cover area. Pipe shall be kept in original shipping packaging until required for installation.

.2 Do not expose pipe to ultraviolet light beyond exposure limits recommended by manufacturer.

.3 Protect piping and manifolds from entry of contaminating materials. Install suitable plugs in open pipe ends until installation.

.4 Where possible, connect pipes to assembled manifolds to eliminate possibility of contaminants and cross-connections.

.5 Piping shall not be dragged across the ground or other surfaces, and shall be stored on a flat surface with no sharp edges.

.6 Protect materials from damage by other trades.

.7 Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

.8 Take necessary precautions to filled system from freezing.

1.6 Submittals

.1 Submit shop drawings in accordance with Section 23 05 00.

.2 Products Data: Submit piping Manufacturer's technical data, product data and installation instructions for GSHX piping materials and products, including data for equipment, fittings, fasteners and associated items necessary for the installation of the piping and manifolds.

.3 Drawings: Using mechanical plans as a reference, provide detailed computer-generated plans drawn to scale for all installation areas. Indicate dimensions (including distances of each borehole from adjacent gridlines), detailed pipe routing (including reverse-return piping arrangement for each borehole zone), piping/slab penetration details, descriptions of materials, general construction, component connections, and installation procedures.

.4 Installer's and Fabricators Qualifications: Submit names and certificates of successful completion of required courses.

.5 Submit computer-generated ground loop heat exchange system design indicating total pipe required, ground loop configuration (i.e. borehole, single pipe horizontal, slinky, etc.), pipe diameter, borehole or trench separation, ground thermal conductivity and diffusivity, and entering and leaving water temperatures. Ground loop heat exchange design calculations shall be performed on industry recognized software.

.6 Maintenance Instructions: Submit instructions for maintenance of the system, including all operating components (Pumps, Accessories, etc.).

.7 Record Keeping: The following minimum detailed records must be kept:

.1 Complete "GHSX Checklist" for each borehole – refer to end of this section.

.2 Detailed records of the purging and flushing operations as follows:

.1 Flow rates for purging (calculated by dividing the totalising flow meter read-out difference by the measure time interval between readings).

.2 Circuits that are open during each flow rate/purge operation.

.3 Length of time that each portion of the GHX is exposed to a flow rate and the flow reversal details during flushing of that portion.

.4 Observations during purging and flushing recorded chronologically.

.3 Pressure test results for each borehole zone, and preliminary and final test of full GSHX system.

.4 As-built dimensional drawings showing locations of all GSHX parts and piping circuits. At completion of project and prior to substantial completion and final payment for work completed under this section, also prepare and submit as "RECORD DRAWINGS", in hard copy and AutoCAD format.

.5 Digital photographs of each borehole zone, and all horizontal zone header piping, prior to backfill/concealment.

1.7 Warranty

.1 Contractor shall provide a two-year all-inclusive warranty for the entire ground-source heat exchange piping system against defects in workmanship and material. Warranty coverage shall include labour and material for necessary repairs, including all ancillary costs such as slab cutting and patching, excavation, replacement of backfill, and generally making-good of the installation and affected finishes as a result of the repair.

.2 Manufacturer shall provide a written guarantee that piping is suitable for the application, temperatures, and pressures specific to the project, for a minimum operating life of 50 years.

Part 2 Products

2.1 General

.1 Ground loop heat exchange materials shall conform with:

.1 CSA C448

.2 CSA B137.1 for HDPE systems,~~ or CSA B137.5 for PEX-a systems~~

.2 THE GSHX HDPE pipe shall have permanent markings in accordance with CSA C448, indicating the intended service as "Geothermal" or "Geo" and the CSA Standard number "C448".

.3 Pipe shall not carry the word "potable" or the letters "P' or "PW" on its surface.

.4 Pipe shall be rated for continuous operation of 100 psi gauge pressure at 180°F (690 kPa @ 82°C) temperature, and 160 psi gauge pressure at 73.4°F temperature (1,103 kPa @ 23°C).

.5 All buried fittings shall be of a permanent design. Field fabricated fittings are not acceptable.

2.2 Pipe and Pipe Fittings – High-Density Polyethylene (HDPE)

.1 Ground loop heat exchange pipe and fittings shall be produced from identical materials constructed of virgin PE3408 IPS-OD SDR-11 or Schedule 40 high density polyethylene with minimum cell classification 34543C per ASTM D-3350 Standard Specification for Polyethylene Plastics, Pipe and Fittings Materials.

.2 Fittings shall be manufactured in facilities designed for that purpose. Allowable HDPE fittings:

- .1 Loop take-off fittings to 1-1/4"ø: Socket or butt fusion.
- .2 Loop take-off fittings above 1-1/4"ø: Saddle fusion
- .3 Butt fusion x flanged.
- .4 Socket fusion x brass NPT.

.3 On header piping NPS 1-¼ and smaller, use regular tee fittings. Bell reducer fittings or reducing tees shall be used at pipe reductions to eliminate trapped air.

.4 Exercise extreme caution to completely remove cutout material.

2.3 Vertical Borehole Heat Exchanger:

.1 General:

- .1 The vertical borehole heat exchanger tip shall be manufactured of one continuous pipe, with no joints in the borehole~~ or shall be manufactured from coated stainless steel components manufactured to the ASTM F2080 standard~~.
- .2 The minimum bend radius at the vertical borehole heat exchanger tip shall not exceed two times the outside diameter of the pipe.
- .3 The vertical borehole heat exchanger shall be a single U-bend or a double U-bend system, consisting of 2 single U-bend pipes attached together.

.2 HDPE-Specific Requirements:

- .1 Vertical GSHX constructed of HDPE pipe shall use SDR-11 or Schedule 40 piping. U-bend shall be constructed and attached to GSHX using heat fusion bonding method. No other fusion joints are permitted on vertical portion of GSHX constructed of HDPE.
- .2 Horizontal (horizontal S and R headers) piping shall be constructed of the same pipe material as the GSHX. Joints shall be made using heat fusion joining method. Minimize number of fusion joints required.
- .3 Horizontal piping shall be installed at minimum depth of ~~48~~72" (~~1,200~~ 1,800mm) below final grade where located outside the building footprint, and minimum depth of 18" (450mm) below slab-on grade where installed within the building footprint.
- .4 Horizontal piping supply and return lines or bundles shall be separated to minimize thermal interference between two. Number of points where supply and return lines cross one another shall be minimized.
- .5 Clean fill, free of large or sharp rock or debris, shall be used to cover horizontal pipe. Horizontal trenches are to be compacted every 8" (200 mm) during backfilling. Refer to ASTM D-2321 for backfill procedures.

2.4 Manifolds

.1 Distribution manifolds shall supplied and installed by the mechanical contractor. Refer to separate requirements under Section 23 21 13.

  .1 Brass manifolds shall be produced from extruded brass round pipe with tapped holes for connections, and be pre-assembled by the manufacturer. 100% of manifolds used shall have been air tested by the manufacturer with no indication of leaks.

  .2 Polypropylene manifolds shall be produced from extruded polypropylene SDR 11 pipe containing a fiber layer to restrict thermal expansion. Holes shall be tapped for connections. Outlet ports shall be fusion welded onto the body of the manifold, with integrated brass threads for connection to the borehole field. Fusion welding shall be done in a factory setting to ensure quality of the manifold. Manifold shall be supplied by the manufacturer with all components pressure tested and with no indication of leaks.

.2 Manifolds shall be equipped with supply and return manifold isolation valves, integral wells for thermometers, digital temperature sensor wells, manometer housings, and air vent/fill ports. Where required by design, each circuit shall be supplied with circuit isolation and balancing valves, integral visual flow gauges, and brass cold expansion compression-sleeve fittings to connect to IGSHPA-approved pipe.

.3 Permanent hydronic pumps connected to manifolds shall be equipped with strainers and air separators.

2.5 Antifreeze

.1 Standard of Acceptance: Dow Chemical "Dowfrost" inhibited propylene glycol, or alternate only as accepted by Consultant.

.2 Antifreeze shall be a safe, environmentally-friendly, and non-toxic solution of propylene glycol.

.3 The percentage of antifreeze shall be measured by volume, not weight, minimum 25%, maximum 30%.

.4 ~~Geoexchange~~ Mechanical Contractor shall be responsible for quantity of antifreeze required for initial ground heat exchanger system fill, testing, and commissioning of system portion shown on drawings. Geoexchange contractor shall be responsible for confirming the final volume of the geoexchange field (taking into account final pipework routing) with the Mechanical Contractor. Geoexchange Contractor shall ~~C~~coordinate isolation, testing, and mixing of systems between GSHX and main HVAC system with Mechanical Contractor.

2.6 Grouting

.1 Vertical GSHX bore holes shall be grouted completely with thermally enhanced bentonite clay grout in conformance with International Ground Source Heat Pump Association's (IGSHPA) standards specified in "Proper Grouting Procedures for Ground-Source Heat Pump System", and in conformance with provincial and local requirements with a minimum thermal conductance of 0.75 btu/hr __ft (m) __˚F (˚C). Provide test report/shop drawing to verify.

.2 Backfill grout from the bottom of the borehole upwards as outlined in the Grouting Procedures, beginning from within (at most) 10 ft (3m) from the bottom of the borehole. Tremmie length and assurance of tremmie placement to the specified depth will be monitored at random.

.3 Contractor shall monitor each bore hole and continue adding grout as required due to settling of grouting material. Top-up boreholes after the grout has settled until returns are observed at the surface.

Part 3 Execution

3.1 Examination:

.1 Examine areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of Work. Do not proceed until unsatisfactory conditions are corrected.

.2 Beginning of installation means acceptance of existing conditions.

3.2 Consultant Review

.1 Provide minimum 48 hours notice to arrange for consultant review of all piping prior to backfill and concealment. At minimum, the following milestones shall be arranged for Consultant Review:

- .1 Completion of borehole/header connections and pressurization of first zone
- .2 Installation of “stub-ups” to main geoexchange manifold location, prior to slab-on-grade concrete pour
- .3 Completion of purge and flush for first zone.
- .4 Witness of Final GSHX Pressure Test

3.3 Waste Removal

.1 Be responsible for collection of groundwater, slurry, cored rock and soil, and other waste related to borehole drilling. Dispose of materials from site in a manner acceptable to Authorities Having Jurisdiction. Do not drain to municipal sewers. Coordinate with General Contractor’s general requirements for on-site dewatering, stormwater management, and construction erosion/sedimentation control.

3.4 Installation of Piping

.1 Install in accordance with manufacturer's published installation manual and/or published guidelines and final shop drawings.

.2 Route piping in an orderly manner, according to layout and spacing shown in final shop drawings.

.3 Avoid sharp bends in piping; install elbow fittings if necessary.

.4 At connections and fittings, use a plastic pipe cutter to ensure square and clean cuts

.5 Join pipes immediately or cap open ends to prevent entry of contaminants until final connections are made.

.6 Each completed section of the GSHX shall be continuously pressurized at 30 psi (207 kPa) minimum until final service connections are completed.

.7 Upper ends of each borehole loop shall be marked with metallic tracer tape buried 12” (300 mm) to 18” (450 mm) below grade. Horizontal piping shall also be marked.

.8 Piping that passes through expansion joints shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 15 inches (40 cm) on each side of the joint. Sleeving shall be secured on pipe to prevent movement during installation of thermal mass.

.9 Mount manifolds in locations shown on drawings. Manifolds shall be mounted as level as possible, with the venting device on the uppermost section. Refer to Pipe Insulation section of this specification for scope of source side (condenser) pipe insulation for geoexchange piping.

.10 Where piping penetrates the slab-on-grade to connect to the manifolds, a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 inches (15 cm) down into and 6 inches (15 cm) above the finished floor level. For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.

.11 At the time of installation of each zone header, connect the pipe to the correct manifold outlet and record pipe length for balancing. If manifold is not installed, cap the end of the zone header pipe and label the circuit numbers along with “S” for supply and “R” for return. Connect pipes to manifold as soon as possible and record circuit lengths. Circuits shall be labeled to indicate circuit length and serviced area.

3.5 Vertical GSHX:

.1 Vertical bore holes shall be maintained open and clean and of sufficient diameter to facilitate installation of U-tube borehole loop. Bore holes shall be backfilled with appropriate grout material to assure pipe contact with the surrounding ground. The grout material shall not contain large, sharp, or jagged rocks or debris. Care shall be taken during installation and grouting not to crush, cut or kink pipe.

.2 After insertion into borehole, each borehole loop shall be purged of air and flushed with water until water runs clear. Provide bottom U-Bend anchors where groundwater/hydrostatic pressures may cause pipe to float.

3.6 Flushing and Purging

.1 General:

.1 This Section pertains to the flushing/purging of the ground loop piping exterior of the building. Piping on the interior of the building connected to the ground loop shall be purged and flushed in accordance with requirements of Section 23 25 00 Chemical Treatment for Piping. In practice, the exterior and interior piping systems can sometimes be purged in a combined operation. Coordinate with Mechanical Contractor.

.2 Flushing is intended to remove foreign debris and silt from the ground loop so that the ground loop contains only clean water.

.3 Purging is intended to remove air from ground loop piping.

.4 Before backfilling trenches, horizontal supply and return zone headers shall be flushed and purged of air and flow tested to ensure portions of GSHX are properly flowing. Portable temporary purging unit shall be utilized and shall consist of the following: purge pump – high volume and high head, open reservoir, filter assembly with by-pass, connecting piping and connection hoses.

.5 Do not use permanent pumps for flushing and purging.

.6 Using purging unit, flush and purge each GSHX zone until free of air, dirt and debris. Velocity of 2 ft/s (0.06 m/s) is required in pipe sections to remove air. Isolate GSHX from main HVAC system with shut-off valves.

.7 Utilizing purging unit, conduct pressure and flow test on GSHX to ensure system is free of blockage. If flow test indicates blockage, locate and remove blockage, repurge, conduct pressure and flow test again until all portions of system are flowing. Flow test must be observed and approved by Consultant.

.8 Flushing Duration: until clean water with no foreign material and no turbidity is present in the ground loop.

.9 Purge Duration: at least two hours for each of the sub-loops (longer if air continues to be evacuated at the end of the two hour period.

.10 Flow Reversal: During flushing/purging the flow direction through the loop shall be reversed at least four times and the total duration that the flow travels in each direction shall be approximately equal at the completion of purging.

.2 Flow Rate and Pressure Specifications

.1 Purging Criterion: The International Ground Source Heat Pump Association (IGSHPA) has adopted a guideline for a minimum flushing and purging velocity of 2 fps (0.6 m/s) throughout the loop pipe network and it shall be used as the basis for Commissioning this system.

.2 Required Flow Rates: The following minimum flow rates are necessary to maintain flow at 2 fps (0.6 m/s) in the respective SDR 11 pipe sizes:

.1 2.5" (65mm) pipe requires 35 USgpm (7.95 m3/h)

.2 2" (50 mm) pipe requires 25 USgpm (4.10 m3/h)

.3 1-½" (38 mm) pipe requires 15 USgpm (2.72 m3/h)

.4 1" (25 mm) pipe requires 7.5 USgpm (1.36 m3/h)

.3 To achieve this flow rate, the pumping apparatus may need to develop a pumping pressure of 25 psi (170 kPa) to 30 psi (207 kPa) of the exterior portion of the ground loop piping is purged in isolation from the interior piping. If the interior piping is purged concurrently, additional pressure will be required.

.4 For vertical bore hole systems caution should be exercised during the purging to avoid significantly exceeding the 160 psig (1103 kPa) pressure rating of the loop pipe with the combination of static + dynamic pressure (note that the hydrostatic pressure at the bottom of a **60m** borehole is approximately **130 psi (896 kPa)**; however, in most cases this pressure is partly counteracted by grout pressure on the outside of the loop pipe).

.3 Pumping Apparatus

.1 The pumping apparatus shall be designed to conform with the descriptions of such an apparatus described in Closed-Loop/Ground Source Heat Pump Systems – Installation Guide, International Ground Source Heat Pump Association, 1988.

.2 The apparatus shall include a reservoir open to the atmosphere. The intake for the pump shall draw from a filtered intake at the bottom of the reservoir. The return flow from the ground loop shall enter the top of the reservoir. Debris flushed from the piping will settle in the reservoir and air purged from the piping will escape from the open top of the reservoir.

.3 The pumping apparatus shall be equipped with the reliable gauges to indicate pressure and flow rate.

.4 Flushing/Purging Hook-Up Location

.1 Flushing and purging shall be conducted in such a manner as to isolate each of the zone sub-loops. Each of the header sets penetrate the building individually. Hence, the ground loop purging and flushing may be readily conducted at the slab penetration.

.2 Flushing and purging of the interior piping connected to the ground loop (including heat pump heat exchangers) will also be required according to Section 23 25 00. If purging of interior and exterior piping is not conducted concurrently, ensure that the methods used to purge the piping inside the building do not cause air or foreign material to be introduced into the ground loop piping. Coordinate with Mechanical Contractor.

.3 If purging of the exterior and interior piping is conducted concurrently, it is recommended that separate preliminary flushing of the exterior and interior piping be conducted first to avoid circulating any foreign debris from one system to the other.

.5 Record Keeping: GSHX inspection report and GSHX checklist to be completed by Contractor and witnessed by the Consultant. During flushing/purging the Contractor shall keep records indicating:

.1 Time and date that flushing/purging started.

.2 Time and flow reversals occurred.

.3 Periodic flow rate and pressure measurements.

.4 Time and date that flushing completed.

.5 Occurrence of any unusual events during flushing/purging.

3.7 Testing

.1 Individual Loop Testing: Each vertical borehole loop shall be pressure tested before insertion into borehole and again after manifolding. Testing shall be conducted at ambient temperature above 10°C (50°F):

.1 HDPE: by water pressure at 100 psi (690 kPa) for minimum of 30 minutes.

.2 Horizontal Zone Header Testing: Connections to vertical GSHX, each horizontal header shall be hydrostatically pressure tested. Testing shall be by water pressure at 100 psi (690 kPa) for minimum of 30 minutes, and then maintained continuously at 30 psi (207 kPa) until final services connections.

.3 Manifold Testing: Use liquid gas detector or soap solution to check for leakage at manifold connections.

.4 Full GSHX Testing:

.1 Preliminary Test:

.1 Perform a preliminary pressure test pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100 psig for 30 minutes.

.2 As the piping expands, restore pressure, first at 10 minutes into the test and again at 20 minutes.

.3 At the end of the 30-minute preliminary test, pressure shall not fall by more than 8 psig from the maximum, and there shall be no leakage.

.2 Main Test:

.1 After successfully performing the preliminary test, perform the main pressure test immediately.

.2 The main pressure test shall last a minimum of 2 hours.

.3 The test pressure shall be restored and shall not fall more than 3 psig after 2 hours. No leakage shall be detected.

.5 Results of tests shall be recorded and supplied to Consultant upon completion of the GSHX installation.

3.8 Antifreeze Charging

.1 After completion of purging/flushing antifreeze shall be added only after the exterior and interior piping has been flushed and purged to the satisfaction of the ground loop engineer.

.2 The antifreeze shall be added such that a pre-measured volume appropriate for achieving the specified weight percentage of propylene glycol is introduced into the loop as a “single slug”. It is important to introduce the antifreeze as a single slug with minimal mixing during the charging process, so that the fluid displaced from the loop during charging does not contain antifreeze.

.3 The Contractor shall estimate the volume of ground loop fluid (outside of the building penetration) based on actual piping installation. To calculate the volume of antifreeze required to attain the specified percentage of propylene glycol, the volume of fluid in the interior piping and the volume of fluid in the heat pump heat exchangers shall be taken into account.

.4 Record Keeping: The Contractor shall maintain detailed records indicating the type and the amount of antifreeze placed in the system and details about the specified product used (including manufacturer, batch numbers, or other identification features of the product).

.5 Detailed Product Information: The specific antifreeze product proposed for use shall be reviewed by the Consultant prior to installation.

GSHX CHECKLIST

GENERAL

GSHX – (Borehole) Number: ______

Reference Drawing: ________

DRILLING DETAILS

Drilling Company: __ Drilled By: ________________

Drill Crew: ______________________________ Drill Rig: ____

Start Date/Time: ______________________________ End Date/Time: ______________________________________

Drilling Method: ______________________________ Bore Pitch/Bearing: ________________________________

Total Drilled Depth: ____________________________ Depth to Water: ____________________________________

Supervised By: ______________________________ **Company**: ____

Signature: ____________________________ **Date/Time**: ____

GSHX PIPING LOOP

Installation Company: ______________________ Installed By: ____

Brand/Type: ______________________________ U-Bend Fitting Type: _________________________

Pre-Install Visual Inspection By: ________________ Pre-Install Test Start Time: ___________________________

Pre-Install Test Pressure (psi): _ Pre-Install Test End Time: ____________________________

Test Witness: ___________________________________ Date: ____

Length Installed: ______________________________ Length In-Situ: ______________________________________

Date/Time Filled with H_20 and Capped or Final Connection: _______________________________________

Supervised By: ______________________________ **Company**: ____

Signature: ______________________________ **Date/Time**: ___________________________________

VERTICAL GSHX GROUT

Grouting Company:_________________________ Poured By:___________________________

Grout Type: ______________________________ Sand Type: ___________________________________

Mix Ratio:__________________________________ Approx. Borehole Volume:______________________
(lbs grout/lbs sand/USgal H_20)

Number of Batches Used:____________________ Approx. Batch Volume:___________

Other Additives: ____

Supervised By: ___________________________ **Company**: ______________________________________

Signature: ___________________________ **Date/Time**:______________________________

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and are to be read, interpreted and coordinated with other parts.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 23 05 00.

.2 Submit shop drawings of pump curves with operating points indicated. Include NPSH curve when applicable.

.3 Submit motor efficiencies for motors 1 hp (0.746 KW) and over, refer to Section 23 05 13 for minimum efficiencies.

1.3 Quality Assurance

.1 Ensure pumps operate at specified system fluid temperatures without binding and cavitation, are non-overloading in parallel or individual operation; operate within 25% of midpoint of published maximum efficiency curve.

.2 Where pumps are operated in conjunction with others such as parallel pumps, show operating points on pump curve.

.3 Under no circumstances use a triple duty flow/check valve on any pump station, provide a check valve and an isolation valve as separate pipeline installations.

1.4 General

.1 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, have 1.15 service factor and be suitable to be driven by PWM variable speed drive controllers. Motor Manufacturer shall submit, in writing, confirmation motors are designed to withstand voltage peaks of 3.1 times the normal voltage and voltage rate of rise of 2000V/µs at frequency of 20 kHz.

.2 For motors below 1.5 kW in size, provide ECM motors complete with manual speed control switch, and 0-10V DC control signal terminal for variable speed control. See Section 23 05 13 for ECM motor requirements.

.3 Acceptable Pump Products – General: Bell & Gossett, Armstrong, Taco Grundfos, Wilo.

Part 2 Products

2.1 General

.1 Statically dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1750 r/min unless specified otherwise.

.4 Domestic water pumps shall be all bronze construction.

.5 Geo-exchange field condenser (source) pumps shall be all bronze, or all stainless steel construction.

2.2 In-Line Circulator Pumps

.1 Suitable for maximum working pressure of 125 psi (860 kPa) and maximum temperature of 225°F (107°C).

.2 Casing: Cast-iron radially split, with flanged connections. Supplied with matching companion flanges.

.3 Impellor: Corrosion resistant cadmium plated steel,

.4 Shaft: Alloy steel with bronze sleeve bearing, integral thrust collar.

.5 Seal Assembly: Mechanical.

.6 Coupling: Flexible self-aligning.

.7 Motor: Resilient mounted, drip proof, sleeve bearing.

2.3 In-Line Circulator Pumps – Domestic Water

.1 Suitable for maximum working pressure of 125 psi (860 kPa) and maximum temperature of 225°F (107°C).

.2 Casing: Bronze radially split, with flanged connections. Supplied with matching companion flanges.

.3 Impellor: Corrosion resistant **stamped brass or bronze**.

.4 Shaft: Alloy steel with bronze sleeve bearing, integral thrust collar.

.5 Seal Assembly: Mechanical.

.6 Coupling: Flexible self-aligning.

.7 Motor: Resilient mounted, drip proof, sleeve bearing.

2.4 Vertical In-Line Centrifugal Pumps

.1 Suitable for maximum working pressure of 175 psi (1,210 kPa) and maximum temperature of 225°F (107°C).

.2 Casing: Cast-iron radially split, single stage, flanged suction and discharge connections, separate tapped opening for venting, draining and gauge connections.

.3 Impellor: Bronze dynamically balanced, keyed drive with locking nut.

.4 Shaft: Stainless steel on split coupled pumps and carbon steel with bronze sleeve on close coupled pumps.

.5 Seal Assembly: Outside unbalanced mechanical seal with factory installed seal flushing line.

.6 Coupling: Close coupled on motors less than 7.5 hp (5.6 KW) and split couplers for motors 7.5 hp (5.6 KW) and larger to permit removal of seal without disturbing motor.

.7 Motor: EEMAC Class B, squirrel cage induction, continuous duty, drip proof, ball bearings.

.8 Accessories: Strainer/suction guide, discharge flow meter/shutoff valve.

2.5 Boiler Feed Pumps

.1 Pump casing and flanges suitable for maximum working pressure of 580 psi (4,000 kPa).

.2 Combination self-priming multi-stage turbine with initial centrifugal stage.

.3 Low NPSH.

.4 Cast-iron casting, bronze impellors, stainless steel shaft.

.5 Grease lubricated ball bearing at drive end and sleeve bearing at suction end.

.6 Packed stuffing box.

.7 Direct drive with flexible coupling.

.8 Steel base.

2.6 Inline, Wet Rotor, Integrated VFD, Pipe Mounted Pump

.1 In-line pipe-mounted pumps with integrated VFD shall be Grundfos MAGNA® wet rotor, in–line, variable speed circulators.

.2 The pump and motor shall be designed and built by the same manufacturer.

.3 The Pumps shall be of quiet "Wet Rotor" design. Maximum noise level of the pump and motor shall be 54dB (A).

.4 The pumps shall be able to operate at maximum 203°F (110°C) and minimum 59°F (15°) water, continuously and at maximum 230°F (110°C) intermittently.

.5 The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region

.6 The pump housing shall be Cast Iron, with laser welded stainless steel Impellers and Stainless Steel neck rings to minimize recirculation and maximise pump efficiency. Pumps shall have tungsten carbide sleeve bearings for extended life. Pumps for Domestic Hot Water application shall be of Stainless Steel housing.

.7 The pump is to be connected directly to a single-phase 4- or 8-pole, synchronous, permanent-magnet motor (PM motor) and had to have been tested with the pump as one unit by the same manufacturer.

.8 The Motor shall have a variable frequency drive integrated in the terminal box and a small control panel on the terminal box. The pump speed shall be controlled by the "Integrated Variable Frequency Drive". No additional devices (such as pressure transducer etc.) are to be required for control of the pumps.

.9 The motor shall be cooled by the pumped fluid and shall be self-ventilating. The stator housing shall have 8 drain holes to enable condensed water to escape

.10 The terminal box shall be made of black composite material, shall have an Enclosure class of IP44 and shall have fiber optic indicator lights for operation indication and trouble shooting

.11 The pump shaft shall be installed horizontally per manufacturer's recommendations. The required inlet pressure by the pump shall be available at the pump inlet

.12 The following control modes are to be available:

  .1 Proportional Pressure control - The pump head is changed continuously in accordance with the water demand in the system.

  .2 Constant Pressure control - A constant head is maintained, irrespective of water demand.

  .3 AUTOADAPT - The differential pressure across the pump is automatically adjusted to match the flow requirements

.13 The control panel on the terminal box should enable selection of the any of the above control modes without any external devices. The control panel should also enable setting desired Pressure set-point. The control panel should show an estimation of flow rate through the pump in 0-100% range.

.14 The controller is to be capable of receiving a "Remote Start/Stop Signal" at a Digital Input for ON/OFF control by an external device (e.g. DDC or other BAS). The controller shall also have a Signal Relay that can be programmed for Fault or Operation indication to an external controller (e.g. DDC or other BAS)

.15 The control shall have an optional Module that can receive 4-20mA speed signal for operation from an external device. The Module shall have the capability of connect two MAGNA pumps for Alternating between the pumps and for Duty/Standby operation.

.16 Magna Communication Card

- .1 Supply complete with optional communication card – GENI MODULE that allows the following contact points:
  - .1 RS485 Connection for GENI BUS or other bus communication.
  - .2 0-10VDC External Analog Input:
    - .1 Via this input the pump can be controlled by an external controller using the following control modes:
      - .1 Constant Curve: The external analog signal will control the pump SPEED within the range from the min speed to the upper limit selected speed.
      - .2 Proportional or Constant Pressure Control: The external analog signal will influence the pressure setpoints set on the controller. 100% signal corresponds to Pressure Setpoint. Anything below 100% will reduce the setpoint to that percentage value.
  - .3 External Signals for Forced Control to Minimum or Maximum Duty
  - .4 Control of Twin-Head Pumps or Two Magna Pumps
    - .1 This allows connecting two MAGNA pumps so that they operate as a twin-head pumps in Master-Slave configuration.
    - .2 The pumps can be set to one of the following operating modes:
      - .1 **Alternating Operation**. Pump operation alternates every 24 hours. If the duty pump stops due to a fault, the other pump will start.
      - .2 **Standby Operation**. One pump is operating continuously. In order to prevent seizing-up, the other pump will start at a fixed frequency. If the duty pump stops due to a fault, the other pump will start.
      - .3 The operating modes are to be selected by means of a mechanical contact in each module.

2.7 Pump Discharge Flow Meter

.1 Provide a Bell & Gossett (Xylem) Venturi Balance and Flow Measurement Valve with Integral Ball/Butterfly Valve. Acceptable Products:

- .1 Taco Accu-flo; IMI Flow design UA or AF; Armstrong APV.

Part 3 Execution

3.1 General

.1 Ensure pumps are installed so no piping or equipment loads are imposed on pump body. Provide stanchions or hangers for this purpose. Refer to Manufacturer's installation instructions for details.

.2 Pumps shall be aligned by qualified millwright and alignment certified.

.3 Check pump rotation.

.4 Pipe drain tapping to floor drain.

.5 "Start-up" strainer baskets in strainer/suction guides must be removed prior to commissioning of systems.

.6 Provide air cock and drain connection on horizontal pump casings.

.7 Provide line sized gate valve and strainer on suction and line sized soft seated check valve.

.8 Provide discharge flow meter/shutoff valve on pump discharge pipe.

.9 Decrease from line size, with long radius reducing elbows or reducers.

.10 Shave or replace pump impellers to meet actual operating conditions.

.11 Where remote control panels are used, Contractor shall allow for wiring from panel to pumps.

.12 Provide seismic restraints for pumps.

.13 Secure control panels for seismic loads.

.14 Where pumps are controlled by a variable speed drive, the minimum speed of the pump shall be set at ±40% of rated RPM, or as directed by the pump supplier based on pump curve and minimum system flows and pressure requirements.

3.2 In-line Circulators

.1 Install as indicated by flow arrows.

.2 Support at flanges on inlets and outlets of unit.

.3 Install with bearing lubrication points accessible.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope

.1 Provide for cleaning and degreasing of systems that use glycol or water as heat transfer medium.

.2 Provide for cleaning and disinfection of domestic hot and cold systems.

.3 Provide temporary strainers, connections and by-pass lines as required.

.4 Provide equipment to add chemicals to systems as specified herein.

.5 Provide equipment to operate and control system as specified herein. Provide appropriate protection so capped off unused piping does not corrode.

.6 Provide corrosion coupons for closed and open loop circulation systems as specified herein, to include testing and analysis at least twice in the first year of warranty

.7 Piping systems to be chemically treated include the following systems:

- .1 Chilled water system(s).
- .2 Hot water heating system(s).
- .3 Heat pump / Geo-exchange water system(s).
- .4 Glycol system(s).

.8 Provide complete start-up and commissioning, including the amounts of chemicals and filter media change-outs sufficient to calibrate the system and provide supplies for the first year of warranty.

1.3 Quality Assurance

.1 Water treatment chemicals and treatment process shall be supplied and performed by Contractor. Work shall be supervised by Water Treatment Specialist who, upon completion, shall certify process is satisfactory and submit report outlining cleaning operation and treatment process. Contractor shall provide name and supplier of chemical treatment specialist as part of post-tender submittals and progress claim breakdown.

1.4 Reference Standards

.1 Provide HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of regulating authorities, except where specified otherwise.

1.5 Submittals

.1 Submit shop drawings including proposed chemicals, quantities, procedures and equipment to be supplied. Provide written operating instructions and system schematics including MSDS data, and safe disposal instructions. Provide samples of testing record sheets with recommended water treatment testing schedule for the proposed treatment.

.2 Provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.

.3 Submit written report containing test results and list of chemicals added every 14 days from time of commissioning to acceptance.

.4 Notify Consultant 48 hours prior to chemical cleaning so work may be verified and reviewed.

1.6 Water Treatment Service

.1 Water Treatment Specialist shall provide supervision of installations, set-up and adjustments and shall submit written report on system operations.

.2 Chemicals, feed systems and test equipment shall be provided by Water Treatment Specialist.

.3 Treatment chemicals shall not contain hydrazine.

.4 Treatment chemicals shall be non-foaming.

.5 Water Treatment Specialist shall instruct maintenance personnel before substantial completion. Written instructions of treatment, dosages, control charts and test procedures shall be included in maintenance manuals.

.6 Provide test kit suitable for chemical treatments used. Test kit shall be made available for on-site tests and provide Myron 3 range TDS meter to check conductivity. Hand kit over to Building Operator at project completion; obtain receipt.

.7 Provide one mild steel and one copper corrosion coupon package to monitor corrosion rate for each open and closed systems.

Part 2 Products

2.1 Materials

.1 System Cleaner:

  .1 Sodium Metasilicate, Sodium Nitrite or acceptable equal and wetting agent compound, which in solution removes grease and petroleum products. Concentration level to be determined by Water Treatment Specialist (PACE Chemicals Ltd. – PURGEX L-24 or PURGEX L-27 for aluminium safe boilers or acceptable equal).

.2 Closed System Treatment (Hot Water, Chilled Water):

  .1 Borated Nitrite based corrosion inhibitor. Maintain levels at 60 – 100 ppm for organic PACE Chemicals Ltd. – BAR COR CWS-105, or at 700 – 1000 ppm of BAR COR CWS-55 (non-organic product) or acceptable equal (use WT-580/780 for aluminium safe boilers). The use of Nitrite only, or Sulphite only will not be accepted.

.3 Glycol System:

  .1 Charge hot water system(s) with a **35%** solution (by volume) in water of inhibited propylene glycol equivalent to DOWFROST.

  .2 Charge geo-exchange and chilled water system(s) with a **25%** solution (by volume) in water of inhibited propylene glycol equivalent to DOWFROST.

2.2 Equipment

.1 Chemical Feed System – Closed Systems (hot water heating and chilled water):

.1 Bypass Pot Feeder: Closed water systems shall have by-pass chemical pot feeder with 2 gal (7.6 L) capacity, constructed of heavy-duty cast-iron or welded steel (suitable for 200 psi (1,380 kPa) working pressure), with quick opening cap and complete with NPS ¾ connections. Install isolating valves on inlet, outlet and drain.

.2 Side Stream Filters: Closed systems shall have side stream filters. 304 L stainless steel or polypropylene plastic filter housing to accept 30 micron – 2-½" (65 mm) x 40" (1.0 m) long filter cartridges and complete with swing bolt lid. Minimum flow rate of 9 USgpm" (35 L/min). A Flow Indicator with stainless steel impeller shall be installed as per Manufacturer's instructions. Include 10 filter replacement cartridges for each side stream filter unit.

.3 Chemical Feed Piping shall be Schedule 40 black steel.

.4 Provide make-up water meter equal to Neptune T-10, Neptune Trident 8 or Rockwell Hersey complete with electronic output for analogue flow monitoring by building automation system.

.5 Corrosion Coupon and Holder Assembly:

.1 Mild steel corrosion coupon.

.2 Holder, NPS ¾ or NPS 1 connection.

.3 Provide malleable or cast-iron cross, NPS ¾ or NPS 1 connection.

.2 Glycol Feed System:

.1 Automatic feed system with manual override, (Neptune Model G-50-1A, Axiom Model SF-100, or acceptable equal), comprising the following:

.1 Pump: 2 USgpm" (7.5 L/min) at 100 psi (690 kPa), bronze gears, stainless steel shaft and carbon bearings, Buna N lip seals. Motor, 1725 rpm, 1/3 HP, 115/1/60 VAC. (Albany Model CEP93-3).

.2 Tank: 45 gal cylindrical, polyethylene tank with hinged poly cover, steel support stand with bottom mount pump shelf, required connections and agitator bracket.

.3 Agitator: Direct drive, 1725 rpm, ¼ HP, 115/1/60 VAC complete with bracket mount and stainless steel shaft and propeller (Neptune Model A-2).

.4 Pressure Switch: Glycol addition shall be controlled by adjustable pressure switch with high and low setpoints. When pressure in loop reaches low setpoint, pump shall start and feed glycol until high setpoint pressure is achieved and pump stops.

.5 Control Panel: NEMA 4X enclosure, 115/1/60 VAC and shall consist of the following:

.1 Power supply cord with moulded plug.

.2 H-O-A switch for pump motor.

.3 Pump "ON" indication.

.4 "LOW" tank level indication with audible alarm.

.5 Push button to silence.

.6 Contacts for remote connection.

.6 Accessories:
  .1 Float switch for low level cut off of pump.
  .2 Pressure switch.
  .3 Relief valve piped back to tank.

.7 Provide pressure gauge located in discharge piping.

.8 Specific gravity hydrometer, Taylor Instruments Standard quality, Model H4130, scale range 1.000 – 1.200, divisions at 0.002 length 12" (300 mm).

.9 Provide chart showing specific gravity of specified solution by volume, at specified temperature.

Part 3 Execution

3.1 Glycol Antifreeze System

.1 Label drain valves with "GLYCOL – DO NOT DRAIN".

.2 Pre-mix solution in mixing tank, demonstrate specific gravity of solution to Consultant at sample points and charge system(s) using feed pump. After system filled, check specific gravity of solution in each system. Leave mixing tank filled with specified glycol solution.

3.2 Eye Wash Station

.1 Provide a self-contained eye wash station in the immediate area of chemical treatment storage and tanks. Secured to wall, equal to Haws model 7501 portable gravity fed eyewash.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Document and is to be read, interpreted and coordinated with other parts.

.2 Refer to Section 23 05 49 for required seismic restraint of ductwork.

1.2 Submittals

.1 Submit a schedule indicating the ductwork standards to be used, including metal gauges, joints and reinforcement, before construction of any ductwork.

1.3 Reference Standards

.1 The construction and installation of ductwork and plenums shall be in accordance with the latest edition of the following referenced SMACNA manuals and ASHRAE handbooks.

- .1 SMACNA - HVAC Duct Construction Standards.
- .2 SMACNA - HVAC Air Duct Leakage Test Manual.
- .3 ASHRAE - Handbook - Equipment Volume.

1.4 General

.1 Duct sizes on drawings indicate clear inside dimensions. For acoustically lined or internally insulated ducts, maintain inside duct dimensions.

.2 Where duct sizes are shown in nominal metric sizes, round and oval duct sizes may be supplied in nearest available sizes in equivalent imperial units.

.3 Provide for openings in correct locations through slabs and walls. Openings shall be planned to include installation of fire dampers at rated fire separations.

.4 Where ducts penetrate roofs, provide roof curbs with flashing and counter flashing.

.5 Arrange for 4” (100 mm) high by 4” (100 mm) wide concrete curbs around duct penetrations through floor slabs outside of duct shafts.

.6 Project drawings are diagrammatic and efforts have been made to provide information regarding number of offsets and transitions, but all are not necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. Required adjustments shall be established when coordinating and field measuring work prior to fabrication and must be provided as part of contract and association costs must be considered and included.

.7 Ductwork shall be clean and free from scale, corrosion and deposits. Ductwork shall be degreased and wiped clean of oil and other surface films with appropriate solvents prior to installation.

.8 Ductwork shall be delivered clean to site and maintained in clean condition. Dirty ductwork shall be removed from site.

.9 Where welding ductwork welding shall be continuous with Everdur welding. Tack welding is unacceptable, except as specifically noted. Paint damaged areas with zinc coating after welding.

.10 Provide seismic restraints for ductwork in accordance with SMACNA "Guidelines for seismic restraints of mechanical systems and plumbing piping systems."

.11 Where a combustible structure and/or there is a combustible ceiling plenum, that plenum shall not be used as an open plenum and all transfer air/return air shall be fully ducted, unless otherwise noted.

Part 2 Products

2.1 Galvanized Steel

.1 Galvanized steel shall have 1-¼ oz/ft² (380 g/m²) galvanizing coat both sides to ASTM A525 G90.

2.2 Ductwork and Plenum Pressures

.1 Provide ductwork and plenums of galvanized steel for static pressure categories listed below.

- .1 6" w.g. (1,500 Pa) static pressure:
  - .1 Supply ductwork and plenums downstream from the discharge automatic control dampers, up to the furthest fire dampers at the ends of supply duct risers (emerging from duct shafts) or to supply dampers in the walls of mechanical rooms.
- .2 4" w.g. (1,000 Pa) static pressure:
  - .1 Supply air ductwork downstream from supply air handling units discharge, to the upstream side of air valves.
  - .2 Exhaust and return air ductwork downstream from return/exhaust air valves to return/exhaust fans and downstream from return/exhaust fans to air handling units and/or outdoor relief.
  - .3 Outdoor intake plenums in mechanical room(s).
- .3 2" w.g. (500 Pa) static pressure:
  - .1 Supply ductwork downstream from air valves to terminal air outlets.
  - .2 Supply ductwork and plenums on systems without air valves.
  - .3 Return air ductwork and plenums, except where otherwise specified.
  - .4 Exhaust and relief air ductwork and plenums, except where otherwise specified (welding/sawdust exhaust).
  - .5 Outdoor air ductwork and plenums, except as otherwise specified.

2.3 Ductwork – Under 2" w.g. (500 Pa) Static Pressure

.1 Provide galvanized steel duct work for system operating pressures 2" w.g. (500 Pa) and less. Ductwork shall be constructed, reinforced, sealed and installed to withstand 1-½ times working static pressure.

.2 Construct rectangular ductwork in accordance with SMACNA Duct Construction Standards Third Edition - 2005.

.3 Nomasco "Ductmate System, Lockformer TDC" or Exanno "Nexus System" may be used for rectangular duct joints.

.4 At least two opposite faces of rectangular ductwork shall be joined together using joint which cannot pull apart.

.5 Construct rectangular duct fittings in accordance with Section 2 and 4, including Figures 4-1 to 4-9 of SMACNA Duct Construction Standards Third Edition - 2005, but excluding beaded crimp joints and snaplock seams.

.6 Construct round ductwork in accordance with Section III, including Tables 3-1 to 3-15 and Figures 3-1 to 3-11, of SMACNA Duct Construction Standards Third Edition - 2005, but excluding beaded crimp joints and snaplock seams.

.7 Construct flat oval ductwork in accordance with Section 3.3 of SMACNA Duct Construction Standards Third Edition - 2005. Joints and seams shall be similar to those indicated for round ducts. Flat oval duct to be used for positive pressure application only.

.8 Construct round and flat oval duct fittings in accordance with Section III of SMACNA Duct Construction Standards Third Edition - 2005. Round elbows shall have centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall have centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall not be less than thickness specified for longitudinal seam straight duct. Adjustable elbows are not permitted.

2.4 Ductwork - 2” w.g. (500 Pa) and Greater Static Pressure

.1 Provide galvanized steel duct work for system operating pressures 3” w.g. (750 Pa) and over. Ductwork shall be constructed, reinforced, sealed and installed to withstand 1-½ times working static pressure.

.2 Construct rectangular ductwork in accordance with SMACNA Duct Construction Standards Third Edition - 2005.

.3 Nomasco “Ductmate System”, Exanno “Nexus System” or “Lockformer TDC, TDF system” may be used for rectangular duct joints.

.4 Construct rectangular duct fittings in accordance with Section 2 and 4 of SMACNA Duct Construction Standards – Third Edition - 2005.

.5 Construct round ductwork in accordance with Section III, including Tables 3-1 to 3-15 and Figures 3-1 to 3-11 of SMACNA Duct Construction Standards Third Edition - 2005.

.6 Construct flat oval ductwork in accordance with Section 3.3, of SMACNA Duct Construction Standards Third Edition - 2005. Joints and seams shall be similar to those indicated for round duct. Flat oval duct to be used for positive pressure application only.

.7 Construct round and flat oval duct fittings in accordance with Section III of SMACNA Duct Construction Standards Third Edition - 2005. Round elbows shall have centreline radius of 1.5 times duct diameter. Construct 90° elbows of not less than 5 tapered section. Seams and joints in round or oval duct fittings and elbows shall be spot welded lap seams at not more than 2” (50 mm) spacing and inside seams sealed with approved duct sealant. If zinc coating is burned the steel during welding, joints shall be painted to prevent corrosion. Sheet metal gauges of fittings and elbows shall not be less than thickness specified for longitudinal seam straight duct, but suitably thick for welding methods used.

2.5 Plenums – Under 2” w.g. (500 Pa) Static Pressure

.1 Provide galvanized steel low pressure plenums, suitable for 2” w.g. (500 Pa) positive or negative pressure, for central plant ventilating and air conditioning equipment.

.2 Construct plenums in accordance with Chapter 9 of SMACNA Duct Construction Standards Third Edition - 2005.

.3 Where building structure does not form bottom surface of walk-in plenum, fabricate plenum floor panels of 14 ga (1.99 mm) galvanized steel, with angle iron reinforcing to limit deflection of floor panels to ¼" (6 mm) under concentrated load of 250 lb (115 kg) at mid span.

.4 Where plenum floors are internally lined, install 16 ga (1.61 mm) thick galvanized steel panel on top of insulation.

.5 Apply silicone sealant CGE Silpruf 2000 series or Dow Corning 781/732 between plenum base angles and concrete or curbs before bolting together.

.6 Reinforce openings in plenum walls with 1-½" (38 mm) x 1-½" (38 mm) x 3⁄16" (4.8 mm) angle iron, secured to main vertical and horizontal reinforcing angles.

.7 Construct access door and casing around door as per SMACNA Standards, casing access doors, with angle iron frame sized to suit plenum wall. Doors constructed of 16 ga (1.61 mm) metal.

.8 Arrange access doors to open against airflow and static pressure.

.9 Weld joints on condensate drains pans. Construct pans of 16 ga (1.61 mm) thick stainless steel Type #302 or #304. Install 1-¼" (32 mm) piping connection, complete with water seal at least 4" (100 mm) deep, from pan drain connection to nearest building drain. Install drain connections to completely drain pans.

.10 Seal piping penetrations through plenum walls, with gland seals as detailed in SMACNA Duct Construction Standards - 2005.

.11 Bulkheads mounting air filters and air coils shall be airtight to prevent air bypass around filters and/or coils.

2.6 Plenums - 2" w.g. (500 Pa) and Greater Static Pressure

.1 Provide medium/high pressure galvanized steel plenums, suitable for specified pressures.

.2 Construct plenums in accordance with Chapter 9 of the SMACNA Duct Construction Standards Third Edition - 2005. If requested, pressure test plenums to specified static pressure (positive or negative) to demonstrate structural integrity.

.3 Where building structure does not form bottom surface of walk-in plenum, fabricate plenum floor panels of 14 ga (1.99 mm) galvanized steel, with angle iron reinforcing to limit deflection of floor panels to ¼" (6 mm) under concentrated load of 250 lb (115 kg) at mid span.

.4 Where plenum floors are internally lined, install 16 ga (1.61 mm) thick galvanized steel panel on top of insulation.

.5 Apply silicone sealant CGE Silpruf 2000 series or Dow Corning 781/732 between plenum base angles and concrete or curbs before bolting together.

.6 Reinforce openings in plenum walls with 2" (50 mm) x 2" (50 mm) x ¼" (6 mm) angle iron, secured to main vertical and horizontal reinforcing angles.

.7 Construct access door and casing around door as per SMACNA Standards, casing access doors, with angle iron frame sized to suit plenum wall. Doors constructed of 16 gauge metal.

.8 Arrange access doors to open against airflow and static pressure.

.9 Weld joints on condensate drains pans. Construct pans of 16 ga (1.61 mm) thick stainless steel Type #302 or #304. Install 1-¼" (32 mm) piping connection, complete with water seal, from pan drain connection to nearest building drain. Install drain connections to completely drain pans.

.10 Water Seal Depth:

.1 4" (100 mm) for 2" w.g. (500 Pa) systems.

.2 5.1" (130 mm) for 3" w.g. (750 Pa) systems.

.3 6" (150 mm) for 4" w.g. (1,000 Pa) systems.

.4 8" (200 mm) for 6" w.g. (1,500 Pa) systems.

.5 12" (300 mm) for 10" w.g. (2,500 Pa) systems.

.11 Seal piping penetrations through plenum walls with gland seals as detailed in the SMACNA Duct Construction Standards Third Edition - 2005.

.12 Bulkheads mounting air filters and air coils shall be airtight to prevent air bypass around filters and/or coils.

2.7 Ductwork - Acoustically Lined

.1 Where rectangular ductwork is indicated acoustically insulated with flexible acoustic duct liner, it shall be installed in accordance with instructions, SMACNA Duct Construction Standards Third Edition - 2005. Duct sizes shown are inside duct liner.

.2 Where round ductwork is indicated acoustically insulated, it shall consist of two concentric round ducts with 1" thick flexible fibrous glass duct liner between ducts. Inner duct shall be perforated and correspond to duct diameter noted on drawings. Outer duct shall be suitable for static pressure and shall be sealed airtight where it joins adjacent ductwork.

2.8 Ductwork - Outdoors

.1 Internally or externally insulated supply, return and exhaust ducts located outdoors on roof, shall be constructed watertight.

.2 Joints shall be caulked with water impervious sealant. TDC clips should be continuous on top and sides of ducts.

.3 Top of finished product (waterproof membrane) shall be pitched to avoid pooling of water.

.4 After pressure testing, exterior of ducts and duct silencers shall be wrapped with waterproof membrane. Membrane shall consist of SBS rubberized asphalt compound, integrally laminated to reinforced aluminum foil, providing waterproof membrane. Product similar to Bakor Foilskin.

2.9 Plenum Insulation Covering

.1 Sheet Metal:

.1 Provide 22 ga (0.85 mm) galvanized sheet metal covering on acoustically lined plenum walls for distance of 4'-0" (1.2 m) downstream from cooling coils.

.2 Perforated Metal:

.1 Provide 22 ga (0.85 mm) thick perforated galvanized sheet metal covering on acoustically lined plenum walls (except immediately adjacent to downstream side of cooling coils where it should not be perforated).

2.10 Air Distribution Plates

.1 Provide perforated air distribution plates at discharge of supply fans if required to provide a balance flow of air through downstream filters and coils.

.2 Modify and reposition plates as necessary to balance airflow through downstream filters and coils to ±10%

2.11 Coil End Covers

.1 Provide coil end casings to eliminate coil frame air leakage.

.2 Provide for cooling coil ends to drop condensate to coil drain pan. Insulate and vapour seal inside of coil end casing to prevent casing condensation and provide closure panels to retain insulation.

2.12 Wire Mesh Screens

.1 Provide wire mesh screens in air intake openings.

.2 Screens shall be constructed from aluminum wire 16 ga (1.29 mm) diameter.

.3 Screen mesh shall be ½" (12 mm).

.4 Mount screens in 20 ga (0.81 mm) thick folded aluminum frames.

2.13 Counter Flashings

.1 Counter flashings - galvanized sheet steel of 22 ga (0.85 mm) minimum thickness.

.2 Counter flashings are attached to mechanical equipment and lap base flashings on roof curbs.

.3 Joints in counter flashings shall be flattened and solder double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around top edge. Storm collars shall be used above roof jacks.

.4 Vertical flange section of roof jacks shall be screwed to face of curb.

Part 3 Execution

3.1 Ductwork and Plenum Installation

.1 Where duct contains a fire damper, construct duct so free area is maintained through damper.

.2 Where duct is internally insulated, enlarge duct to not reduce free area.

.3 Make taper of diverging transitions less than 20° and taper of converging transitions less than 30° in accordance with SMACNA Duct Construction Standards Third Edition - 2005. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.

.4 Make inside radius of rectangular duct elbow at least equal to duct width, measured in direction of radius. If space conditions do not permit full radius elbow, use square elbows with multi-blade turning vanes.

.5 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 22 ga (0.85 mm). Vanes shall be spaced at 1-½" (38 mm) centres and shall turn through 90° with radius of 2" (50 mm). Vanes shall not include straight trailing edge. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 18 ga (1.02 mm).

.6 For under 2" w.g. (500 Pa) pressure systems, install tie rods to limit maximum unsupported vane length to 36" (914 mm). Refer to Figure 2-4 of the SMACNA Duct Construction Standards Third Edition – 2005.

.7 For 2" w.g. (500 Pa) and greater pressure systems, install tie rods to limit maximum unsupported vane length to 18" (450 mm). Refer to Figure 2-4 of SMACNA Duct Construction Standards Third Edition - 2005

.8 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs to suit site conditions.

.9 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with SMACNA Duct Construction Standards Third Edition - 2005. Adjustment shall be accessible outside duct with lockable quadrant operator or through grille or register with key-operated worm gear mechanism.

.10 Cross-break or bead metal duct panels unless otherwise noted.

.11 Do not cross-break duct panels on 2" w.g. (500 Pa) and greater static pressure systems.

.12 Do not cross-break bottom duct panels when ductwork is handling moisture.

.13 Roof mounted ducts shall have standing seams and shall be sealed weather tight.

.14 Grade ductwork handling moist/humid air, minimum of 1" (25 mm) in 10'-0" (3.0m) back to source. At low points in ductwork, provide 6" (150 mm) deep drain sump and 1-¼" (32 mm) diameter drain connection with deep seal trap and pipe to drain.

.15 Construct ductwork handling moisture with three sided bottom sections and separate top panel. Install three sided bottom sections and internally seal transverse joints with CGE Silicone Sealant "Silpruf". Then install top panels and seal top panel seams and joints.

.16 Provide floor drains in outside air and humidifier sections with deep seal traps.

.17 Provide moisture collection sections inside louvres for outside air and exhaust air.

.18 Support ductwork using galvanized steel straps, cadmium plated threaded rods, flat bar or angle hangers. Attachments to structure shall be compatible with structure and selected for load of ductwork. Install ductwork hangers in accordance with Chapter 5 of SMACNA Duct Construction Standards Third Edition - 2005.

.19 Support duct risers at base and each floor and not greater than 12'-0" (3.6 m) intervals.

.20 Prior to fabrication of ductwork, coordinate and field measure to ensure complete installation respecting other services. Provide necessary fittings, offsets, and alternate construction methods to facilitate installation.

.21 Arrange ductwork and plenums so duct and plenum mounted equipment can be removed.

.22 Arrange access doors to open against airflow and static pressure.

.23 Provide necessary baffling in manufactured or built-up mixed air plenums to ensure good mixed air temperature with variations of not more than ± 9°F (5.5°C) under operating conditions.

.24 Ducts passing through non-rated fire separations, sound insulated walls and through non-rated walls and floors shall be tightly fitted and sealed on both sides of separation with silicon sealant to prevent passage of smoke and/or transmission of sound (ULC approved fire stop sealant is not required). Where ducts are insulated, provide 24 ga (0.70 mm) thick galvanized steel band tightly fitted around insulation and caulk to band.

.25 During construction, protect openings in ductwork from dust infiltration by covering with polyethylene and protect floor outlet duct openings with metal caps.

.26 Where ductwork passes through open web steel joists, coordinate with joist fabricator before fabricating ductwork.

.27 Where ducts penetrate roofs, install sleeves and roof curb complete with flashing and counter flashing. Pack sleeves in roof with fibreglass insulation.

.28 Provide drip pans under piping and shields for protection of electrical panels and equipment.

.29 Unless noted otherwise, line builder's shafts and air plenums used as ducts and plenums with sheet metal.

3.2 Ductwork Leakage Test

.1 Leakage test all 2" w.g. (500 Pa) and greater static pressure supply ductwork as recommended in SMACNA HVAC Air Duct Leakage Test Manual, 1985 Standards, to static pressure 2" w.g. (500 Pa) in excess of specified ductwork design static pressure.

.2 Use equipment capable of demonstrating leakage.

.3 Test the first 100'-0" (30 m) of installed ductwork in presence of Consultant.

.4 Test 100'-0" (30 m) section of under 2" w.g. (500 Pa) static pressure ductwork, where complete systems over 100'-0" (30 m) long are installed to static pressure 2" w.g. (500 Pa).

.5 The total allowable leakage for system shall be no greater than **5**% of total system capacity.

.6 Submit test reports for ducts tested.

3.3 Ductwork and Plenum Cleaning

.1 All ductwork and equipment installed shall be free of scale, debris and dirt.

.2 Maintain duct and equipment openings covered with poly or equivalent to prevent entry of dirt.

.3 Clean plenums and buried supply ductwork with industrial vacuum cleaner on completion of duct and plenum installation.

.4 Install air filters for specified performance.

.5 Blow out supply ductwork, (by means of supply fan) at completion of duct and plenum installation and prior to installation of air terminals.

.6 Ductwork shall be considered clean when foreign material visible to naked eye has been removed. Random sampling review by Consultant will be conducted to check for cleanliness.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Catalogued or published ratings shall be obtained from tests carried out by Manufacturer or from independent testing agency signifying adherence to codes and standards.

.2 Flame and smoke spread ratings less than 25/50 and tested in accordance with CAN/ULC-S012-07 "Tested for Surface Burning Characteristics of Building Materials".

Part 2 Products

2.1 Backdraft Dampers - Medium Duty

.1 Minimum Requirements:

- .1 16 ga (1.61 mm) galvanized steel or 16 ga (1.61 mm) aluminum channel frame.
- .2 14 ga (1.63 mm) aluminum blades, complete with stiffening ribs/bends.
- .3 Full blade length shafts, brass ball or nylon bearings.
- .4 Felt or neoprene anti-chatter blade strips.
- .5 Blade connecting linkage with eyelet and pin bearings.
- .6 Maximum blade length of 30" (762 mm), use multiples for larger dimensions.
- .7 Manufacturer's label.
- .8 Where balanced backdraft damper (BBD) is indicated, damper shall incorporate adjustable counter balance weight and lever.
- .9 Maximum pressure drop across damper at 800 ft/m (4.06 m/s) shall be 0.18" w.g. (45 Pa).

.2 Standard of Acceptance:

- .1 Airolite 625, Penn CBD-6.

2.2 Balancing Dampers

.1 Construction in accordance with SMACNA Duct Standards. PIN type balancing dampers are not permitted.

.2 Minimum Requirements:

- .1 Rectangular ducts:
  - .1 Up to 12" (300 mm) deep - single blade (butterfly type).
  - .2 13" (325 mm) to 16" (400 mm) deep - two opposed blades, mechanically interlocked with pivots at quarter points.
  - .3 17" (430 mm) deep and over - multiple opposed blades, mechanically interlocked with blades not greater than 8" (200 mm) deep and pivots equally spaced.

.2 Round Ducts:
  .1 Single Blade (butterfly type).
.3 Material:
  .1 Minimum 16 ga (1.61 mm) thick galvanized steel blades on butterfly dampers.
  .2 Minimum 16 ga (1.61 mm) thick galvanized steel blades on multi-blade dampers with rigidly constructed galvanized steel frame (no frame required on single blade dampers).
.4 Bearings:
  .1 End bearings on low pressure single blade dampers above 12" (300 mm) diameter.
  .2 Bearings on multiple blade dampers shall be bronze iolite type.
.5 Operating Mechanism:
  .1 Lockable quadrant type with end bearing on accessible rectangular ducts up to 16" (400 mm) deep and on accessible round ducts.
  .2 Wide pitch screw mechanism type with crank operator on accessible rectangular ducts 17" (430 mm) and over in depth and on inaccessible rectangular and round ducts.
  .3 Override limiting stops.
  .4 No blade movement in set position.
.6 Concealed Regulators:
  .1 For drywall ceilings with no access panels, provide concealed balancing damper regulators embedded in finished ceiling, mounted behind grilles, on or inside plenum slot diffusers and various other types of diffusers. Concealed damper regulator to be connected to balancing damper by means of flexible Bowden cable and installed flush with ceiling. Cover plate held in place with 2 screws and easily removed for damper adjustment. Concealed damper regulator similar to Young Regulator Co. Model No. 270-301. Provide necessary hardware, including Young Regulator balance damper model 5020-CC, Bowden cable and Young Regulator Model 030-12 wrench.
  .2 Drawing designation: D (CR).

2.3 Duct and Plenum Access

.1 Dimensions:
  .1 Doors:
    .1 20" (500 mm) wide x 54" (1,350 mm) high.
    .2 Head of door 70" (1,780 mm) above floor.
  .2 Panels:
    .1 15" (380 mm) x 20" (500 mm).
    .2 Where far corners of the duct are closer than 20" (500 mm) and equipment within duct is closer than 12" (300 mm) size may be reduced to 16" (400 mm) x 12" (300 mm) or 18" (450 mm) x 10" (250 mm) elliptical.
    .3 Where space will not permit above dimensions they should be matched as closely as possible and additional access provided as required.

.2 Products:

.1 Doors - construct in accordance with SMACNA Duct Standards Figure 6-12 except for latch type. 1-½" (38 mm) thick insulation.

.2 Panels - Nailor Hart, Ventlok, 1" (25 mm) thick insulation.

.3 Gaskets - neoprene or foam rubber.

.3 Hardware:

.1 Panels up to 16" (400 mm) x 12" (300 mm) - 2 sash locks.

.2 Panels – 15" (380 mm) x 20" (500 mm) - 4 sash locks.

.3 Doors - piano hinge and Ventlok 310 latches complete with front and inside handles and front door pull.

2.4 Duct Connectors - Thermal Breaks

.1 Provide flexible duct connections to provide thermal breaks in sheet metal ducts and plenums passing through or terminating at exterior of building. Install inside building.

.2 Minimum Requirements:

.1 Pre-assembled 3" (75 mm) long thermal barrier with 3" (75 mm) long, 24 ga (0.70 mm) galvanized steel duct connectors on each side of thermal break.

.2 Thermal break - heavy fibreglass fabric with elastomer coating.

.3 Standard of Acceptance:

.1 Duro Dyne "Durolon," Ventfabrics "Ventlon."

2.5 Duct Connectors - Vibration Isolation

.1 Provide flexible duct connections to provide vibration isolation at duct and plenum connections to fan and air handling units. See Figure 2-19 SMACNA Duct Standards.

.2 Minimum Requirements:

.1 Pre-assembled 3" (75 mm) minimum long flexible connection with 3" (75 mm) long 24 ga (0.70 mm) galvanized steel duct connectors on each side of flexible connection. Flexible connector - fibre glass fabric with elastomer coating.

.3 Centrifugal fans with 36" (914 mm) diameter and larger fan wheels, use 6" (150 mm) long flexible connection.

.4 Standard of Acceptance:

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

2.6 Ductwork - Flexible - Plain

.1 Provide factory fabricated plain, flexible air ductwork for the following applications:

.1 Connections to air terminals.

.2 Connections to downstream side of air valves.

.3 Connections to round fire dampers (up to 12" (300 mm) diameter) min. 10" (250 mm) long to a maximum of 14" (350 mm) long. To act as fire damper access section.

.2 Minimum Requirements:

.1 Non-corrosive spirals wire reinforcing flexible vinyl coated fibreglass cloth membrane.

.2 Suitable for up to 10” w.g. (2,500 Pa) positive static pressure and 1” w.g. (250 Pa) negative static pressure.

.3 UL or ULC labelled, Class 1, duct connector.

.4 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

.3 Standard of Acceptance:

.1 Flexmaster FAB4, Thermaflex SLP10, ATCP UPC#017 Class ‘O’.

2.7 Ductwork - Flexible - Insulated

.1 Provide factory fabricated insulated flexible ductwork for the following application:

.1 Connections to air terminals where indicated.

.2 Minimum Requirements:

.1 Flexible vinyl coated steel helix bonded to inner duct liner. Fibrous glass thermal insulation.

.2 Outer jacket of metalized fire-resistant vapour barrier.

.3 Suitable for up to 2” w.g. (500 Pa) positive static pressure and/or 1” w.g. (250 Pa) negative static pressure.

.4 UL or ULC labelled, Class 1, duct connector.

.5 Acoustically rated.

.3 Standard of Acceptance:

.1 Gladd-Flex ABL-181, Thermaflex M-KE, Wiremold WK, ATCO UPC #070.

2.8 Ductwork and Plenum Sealers

.1 Provide water-based duct sealing compounds for use in fabrication of ductwork and plenum joints.

.2 Low Pressure Systems - SMACNA Seal Classification B. Medium and High Pressure Systems - SMACNA Seal Classification A.

.3 Standard of Acceptance:

.1 Foster 32-19, Hardcast Versa Grip, Hardcast Foil Grip 1402, Robson’s Duct Seal-WB, United Duct Sealer, Trans Continental Multi-Purpose.

.4 Where accessible, apply sealer to inside of joints on ducts and plenums under positive pressure - e.g. discharge side of fans.

.5 Apply sealer to outside of joints on ducts and plenums under negative pressure - e.g. suction side of fans.

2.9 Fire Dampers

.1 Minimum Requirements:

.1 Fire dampers shall be ULC or Warnock Hersey tested and shall bear testing agency’s label.

.2 Fire dampers shall meet requirements of National Building Code and authorities having jurisdiction.

.3 Fire dampers shall be "dynamic," rated to close under airflow

.4 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire separation.

.5 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type in horizontal position with vertical airflow.

.6 Fire dampers in low-pressure ductwork may be multi blade or curtain type.

.7 Fire dampers in medium and high pressure ductwork shall be curtain type.

.8 Curtain fire dampers shall be blades retained in recess so free area of connecting ductwork is not reduced.

.9 Fusible Links: ULC approved with melting point of 165°F (74°C) on supply, return and exhaust air systems. Use fusible links with melting point of 286°F (141°C) on return and exhaust air systems if used for smoke venting.

.10 Standard of Acceptance

.1 Dynamic Type – Price FDD, Type A, B, or C as required, Nailor, Controlled Air.

.11 Fire damper access panel/door in rigid ductwork shall be equal to Nailor 0800 type, with acoustic insulation of duct is lined, without insulation if duct is unlined.

2.10 Flow Measuring Devices - Air

.1 Flow Measuring Station (refer also to section 25 05 01):

.1 16 ga (1.61 mm) thick galvanized steel casing with duct connecting flanges.

.2 Aluminum honeycomb air straightening cell.

.3 Total pressure sensors and static pressure sensors interconnected by copper manifolds.

.4 Total and static pressure external ports with fittings for connecting to flow meter or control system.

.5 Identification label listing unit size, design air quantity and direction of air flow.

.6 Capable of 0-5000 fpm range, 2% of reading sensor airflow accuracy, complete with transmitter configuration to match DDC Controls connection and measurement requirements.

.7 Accessories:

.1 Magnehelic differential pressure gauge scaled in air volume cfm (L/s).

.8 Standard of Acceptance:

.1 Air Monitor Fan E and DAMD, EBTRON Gold GTx116-P+, Ebton Elf for ducts less than 14" (350 mm) diameter..

.2 Airflow Probe (Duct or Fan Inlet):

.1 Aluminum construction.

.2 Multiple traverse probes.

.3 Traverse probe to contain multiple total and static pressure sensors located along exterior surface of probe and internally connected to respective averaging manifolds.

.4 Threaded end support rod and mounting plate with gasket and signal fittings.

.5 Fan inlet probes (two per inlet) with dual end support swivel brackets suitable for mounting in fan inlet bell.

.6 Capable of producing an output signal linear and scaled to air volume (4-20 mADC, 0-10 VDC, 0-5VDC).

.7 Capable of local digital display of continuous indication of air volume.

.8 Standard of Acceptance:

.1 Air monitor VOLU-probe/7200AZ (Duct).

.2 Air monitor VOLU-probe/7200AZ (Fan Inlet).

.3 Adjust tensions on latches and permanently mark final setting of adjustment screws.

Part 3 Execution

3.1 Balancing Dampers

.1 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing complete with 1” (25 mm) high stand-off bridges for operators to allow full, continuous duct insulation.

.2 Provide balancing dampers at each run out to grille or diffuser.

.3 Identify airflow direction and blade rotation and open and closed position

.4 On round ductwork larger than 12” (300 mm) diameter and externally insulated rectangular ductwork, provide sheet metal bridge to raise quadrant type operator above insulation thickness (coordinate with Section 23 07 13). Provide open end bearing where bridges are used. Bridges on uninsulated round ducts shall be at least 1” (25 mm) high.

.5 Where quadrant type operators are used, lever shall be arranged parallel with damper blade complete with 1” (25 mm) high stand-off bridge for operators to allow continuous duct insulation to be applied on the duct.

3.2 Backdraft Dampers

.1 Install backdraft dampers on exhaust and relief openings through building walls and roof on exhaust fans where control dampers are not called for or indicated.

3.3 Control Dampers - Automatic

.1 Packaged equipment specified to be complete with control dampers, shall include control dampers as normally supplied by equipment Manufacturer unless otherwise noted.

.2 Other automatic control dampers are specified in Controls Sections.

.3 Under this section be responsible for receipt, handling, storage and installation of control dampers supplied under Control or other Sections.

.4 Indicated size of control dampers is dimension outside frame. Oversize ductwork to include depth of damper frame if pressure drop across damper exceeds 0.1” w.g. (25 Pa).

.5 Control damper frames shall be fitted tightly into ductwork and sealed airtight.

.6 Check that dampers are installed square and true. Ensure damper end linkages are easily accessible. Provide saw-cuts with black paint in the exposed ends of all damper shafts, aligned with damper blade for visual indication of damper blade position.

.7 Do not install control dampers in thickness of wall unless otherwise indicated.

3.4 Duct and Plenum Access

.1 Locations: Provide access doors and panels as follows:

- .1 Doors: Where indicated on drawings.
- .2 Panels:
  - .1 Every 40’-0” (12 m) on ductwork.
  - .2 Base of each duct riser.
  - .3 Both side of equipment blocking duct e.g.
    - .1 Air flow measuring stations.
    - .2 Coils.
  - .4 At or to one side of other equipment in duct, e.g.
    - .1 Backdraft dampers (counter weight side).
    - .2 Balance dampers serving multiple outlets/inlets.
    - .3 Bearings (fans/motors).
    - .4 Control dampers.
    - .5 Control sensors.
    - .6 Fire dampers (rectangular ducts and round ducts 13” (325 mm) diameter and larger - latch side).
    - .7 Heat detectors (upstream from device)
    - .8 Smoke detectors (upstream from device).
  - .5 Panels need not be provided where access in available through door or register mounted to side of duct.
- .3 Patches:
  - .1 Where required for cleaning and where access panels are not specified e.g. on both sides of turning vanes.
- .4 Flexible duct - on round duct and round fire dampers up to 12” (300 mm) diameter.

.2 Seal frames airtight.

.3 Install to not interfere with airflow.

.4 Install to provide access for service and cleaning.

.5 Do not use sheet metal screws for attaching access panels to ductwork.

.6 Round ducts 13” (325 mm) diameter and larger shall include a short collar for installation of access panels.

.7 Small rectangular ducts shall be transitioned to minimum dimension across duct of 13” (325 mm) for installation of access panels.

3.5 Duct Connectors - Vibration Isolation

.1 Ensure flexible duct connectors do not reduce duct free area on suction side of fans.

3.6 Ductwork - Flexible

.1 Installed lengths shall be limited to 6 times duct diameter but not longer than 4'-0" (1.2 m).

.2 Connect to ductwork and diffusers with stainless steel worm drive clamps or Panduit adjustable clamps or Thermaflex duct strap applied over two wraps of duct tape. Use stainless steel clamps on connections to fire dampers.

.3 Minimum centreline radius of flexible ductwork bend shall be 1.5 time duct diameter, alternatively, sheet metal elbow may be used at branch takeoffs and boot diffuser connections.

.4 Support with 1" (25 mm) x 22 ga (0.85 mm) galvanized steel straps at a maximum of 24" (600 mm). Straps shall completely encircle duct.

.5 Support clear of ceiling assembly, light fixtures and hot surfaces.

3.7 Fire Dampers

.1 Install in accordance with the SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems - Fourth Edition 1992. Demonstrate fire damper drop test for **50%** of fire dampers installed in this project.

.2 Fire damper sleeves must not extend more than 3" (75 mm) from wall on each side.

.3 Fire dampers shall be installed within wall thickness of fire separation.

.4 Wall openings sized to allow sleeve/damper expansion.

.5 Arrange dampers so linkages and locking catches are accessible from access side of fire damper. Provide an access panel at all fire dampers, complete with red stencilled "F.D" label.

.6 Install to close in direction of normal airflow.

.7 Size so free area of duct is maintained through assembly. All fire dampers shall be Type B – Blades of airstream, unless specifically noted otherwise or as required for specific installation.

.8 Install in galvanized steel sleeve, retained in place with retaining angles on four sides at each face of wall.

.9 Connect ductwork to damper sleeves using break-away duct joints on faces.

3.8 Flow Measure Devices - Air

.1 Install in accordance with Manufacturers recommendations. Minimum distance from air turbulence - producing fittings, transitions etc. shall be maintained.

.2 Mount air volume gauges at height for easy visual inspection and install interconnection piping.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Catalogued or published ratings shall be from tests carried out by Manufacturer or from independent testing agency signifying adherence to codes and standards.

1.3 Submittals

.1 Fan shop drawings shall include sound rating data and fan curves showing operating point plotted on curves.

.2 Fan shop drawings shall include motor efficiencies. Refer to Section 23 05 13 for minimum motor efficiencies.

1.4 General

.1 Motors powered by variable speed drive controllers shall be EEMAC class B with Type F 'inverter duty' insulation, shall have 1.15 service factor on sine wave power, 1.0 service factor on PWM power and meet NEMA Code MG-1, 1993 Part 31.

.2 Provide ECM DC motors on all motors below 1.5 kW. To be complete with 0-10V DC controls signal terminal for variable speed control. See Section 23 05 13 for ECM motor requirements.

Part 2 Products

2.1 Air Curtain Units

.1 Base frame of 16 ga (1.61 mm) thick steel.

.2 2-speed direct driven double inlet forward curved fans.

.3 Fans balanced and rubber isolated.

.4 Aluminum cover housing with inlet grille.

.5 Discharge grille with adjustable vanes integral with the unit or remote mounted in the ceiling. Provide duct extension for ceiling mounted units.

.6 High-off-low fan switch integral with unit suitable for remote mounting.

.7 Sound level 10'-0" (3.0 m) in front of the unit in free field shall not exceed 59 dBA on high speed and 54 dBA on low speed.

.8 Unit shall be ULC listed and shall bear AMCA certified ratings seal.

2.2 Fans – General

.1 Provide fans selected for maximum efficiency and generating noise levels on site not exceeding levels indicated. If fans are not specified at maximum efficiency, advise mechanical Consultant before tendering and submit alternate price for maximum efficiency fans. If approval to supply noisier fans is not obtained prior to tendering, provide equipment meeting ASHRAE levels on site without loss in efficiency.

.2 Submit fan sound power levels with shop drawings measured to applicable AMCA standards, or other data acceptable to Engineer. Provide test data, if requested. Indicate on shop drawings test configuration, including ductwork, and end reflection corrections applied to data and/or if such corrections have been omitted.

.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA-99-83. Dynamically balance fans to 1.5 mm/s vibration amplitude, maximum measured on bearing housings. Provide fan shafts with critical speed at least 1.5 times operational speed.

.4 Ratings: based on tests performed in accordance with AMCA 210, and ASHRAE 51-85. Unit shall bear AMCA certified rating seal.

.5 Refer to drawings for motor position, rotation and discharge arrangements.

.6 For motors less than 10 hp (7.5 KW) provide standard adjustable pitch drive sheaves +/- 10% range. Use mid-position of range for specified rpm (r/min).

.7 For motors 10 hp (7.5 KW) and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.

.8 Match drive and driven sheaves.

.9 All fans shall be direct drive

.10 Minimum drive rating shall be 150% of nameplate rating of motor.

.11 Bearings shall have minimum L-10 life of 100,000 hours based on maximum safe speed of fan class.

.12 Where required, fans shall be treated to suit airstream in which they are used.

.13 Provide secure attachment points for seismic restraints. Mounting brackets shall be suitable for seismic loading.

2.3 Fans – Motors and Variable Speed Drives

.1 Provide motors and variable frequency drive/motor assemblies generating noise levels which are imperceptible in occupied space, and outside building, relative to fan noise. Provide acoustical data confirming required performance prior to tendering. If approval is not obtained prior to tendering, provide equipment meeting specified imperceptible requirement without loss in efficiency.

2.4 Fans – Centrifugal

.1 Welded steel fan wheel with air foil blades, unless otherwise specified.

.2 Bearings: Heavy-duty pillow-block grease lubricated ball or roller self-aligning type.

.3 Gasketted scroll access panel, secured with quick release fasteners.

.4 ¾” (19 mm) scroll drain and brass plug.

.5 Enamel painted steel fan wheels and inside scrolls.

.6 Prime coat painted outside scroll including supports and steel accessories.

.7 Rust preventative coating on fan shafts.

.8 Drip proof motor.

.9 On single inlet fans provide extended lubricators on inlet side bearings.

.10 Coupling guards.

.11 Fan inlet safety screens.

.12 Steel frame base and motor slide rails.

.13 Acceptable Products: Penn/Barry, Twin-City, Chicago, Greenheck, Loren-Cook.

2.5 Fans – Centrifugal (Plenum)

.1 Welded steel fan wheel with airfoil blades, unless otherwise specified.

.2 Bearings: Heavy-duty pillow-block grease lubricated ball or roller self-aligning type.

.3 Gasketted scroll access panel, secured with quick release fasteners.

.4 ¾" (19 mm) scroll drain and brass plug.

.5 Enamel painted steel fan wheels.

.6 Rust preventative coating on fan shafts.

.7 Drip proof motor.

.8 Fan assembly fully enclosed with expanded mesh screen, approved to WCB Standards.

.9 Direct drive fans shall be designed specifically for the duty and allow for easy motor replacement. Provide heavy-duty mechanical coupling and bearings for arrangement 8 where called for.

.10 Coupling guards.

.11 Fan inlet safety screens.

.12 Steel frame base and motor slide rails.

.13 Acceptable Products: Twin-city, Chicago, Greenheck, Loren-Cook

2.6 Fans-In-Line Centrifugal

.1 In-line centrifugal fan with axial flow construction.

.2 Square housing, steel with galvanized finish.

.3 Access panel to provide cleaning and service access.

.4 Backward inclined, non-overloading wheel.

.5 Drip-proof motor.

.6 Permanently lubricated pillow block ball bearings.

.7 Rust preventative coating on shafts.

.8 Direct driven

.9 Plug-in electrical disconnect switch, mounted on the outside of the fan housing.

.10 Insulated housing lining.

.11 0-10 VDC control

.12 Acceptable Products: Greenheck, Loren-Cook, Twin-city

2.7 Fans – Roof Exhaust

.1 Centrifugal non-overloading wheel.

.2 Belt or direct drive as scheduled.

.3 Spun aluminum housing

.4 Upblast discharge, where scheduled.

.5 Parts corrosion resistant.

.6 Vibration isolators.

.7 Wiring post.

.8 Head mounted disconnect switch.

.9 Discharge bird screen.

.10 Roof curb – as scheduled.

.11 Backdraft damper – as scheduled.

.12 Acceptable Products: ACME, Greenheck, Loren-Cook, Twin-city

2.8 Gauges – Air Pressure

.1 Ranges:

  .1 Supply fans: 0 - 6” w.g. (1,500 Pa).

  .2 Return/exhaust fans: 0 - 2” w.g. (500 Pa).

.2 Standard of Acceptance:

  .1 Dwyer Series 2000.

Part 3 Execution

3.1 Air Curtains

.1 Air curtain units to be mounted as indicated on drawings (exposed above door or concealed above ceilings). On ceiling located units, install discharge grille supplied with unit in ceiling and connect to unit with duct extension.

3.2 Fans

.1 Install fans as indicated, complete with vibration isolators and seismic restraints as specified in Sections 23 05 48 and 23 05 49.

.2 Install fans with flexible connections on inlet ductwork and on discharge ductwork. Ensure metal bands of connectors are parallel with minimum 1” (25 mm) flex between ductwork and fan during running.

.3 Install connectors to be clear of air stream. Provide flange extensions as necessary. Ensure accurate alignment of duct of fan.

.4 Provide safety screens where fan inlet or outlet is exposed.

.5 Provide and install sheaves and belts required for final air balance.

.6 Assist Balancing Agency in altering blade pitch angles as required for final air balance. Provide access to fan wheel for blade adjustment.

.7 Mount floor mounted fans on 4" (100 mm) thick concrete housekeeping bases (bases under Division 3).

.8 Mount roof mounted fans on curbs 8" (200 mm) minimum above roof.

3.3 Gauges – Air Pressure

.1 Mount gauges for easy visual inspection.

.2 Piping to be formed in true vertical/horizontal lines free from kinks.

.3 Seal penetrations of plenums or ducts.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 Single-Duct Variable Air Volume Box

.1 General:

- .1 Manufacturers, other than those listed in the acceptable products list, wishing to bid shall make detailed submission responding to each point outlined in specification in exact same form. Listing of valve for valve, taken from drawings, shall be included, showing design selection for alternate proposed with airflow capacities and minimum static pressure requirement.

.2 Minimum Requirements:

- .1 Rated to AHRI Standard 880 with ARI seal. Provide identical products to tested unit.
- .2 Air valves shall be supplied as factory assembly unit, comprising of basic unit, access section, reheat coil and attenuator, as specified – see Equipment Schedules on drawings.
- .3 At inlet velocity of 2,000 ft/m (10 m/s), differential static pressure required to operate any air valve size shall not exceed 0.15” w.g. (37 Pa) for any unit with attenuator section and without reheat coil.
- .4 Air valves shall incorporate multi-point flow sensor equal to flow measures as per 23 33 00. Cross flow sensor or button sensors are not acceptable.
- .5 Casing constructed from 22 ga (0.85 mm) thick galvanized steel. Provide attachment tabs on top of casings for ceiling hangers.
- .6 Pressure independent operation.

.3 Unit Internal Insulation:

- .1 Standard Insulation:
  - .1 1” (25 mm) fibreglass insulation. Exposed face of insulation to be faced with non-woven mat. Exposed raw edges and joints to be sealed with galvanized metal.

.4 Control Dampers:

- .1 Heavy gauge steel damper with peripheral gasket and self-lubricated bronze oilite or Delrin bearings.

.2 Air leakage of closed damper shall not exceed 2% of nominal rating at 3" w.g. (750 Pa) inlet static pressure.

.5 Access Panels:

.1 8" (200 mm) x 5" (125 mm) lift-off galvanized access panel. Positive gasket seal and camlocks. Mounted in frame and located upstream of reheat coil on the top and bottom of air valve.

.6 Sound Attenuators:

.1 Standard Attenuator:

.1 Casing constructed from 22 ga (0.85 mm) thick galvanized steel. Provide attachment tabs on top of casing for ceiling hangers.

.2 Attenuator lined with 1" (25 mm) fibreglass insulation. Exposed face of insulation to be faced with non-woven mat. Exposed raw edges and joint to be sealed with glasfab and or metal nosing insulation coating/sealer.

.7 Selection Range:

Inlet Size	**Selection Range (cfm (L/s))**	**Minimum Turndown (cfm (L/s))**
6" (150 mm)	80 cfm (38 L/s) - 380 cfm (180 L/s)	80 cfm (38 L/s)
8" (200 mm)	380 cfm (180 L/s) - 700 cfm (330 L/s)	148 cfm (70 L/s)
10" (250 mm)	700 cfm (330 L/s) - 1,165 cfm (550 L/s)	230 cfm (110 L/s)
13" (325 mm)	1,165 cfm (550 L/s) - 1,630 cfm (770 L/s)	320 cfm(150 L/s)
14" (350 mm)	1,630 cfm (770 L/s) - 2,120 cfm (1,000 L/s)	445 cfm (210 L/s)
16" (400 mm)	2,120 cfm (1,000 L/s) - 2,540 cfm (1,200 L/s)	580 cfm (275 L/s)

.8 Acoustic Requirements:

.1 Provide air valves as indicated on drawings and scheduled, such that noise criteria specified in Table 1 below are not exceeded under the following site conditions. Meet applicable Codes and other specified requirements.

.1 1.5" w.g. (375 Pa) static pressure on supply and return/exhaust units.

.2 Armstrong Cortega769 ceiling tile.

.3 Price SPD/ASPD series square plaque diffuser selected for 700 ft/m (3.56 m/s) neck velocity, as specified.

.2 Conduct full mock-up tests with Representative air valves, suspended ceiling, diffuser and simulated room absorption, to demonstrate specified NC criteria will be met.

.3 Submit proposed test details prior to testing. Test data to include measured noise level (as opposed to sound power) under mock-up conditions, as indicated in AHRI 880 – 2011 Performance Rating of Air Terminals, Figure 1, together with mock-up room details, dimensions and measured absorption (using reference sound source). Submit statement of test accuracy.

.4 Provide measured data, together with details of added treatment required to meet criteria, e.g. Thermaflex MK-E lined flexible connector, additional treatment to control radiated noise, etc.

Table No. 1
Maximum Allowable Background Noise Levels, NC

Max. NC	**Areas**
30-40	Corridors and Public Areas
30	Offices
30	Conference Room/Board Room
35	Multi-purpose
45	Storage
--	Mechanical/Electrical/Communications

.9 Air Valve Identification:

.1 Manufacturer shall number air valves in accordance with numbers indicated on drawings. Secure 2" (50 mm) high, Gothic style, self-adhesive, black, stick-on letters (Letrasign or Brady Quick-Align) on one side and on bottom of air valves.

.10 Controls and Actuators:

.1 To be supplied by controls contractor as a part of the scope of work under Division 25

.11 Standard of Acceptance: EH Price SDV-5 (supply), SDV-5 (return/exhaust).

.12 Acceptable Manufacturers: EH Price, Nailor, Titus.

Part 3 Execution

3.1 Air Terminal Units - Air Valves

.1 Install in accordance with Manufacturers recommendations.

.2 Arrange for suitable ceiling access to units. Provide access doors or locate near easily removable ceiling components.

.3 Support air terminal units independently of ductwork.

.4 **Install units with minimum four duct diameters straight inlet duct**, same size as inlet.

.5 Where inlet flow deflections and/or turbulence alter factory calibration by more than 10%, installer shall field adjust the air volume calibration settings to compensate.

.6 Provide seismic restraints in accordance with details in SMACNA Guidelines or alternatively slack cables.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 Air Terminals

.1 General:

- .1 Grilles, registers and diffusers shall be product of one Manufacturer.
- .2 Refer to drawings for sizes and air quantities.
- .3 Refer to schedules on drawings for details.
- .4 Base air outlet application on space noise level of NC 30 maximum.
- .5 Air terminals shall be checked for compatibility with ceiling types. Refer to Architectural reflected ceiling plans.
- .6 Manufacturer (other than design listed) shall match performance data and indicate specific comparison for each item, with shop drawing submission.
- .7 Ceiling mounted air terminals shall be provided with means for attachment of two seismic security wires at opposite corners on each air terminal.
- .8 Provide concealed baffles, where necessary, to direct air away from walls, columns or other obstructions within radius of air terminal operation.
- .9 Provide auxiliary frames for diffusers located in drywall ceilings and grilles mounted in gypsum walls in public areas. In other areas grilles should be attached to ductwork, or flanged to outside of the opening.
- .10 Standard of Acceptance for General Grilles, Registers and Diffusers: EH Price, Nailor, Titus, Krueger, Trox

2.2 Louvres - Stationary

.1 General:

- .1 Extruded aluminum frames and blades.
- .2 Welded construction with exposed joints ground flush and smooth or mechanically fastened with stainless steel fasteners.
- .3 Lower assembly sealed and water tight.
- .4 Removable 16 ga (1.29 mm) diameter aluminum wire bird screen with ½" (12 mm) mesh. Bird screen mounted in 20 ga (0.81 mm) thick aluminum folded frame. Frame to be installed inside louvre.
- .5 Anodized permanodic hard colour finish as selected by the architect.

.2 Specific:

.1 Drawing designation - Type “L-1”

.2 Frame 6” (150 mm) deep.

.3 6” (150 mm) deep blades inclined at 45° to the horizontal.

.4 Blades at 3-½” (90 mm) on centres.

.5 Blades arranged with up-turned rain stops on trailing edges and drop channels on leading edges.

.6 Jamb drainage channels.

.7 Blades and frame 12 ga (2.05 mm) thick extruded aluminum.

.8 Standard of Acceptance: Airolite K-6776, West Vent XT-635WV.

2.3 Hoods - Gooseneck

.1 Galvanized steel construction.

.2 Thickness and fabrication to ASHRAE and SMACNA standards.

.3 ½” (12 mm) aluminum wire bird screen mounted in removable U-frame.

.4 Mount unit on minimum 18” (450 mm) high curb base.

.5 Control damper.

2.4 Hoods - Roof - Relief/Intake

.1 Aluminum construction.

.2 Shape as indicated.

.3 ½” (12 mm) aluminum wire bird screen mounted in removable U-frame.

.4 Factory baked enamel finish.

.5 Mount unit on minimum 18” (450 mm) high roof curb.

.6 Control damper.

Part 3 Execution

3.1 Air Outlets and Inlets

.1 Provide grilles, registers, diffusers as schedule and as noted on the plans. Provide specific mounting type coordination with wall, floor and ceiling types as noted.

.2 Install with cadmium plated screws in counter sunk holes where fastenings are visible.

.3 Install ductwork as high as practical, using offsets where required to obtain maximum duct neck lengths for diffusers.

.4 Refer to Architectural Reflected Ceiling plans for exact locations of air terminals, and coordination with ceiling type.

.5 Paint ductwork behind grilles with matte black paint where duct or insulation surfaces are visible.

.6 Attach registers and grilles to branch ducts with duct necks having minimum length to prevent grille or register damper from protruding into branch duct.

.7 Where air terminals are installed in mechanical grid ceiling, provide minimum two 12 ga (2.75 mm) galvanized steel wire seismic security bridles at opposite corners of each air terminal and such that air terminal cannot fall.

.8 Hand over door grilles to General Contractor for installation.

3.2 Louvres

.1 Provide necessary flashing and counterflashing for louvres installed in walls.

.2 Caulk louvre and flashing and counterflashing to make installation water tight.

.3 Blank-off panels shall be constructed to SMACNA standards, minimum 20 ga (1.00 mm) sandwich panel with 1" (25 mm) thick fibreglass insulation.

.4 Blank-off panels shall have painted flat black enamel finish.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Filters - Quality Assurance

.1 Filters shall be by one Manufacturer.

.2 Filter media shall be ULC listed and labelled, Class I or Class II.

.3 Filters shall be suitable for air at 100% RH and air temperatures between 37°F (3°C) and 122°F (50°C).

.4 Dust holding capacity: Air Filter Institute (AFI) Test.

.5 Efficiency: based on ASHRAE 52-76, atmospheric dust spot efficiency. “Absolute filter” efficiency shall be tested with 0.3 Poly-alpha-olefin (PAO) smoke.

.6 Representative filters shall have been tested by an independent test laboratory and test results shall be made available on request

Part 2 Products

2.1 Filters - General

.1 Mark filter identification on each filter.

.2 Provide two sets of filter media (for each filter) - one for initial installation and one for handover to the Owner as a spare.

.3 Panel filter media used during “temporary heating” shall be replaced by new media on substantial completion.

.4 Filters sections shall be designed for 500 ft/m (2.54 m/s) maximum air flow velocity.

.5 Filters sizes shall conform to one of the following sizes: 24” (600 mm) x 24” (600 mm), 24” (600 mm) x 20” (500 mm), 24” (600 mm) x 12” (300 mm), or 12” (300 mm) x 12” (300 mm).

.6 Roll type filters, automatic advance or otherwise will not be considered acceptable means of filtration.

.7 Use of permanent washable type impingement filters not acceptable.

2.2 Filters - Panel Type

.1 2” (50 mm) thick disposable pleated cotton media.

.2 Enclosing frame shall be constructed from rigid, heavy-duty high wet strength beverage board with diagonal support members bonded to both sides of each pleat.

.3 Efficiency: MERV 8 per ASHRAE Standard 52.2 and an average dust spot efficiency of 25% to 30% per ASHRAE Standard 52.1.

.4 Standard of Acceptance: AAF AM-AIR 300, Farr 30/30.

2.3 Filters - Final

.1 Minimum Requirements:

.1 300 mm deep disposable V-bank filter

.2 Rigid galvanized steel enclosing frame.

.3 Efficiency: MERV 11 with an initial pressure drop no greater than 53 Pa (0.21" w.g.)

.4 Fan static pressure design to account for 250 Pa pressure drop across filter section

.2 Standard of Acceptance:

.1 DAFCO FP Mini-Pleat FP-11 or Camfil Farr Durafil DU4V-ES-EV11

2.4 Filters - Carbon

.1 Minimum Requirements:

.1 300 mm deep activated carbon impregnated pleated V-Cell cartridge design filter.

.2 Media: Impregnated 60% CTC activated carbon from coconut shell blended with Potassium Permanganate, 50-55 minute absorption capacity in accordance with standard accelerated chloropicrin test.

.3 Efficiency: MERV 15 with 90 Pa (0.36" w.g.) initial pressure drop.

.4 Fan static pressure design to account for 400 Pa pressure drop across filter section

.2 Standard of Acceptance:

.1 DAFCO FP Gas Phase Filter or Camfil Farr CamSorb CH CFS-002

2.5 Filter - Holding Frames

.1 Built-up Frames:

.1 **Provide separate holding frames for each bank of panel filters and each bank of final filters.**

.2 Factory fabricated from 14 ga (1.99 mm) galvanized steel with spring retaining clips and neoprene gaskets.

.2 Slide-In-Frames:

.1 Provide slide-in-channels for filters mounted in ductwork where noted. Provide hinged and gasketted access doors.

2.6 Filter Housings

.1 Factory manufactured. Rigid galvanized steel casing minimum 16 ga (1.61 mm) thick.

.2 Housing to have a high degree to sealing integrity. Filters shall fit tightly in housing with no air leakage between filters and between filters and housing.

.3 Extruded aluminum or steel tracks for slide-out, side withdrawal of filters.

.4 Hinged access door for filter servicing.

.5 Standard of Acceptance: AAF Poly-Seal, Cambridge Side-Flo, Farr Glide/Pack.

2.7 Filter Gauges

.1 Application:

.1 Across each filter bank. (Provide two individual gauges for combined panel and final filter banks.)

.2 Minimum Requirements:

.1 Ranges:

.1 Panel filters: 0 - 1" w.g. (250 Pa).

.2 Final filters: 0 - 2" w.g. (500 Pa).

.3 Carbon filters: 0 - 2" w.g. (500 Pa).

.3 Standard of Acceptance:

.1 Dwyer Photohelic Series 3000.

Part 3 Execution

3.1 Filters

.1 Do not operate fan system connected to filter banks until filters (temporary or permanent) are in place. Provide new filters at handover to Owner. Replace filter used during construction.

.2 Provide filter banks in arrangement shown with removal and access indicated. Demonstrate removal of filters prior to substantial completion.

.3 Provide and install Dwyer filter pressure gauges across each filter installation.

3.2 Filter Gauges

.1 Mount gauges for easy visual inspection.

.2 Piping to be formed in true vertical/horizontal lines free from kinks.

.3 Seal penetrations of plenums or ducts.

3.3 Filter Holding Frames

.1 Built-up frames shall be installed and bolted together (and sealed air-tight with specified duct and plenum sealers) to form filter bank.

.2 Provide necessary reinforcing for filter banks over three frames high. Brace with vertical steel stiffeners, minimum 14 ga (1.99 mm) thick, riveted or bolted to frames and attached to top and bottom of plenum. When bolting frames together, provide spaces between holding frames as necessary to centre filters on coils (see drawing sections).

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Certification of Ratings

.1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or those ordered from independent testing agency signifying adherence to codes and standards.

Part 2 Products

2.1 Breeching and Chimneys - All Fuels

.1 Minimum Requirements:

- .1 Factory-built, seismically-rated, sectional prefabricated double wall breeching and chimney.
- .2 ULC listed.
- .3 Type 304 type stainless steel outer jacket with minimum thickness of 24 ga (0.51 mm) for 6" (150 mm) through 24" (600 mm) ID sizes and 20 ga (0.81 mm) for 28" (710 mm) through 48" (1,200 mm) sizes.
- .4 1" (25 mm) air space between jacket walls or fibre insulation between inner and outer pipe of 1" (25 mm), 2" (50 mm) or 4" (100 mm) thick as shown on project plants.
- .5 Type **316** stainless steel inner liner with minimum thickness of 20 ga (0.95 mm) for sizes 6" (150 mm) thorough 36" (914 mm) ID and 18 ga (1.27 mm) for sizes 41" (1,050 mm) through 48" (1,200 mm) ID.

.2 Accessories:

- .1 Entire stack system from each boiler or appliance to termination shall be from one Manufacturer and shall include for required components such as pipe lengths, adjustable pipe lengths, tees, elbow, ventilated roof thimble, insulated exit cone termination, supports, guides, flanged boiler adaptor, joint sealant, angle rings, drain sections, etc.

.3 Standard of Acceptance:

- .1 Metalbestos PS (or IPS-C1, IPS-C2 or IPS-C4), Security.

2.2 Gas Vent

.1 Minimum Requirements:

- .1 Chimneys, ULC labelled, Type B, gas vent only.
- .2 Sectional pre-fabricated double wall with mated fittings and couplings.
- .3 Outer galvanized steel casing, intermediate air space, inner aluminum alloy liner.

.2 Accessories:

.1 Include for required components, such as pipe lengths, tees, elbows, support pates, roof flashings, storm collar, wall thimble, fire stop spacer, vent cap etc.

.3 Standard of Acceptance:

.1 Metalbestos RV - 3” (75 mm) to 8” (200 mm) ID, Security.

2.3 Expansion Compensators

.1 Minimum Requirements:

.1 Multiple T321 stainless steel bellows construction.

.2 Telescoping stainless steel internal liner.

.3 Rated for minimum 3000 movement cycles.

.4 125# welded plate steel flanges.

.5 Minimum 3” (75 mm) axial movement.

.6 Suitable for continuous operation at maximum system pressure, temperature, and velocity.

.7 Suitable for continuous exposure to flue gases (natural gas and No. 2 fuel oil).

.8 Minimum clear inside diameter to match breeching ID.

.2 Standard of Acceptance:

.1 Flextech Industries Inc. Model FBXL-PP-CS-TL. Submit shop drawings.

2.4 Flues and Venting for Condensing Boilers and Condensing Gas Fired Appliances

.1 Provide Type BH S636 approved plastic venting material, that is approved for a flue gas temperature of 90°C or greater (approved CPVC and Polypropylene).

.1 Acceptable Product: Centrotherm Polypropylene Venting System.

.2 Provide the Manufacturer’s proprietary venting system where specifically approved for that appliance.

.3 S636 venting materials are only required for the portion of the venting system conveying products of combustion, including the termination.

Part 3 Execution

3.1 Chimneys

.1 Install in accordance with Manufacturers recommendations.

.2 Support chimneys at bottom, roof and intermediate levels as indicated. Install thimbles here penetrating roof, floor and ceiling.

.3 Install chimneys penetrating roofs as indicated, complete with flashings to suit installation.

.4 Install guy wires as necessary.

.5 Exposed metal parts outside building to be painted with heat and corrosion resistant primer and finish pain.

.6 Install plastic venting systems for condensing appliances in accordance with ULC S636 and latest CSA B149 Code with Supplements.

3.2 Expansion Compensators

.1 Install in accordance with Manufacturer's recommendations.

.2 Provide adjacent breeching sections with oversize flanges as required to maintain clear inside breeching diameter through compensator.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Reference Standards

.1 Install packaged boiler(s) in accordance with current Regulations of the Province of BC, CSA B51, ASME Codes, CSA B140.7.2., CAN1-3., Canadian Electric Code, CSA B139, CSA B139S1, CAN1-B149.1, ANSI B31.1, except where specified otherwise.

1.3 Submissions

.1 Submit certificate of inspection from BC Safety Authority.

1.4 Shop Drawings

.1 Submit shop drawings as per Section 23 05 00.

.2 Indicate components, assembly dimensions, weights and loadings, required clearances, location and size of field connections, valves, strainers and thermostatic valves required for complete system.

.3 Submit product data indicated rated capacities, weights, specialities and accessories, electrical requirements and wiring diagrams, including heating surface area.

.4 Submit Manufacturer's installation instructions.

1.5 Start-Up

.1 Manufacturer's Representative to provide start-up and burner adjustment service and maintenance and operating instructions to Owner's maintenance staff. Test reports to be submitted for review and inclusion in maintenance manuals.

Part 2 Products

2.1 General

.1 Packaged Boiler: Complete with burner and necessary accessories and controls, and ready for attachment of water supply, return and drain piping, (including condensate drain on condensing boilers, fuel piping, electrical connections, and chimney connection. UL/ULC labelled.

.2 Designed and constructed in accordance with ASME Code requirements.

.3 The pressure vessels shall bear Canadian Registration Number (CRN) for The Province of BC before being shipped from the factory.

.4 Electrical components CSA approved.

.5 Packaged boiler must receive factory tests to confirm construction, controls, and operation of unit. Boilers to be test fired before shipment.

.6 Include boiler assembly and wiring diagrams and operating and maintenance manual with boiler package.

.7 Check available drawings and ensure the proposed boiler will fit in space allotted and can be maintained and operated in normal manner.

.8 Include and install boiler power and boiler gas valve kill switch, equal to red mushroom cap, labelled emergency boiler shut-off – example Pilla 'WPSMP' switch.

2.2 Boilers – High Efficiency Condensing

.1 Minimum Requirements:

- .1 Provide forced draft gas fired high efficiency condensing hot water boiler with insulated jacket, controls and boiler trim.
- .2 CSA efficiency requirements: 95% or better combustion efficiency and 97% or better thermal efficiency as tested by AHRI BTS-2000 Testing Standard Method. Each boiler shall be capable of 5:1 turndown or better rate without loss of combustion efficiency.
- .3 Certified with Eco Logo from Environment Canada.

.2 Boiler Construction:

- .1 The water heating condensing boiler shall be of gas fired design, featuring high-quality stainless steel and titanium alloy self cleaning, scale formation resistant heat exchanger and a full modulating gas burner with positive pressure flue discharge.
- .2 Assembly conforms to ASME Code requirements and test for maximum working pressure of 1,034 kPa water.
- .3 Structural steel base with front plate, removable panels and lifting lugs. Provide secure attachment points for seismic anchoring.
- .4 Entire boiler insulated with 100 mm thick glass fibre and finished with steel jacket finished with factory applied baked enamel.

.3 Boiler Heat Exchanger.

- .1 SA240-316Ti titanium stabilized stainless steel combustion chamber and a single pass Inox-Crossal flue part of the heat exchanger or equipment.
- .2 The boiler shall operate at a maximum Delta T of 100F and shall not have low temperature limit.
- .3 The flue gasses shall pass by the return water in a counter-flow direction only, for maximum heat transfer effectiveness.
- .4 ASME maximum allowable working pressure (MAWP): 75 psig; ASME maximum operational water temperature (Adjustable High Limit): 190°F (88°C); ASME maximum water temperature (Fixed High Limit): 210°F (99°C).

.4 Hot Water Boiler Trim:

- .1 Combination water pressure and temperature gauge, and ASME rated pressure relief valves.
- .2 Low water cut-off with manual reset and special retard circuit to automatically prevent burner operation when boiler water falls below safe level. Low water cut-off must automatically reset on resumption of power at device.
- .3 Electronic operating temperature controller shall control burner operation to maintain boiler water temperature.
- .4 Limit temperature controller shall control burner to prevent boiler water temperature from exceeding safe system temperature.

.5 Provide boiler air vent tapping.

.6 Provide motorized isolation valves in return line for each boiler.

.7 Provide neutralization tanks for vent condensation.

.8 Provide manufacturer's approved multiple boiler low-loss distribution manifold.

.5 Burner.

.1 Burner operation shall be modulating with low fire position for ignition.

.2 Forced draft gas burner with electric ignition, cast aluminum, hinged monoblic design equipped with Low-Nox burner technology and gas pressure regulator.

.3 Pre-wired, factory assembled electronic controls on control cabinet with flame scanner or detector, programming control, relays and switches. Provide pre-purge and post-purge ignition and shut-down of burner in event of ignition pilot and main flame failure with manual reset.

.4 Single wall venting system, Category IV for each boiler separately.

.6 Controls.

.1 The boilers shall be complete with packaged electronic controls capable of accepting remote 0-10V input (including 0-1V input disabling the system) and/or interface to the boiler native detached cascade control via Modbus or LON protocol (for multiple boiler installations) c/w 0-10V input and outdoor reset capability featuring user interface control panel with graphic output.

.2 The boiler and the detached cascade controls shall be programmable for various types of boilers and system layouts (including hybrid systems) with regards to their specifics, self-adjust to varying operating environments, system layouts and shall have sequencing and load management priority for both electrical and fuel savings in its self-learning, site-adaptation logic.

.3 Control strategy shall be adjustable to specific boiler design, trim and output. Both boiler and detached cascade controls feature self-diagnostic function, external enable, external disable and alarm output.

.4 Boiler control shall operate isolation valve for enhanced system efficiency; the isolation valve on the lead boiler shall be commanded to be open at all times. The detached cascade control shall operate all boilers and provide alarm output.

.7 Venting.

.1 The boiler system shall be CSA approved for a common venting system. Each boiler shall be equipped with flue gas AL29-4C stainless steel or PP(s) plastic S636 individual venting.

.2 Venting shall feature condensate disposal and have 2" (50 mm) clearance to combustibles.

.8 Drain.

.1 The boiler shall have a gravity drain with condensate neutralization

.9 Standard of Acceptance: Viessmann Vitodens, Cleaver Brooks Clearfire, Buderus SB Series.

2.3 Boiler Sequence Control

.1 Hot Water Boiler Sequencing:

.1 Supply lead lag programming control to integrate multiple boiler installation and automatically sequence firing of boilers in balance with heat pumps and changing load conditions. Refer to section 25 90 01.

.2 Control shall automatically program individual boilers in or out of operation in response to temperature variations as sensed by temperature sensor installed prior to water header common to boilers and heat pumps.

.3 Temperature sensor, through controller, shall operate ON-OFF switches, one for each boiler, each wired into its respective boiler control operating high limit cut-off (ON-OFF) control circuit. Switches shall be sequenced (see below) at fall in flow water temperature

.4 Manual selector switch shall alternate **two** boilers through PE switches to the following sequence.

Sequence	Lead Boiler	Second Boiler
A	#1	#2
B	#2	#1

Part 3 Execution

3.1 Installation

.1 Install boilers on 4” (100 mm) concrete housekeeping pad

.2 Do not deviate from required service and maintenance clearances as required by code.

.3 Mount unit level. Anchor boiler with bolts and inserts suitable for seismic loading.

.4 Make required natural gas piping and electric connections including control wiring between boiler control panel Provide boiler power ‘kill switch’ with red lettered label immediately outside boiler room door. Boiler kill switch shall be hard wired to the boiler gas solenoid valve(s), by the mechanical contractor.

.5 Pipe relief valves and air vents on hot water boilers to floor drain.

.6 Natural gas fired installation to CAN1-B149.1

.7 Manufacturer’s Representative shall:

.1 Certify installation in writing.

.2 Provide start-up and burner adjustment service.

.3 Carry out on-site performance verification tests.

.4 Provide maintenance and operating instructions.

.8 Test reports to be submitted for review and inclusion in maintenance manuals.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Constructed in accordance with Section VIII, CSA B51-M1986 and Provincial Pressure Vessel regulations.

1.3 Submittals

.1 Shop drawings shall include dimensions, locations and size of tappings, and performance data to compare with specification.

Part 2 Products

2.1 Heat Exchangers – Plate and Frame – To be certified to ARI-400-2014.

.1 Suitable for maximum working pressure of 125 psi (860 kPa).

.2 Frames: Carbon steel with baked epoxy enamel finish.

.3 Guide Bars: Hard chrome-plated carbon steel with zinc treated carbon steel paint protected shroud.

.4 Plates: Type 304 stainless steel.

.5 Nozzles: Constructed of 316L stainless steel.

.6 Gaskets: Nitrile or Ethylene propylene rubber.

.7 Acceptable Products: Alfa Laval, Xylem (Bell & Gossett), Armstrong, Sondex, GEA.

Part 3 Execution

3.1 Plate Type Heat Exchanger Installation

.1 Install level. Anchor heat exchangers and supports with bolts and inserts suitable for seismic loading.

.2 Install with safety relief valve piped to drain hose bibb and drain valve.

.3 Install thermometer wells with thermometers on inlet and outlet of water side.

.4 Install pressure gauge on inlet and outlet pipes.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

.1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or by independent testing agency signifying adherence to codes and standards.

1.3 References

.1 AHRI 1060 latest edition.

Part 2 Products

2.1 Heat Recovery Ventilators

.1 General:

- .1 Factory packaged, self-contained and pre-wired unit, CSA certified.
- .2 Packaged heat recovery ventilator consisting of damper change over energy recovery heat exchanger, ventilation air fan, exhaust air fan, dampers, temperature sensors and controls, suitable for operation with low outdoor air temperatures (-22°F (-30°C)).
- .3 Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the ETL and (C)ETL label of approval.
- .4 Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.
- .5 Tested and rated in accordance to AMCA 210, AHRI 1060 and ASHRAE 84, test procedures for airflow and thermal effectiveness.
- .6 Single point power connection only, voltage to be 575 V / 3 PH / 60 Hz
- .7 Unit shall be supplied with variable speed drives for exhaust and supply fans. VSDs shall comply with requirements of section 23 05 14
- .8 Units shall be run tested prior to shipment.
- .9 Unit shall be capable of providing constant volume at specified external static pressure at all fan operating speeds.

.2 Unit Cabinet:

- .1 Custom low profile configuration
- .2 Unit shall include baked on, polyester pre-painted 20 ga (1.00 mm) galvanized steel finish. Warranty cabinet finish for 10 years against cracking, chipping, peeling, brazing or spotting.
- .3 Cabinet shall be insulated throughout with minimum 2" (50 mm) foil faced fire retardant material.
- .4 Painted galvanized metal cabinet, internally lined and insulated

.5 Main access panel shall be hinged and provide access to components requiring servicing.

.6 Outdoor and exhaust side filters with service access.

.3 Drain Pans:

.1 Provide aluminum unit drain pans under cooling coils and heat recovery sections, minimum 2" (50 mm) deep with welded corners and coated with water-proofing compound. Each side of pan shall be provided with 1-¼" (32 mm) NPS drain connection. Cap unused drain pipes.

.4 Filters:

.1 Material to match casing.

.2 Filters and arrangement as scheduled. Standard size filters shall be used. Use of odd-sized filters is not permitted.

.3 Flat or angled filter section to limit filter velocity, based on gross area to less than 400 ft/min (2.0 m/s).

.4 Access to filters through hinged door with suitable hardware.

.5 Provide external mounted filter gauge gauges across filter banks to meet requirements of 23 41 00

.6 Pre-filters to meet the requirements of specification section 23 41 00

.7 Final filters to meet the requirements of specification section 23 41 00

.8 Carbon filters to meet the requirements of specification section 23 41 00

.5 Fans:

.1 Supply air and exhaust air fans with variable speed motors. Motors to meet the requirements of specification section 23 05 13

.2 Fans shall be direct drive centrifugal (plug) fans. Fans shall comply with specification section 23 34 00

.3 Fan ratings based on tests in accordance with AMCA Standard 210.

.4 Fans selected to operate on stable, efficient part of fan curve when delivering air quantities scheduled against static pressure of system.

.5 Fan blades shall be statically and dynamically balanced and tested prior to shipment.

.6 Fan shall be provided with internal vibration isolation mounts.

.7 Motors shall be continuous duty, permanently lubricated and matched to fan loads. Motor selection shall include 15% service factor.

.6 Coils:

.1 To be supplied by unit Manufacturer as scheduled.

.1 Coil Casings: Material to match unit casing. Provide insulated sheet metal housings over cooling coil return bends. Blank-off plates as required.

.2 Heating coils: ARI tested to 250 psi (1,725 kPa) as per AHRI Test Code. Pitched in unit casing for drainage. Copper tube mechanically expanded into aluminum fins. Performance as scheduled.

.3 Cooling coils: Tested to 250 psi (1,725 kPa) as per AHRI test code. Copper tube mechanically expanded into aluminum fins. Performance as scheduled.

.7 Damper Change over Energy Recovery Heat Exchanger:

.1 Switchover damper section shall be comprised of multi section low leakage dampers operated by fast acting electric actuators (pneumatic on sizes RG 33000 and larger). RG 1000-6500 shall have damper switching times of 0.75 seconds. RG 7500-18000 shall have damper switching times of 3 seconds. Single blade damper sections are not acceptable. Each damper shall control one of the 4 airways, upper-horizontal, lower-horizontal, forward-vertical and rear-vertical. Dampers shall be capable of orienting to close off outside air to the building without needing external shut off dampers. Dampers shall also be capable of orienting to allow 100% recirculation of air without using heat recovery device for off peak or unoccupied heating modes.

.2 Heat transfer surfaces: corrugated aluminum, frame mounted

.3 Cross contamination: A minor amount of return recirculation is permitted.

.4 Condensate drain: NPS 1.

.5 Hinged access panels.

.6 Performance characteristics: as indicated.

.7 Custom recessed damper drive option

.8 Each cassette bank will be divided into (1) sections: (1) 2.5Wx2H and (1) 2Wx2H. The 2Wx2H sections will be furnished two position VAV dampers. The damper actuators will be 24VAC, power close, spring open and factory wired to an external junction box on each housing. The vertical dividing partitions will be double wall insulated.

.9 Five year parts and labour warranty on heat exchanger material and system.

.8 Controls:

.1 Unit shall be provided with factory mounted and factory wired microprocessor control, requiring only field connection to building DDC system and wiring to unit mounted terminal strips.

.2 Service connectors shall be quick disconnect type.

.3 Unit circuitry shall allow dry contacts for full HRV control to meet requirements of 25 05 01 Integrated Automated, 25 90 01 Systems Sequences of Operation and 25 90 02 Control Points List. Dry contacts for control functions to be building DDC system compatible.

.4 Automatic defrost cycle.

.5 Dirty filter contacts.

.9 Access Doors

.1 Provide access doors as indicated on drawings, and to the following sections:

.1 Fan sections.

.2 Heat recovery sections

.3 Filter casing section.

.4 Heating / Cooling coil section(s).

.2 Access doors shall be hinged, gasketted, insulated double panel sandwich construction, free from warping and buckling, complete with doorframe.

.3 Access doors shall be complete with heavy-duty safety handles operable from either side.

.10 Vibration Isolation:

.1 Internally isolate fan/motor assembly with flexible connection between fan and cabinet. Isolators provided by unit Manufacturer and shall meet requirements of Section 23 05 48 for seismic restraint.

.11 Electrical

.1 Field wiring access to be provided through unit base into isolated enclosure with removable cover.

.2 Power wiring to be single point connection.

.3 Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.

.4 Factory mount and wire unit main power disconnect device overcurrent and SCCA rated for total unit power connection.

.5 Factory installed safety barrier shall isolate all high voltage components, mounted inside electrical compartment, to protect service personnel from incidental contact.

.6 Factory mount and wire line-to-120 volt convenience outlet transformer. Field wiring of convenience outlet not acceptable.

.7 Provide one 120 V/1 Phase connection to junction box for marine lights.

.8 Factory to mount and wire optional 120 volt convenience outlet. Field wiring of conveniences outlet not acceptable.

.12 Accessories:

.1 Frost Control Options:

.1 Damper Defrost: Unit shall have continuous damper operation on outdoor air inlet to prevent frost build-up.

.2 Corrosion resistant external finish, suitable for outdoor installation.

.3 Duct-Mounted Smoke Sensor with controller for field installed control of fan operation.

.4 Flow Measuring Stations on exhaust and outside air steams

.5 CO2 Controller: Non-dispersed infrared control shall be provided to trigger ventilation at levels above 1,000 ppm of CO2.

.13 Standard of Acceptance: BKM

.14 Acceptable Alternates: BKM, Tempeff

Part 3 Execution

3.1 Heat Recovery Ventilators Installation

.1 Install in accordance with Manufacturer’s recommendations.

.2 Start-up Heat Recovery Ventilators in accordance with Manufacturer’s start-up instructions. Provide start-up report to Consultant, and include in O & M manual.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 References

.1 AHRI 430 latest edition and AHRI 260 latest edition.

Part 2 Products

2.1 Indoor Air Handling Units (AHU-1)

.1 General:

- .1 Factory assembled airtight modular components as scheduled.
- .2 Refer to drawings for specific dimensions, duct connections and general arrangement.
- .3 Standard of Acceptance: Trane, Engineering Air, McQuay, York, Scott Springfield, Haakon

.2 Casing:

- .1 16 ga (1.61 mm) galvanized steel reinforced and braced for rigidity, minimum panel thickness equal to 2" (50 mm) double walled foamed insulation unless specified otherwise.
- .2 Where not galvanized, steel parts to be painted with corrosion resistant paint.
- .3 Finish entire unit inside and out with baked enamel.
- .4 Casings shall be supported on welded structural channel supports designed for support of entire unit without deflection. Construct casing to meet seismic requirements. Provide secure attachment points for seismic anchoring.

.3 Drain Pans:

- .1 Provide integral unit drain pans under cooling coils, minimum 2" (50 mm) deep with welded corners and coated with asphaltic water-proofing compound. Each side of pan shall be provided with 1-¼" (32 mm) NPS drain connection. Cap unused drain pipes.
- .2 Units with sprayed coil section or humidifier shall have drain pan under entire fan section to drain water carried over from coil or humidifier.

.4 Insulation:

- .1 Insulate internal surface of panels with 1" 3 lb/ft³ (25 mm 48 kg/m³) neoprene coated flexible duct liner. Use 2" (50 mm) thick insulation where scheduled or indicated on drawings.
- .2 Apply with 100% coverage of adhesive with clip pins.
- .3 Cover insulation on bottom of unit with galvanized sheet metal.
- .4 Seal joints and raw edges with fibrous glass reinforcing fabric and insulation sealer.

.5 Fans:

.1 Free standing AMCA-rated **Direct Drive** centrifugal fans with airfoil wheels. Stable pressure curve and low sound power. Factory wired to on board variable speed frequency drive. VSD to meet requirements of 23 05 14

.2 Heavy duty, self-aligning bearings. Extend lubrication fittings to exterior of fan casing.

.3 Provide variable sheaves for motors 7.5 hp (5.6 KW) and under and fixed sheaves for 10 hp (7.5 KW) and over.

.4 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, shall have 1.15 service factor and shall be suitable to be driven by PWM variable speed drive controllers. Motor Manufacturer shall submit in writing confirmation that motors are designed to withstand voltage peaks of 1400V and voltage rate of rise of 2000V/microsecond at frequency of 20 kHz.

.6 Variable Volume Control:

.1 Unit supplier to provide integral variable frequency drive for controlling motor speed, factory mounted and wired complete with SCA stamps, through single point power supply. VSD to meet requirements of 23 05 14

.7 Filter Boxes:

.1 Material to match casing.

.2 Filters and arrangement as scheduled. Standard size filters shall be used. Use of odd-sized filters is not permitted.

.3 Flat or angled filter section to limit filter velocity, based on gross area to less than 400 ft/min (2.0 m/s).

.4 Access to filters through hinged door with suitable hardware.

.5 Provide external mounted filter gauge gauges across filter banks to meet requirements of 23 41 00

.6 Final filters to meet the requirements of specification section 23 41 00

.7 Carbon filters to meet the requirements of specification section 23 41 00

.8 Mixing Boxes:

.1 Material to match casing. Mixing box to control mixed air temperature within 9°F (5.5°C) across face to outlet.

.2 Control dampers for mixing boxes shall be provided by unit Manufacturer to the quality equivalent to specified in Controls Section.

.3 Damper motors to be provided by Controls Section.

.9 Coils:

.1 To be supplied by unit Manufacturer as scheduled.

.1 Coil Casings: Material to match unit casing. Provide insulated sheet metal housings over cooling coil return bends. Blank-off plates as required.

.2 Cooling coils: Tested to 250 psi (1,725 kPa) as per AHRI test code. Copper tube mechanically expanded into aluminum fins. Performance as scheduled.

.10 Access Doors

.1 Provide access doors as indicated on drawings, and to the following sections:

.1 Supply and return fan sections.

.2 Mixing section.

.3 Filter casing section.

.4 Cooling coil section(s).

.2 Access doors shall be hinged, gasketted, insulated double panel sandwich construction, free from warping and buckling, complete with doorframe.

.3 Access doors shall be complete with heavy-duty safety handles operable from either side.

.11 Vibration Isolation:

.1 Internally isolate fan/motor assembly with flexible connection between fan and cabinet. Isolators provided by unit Manufacturer and shall meet requirements of Section 23 05 48 for seismic restraint.

.12 Electrical

.1 Field wiring access to be provided through unit base into isolated enclosure with removable cover.

.2 Power wiring to be single point connection.

.3 Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.

.4 Factory mount and wire unit main power disconnect device overcurrent and SCCA rated for total unit power connection.

.5 Factory installed safety barrier shall isolate all high voltage components, mounted inside electrical compartment, to protect service personnel from incidental contact.

.6 Factory mount and wire line-to-120 volt convenience outlet transformer. Field wiring of convenience outlet not acceptable.

.7 Provide one 120 V/1 Phase connection to junction box for marine lights.

.8 Factory to mount and wire optional 120 volt convenience outlet. Field wiring of conveniences outlet not acceptable.

.13 Low Voltage

.1 Factory mount and wire 24 volt control system complete with required transformers and fusing.

.2 Wiring shall be factory CSA approved.

.3 Complete factory power wiring in EMT conduit from motoes and lights to point power connections.

.4 Provide power connections from each fan motor to junction boxes on outside of unit casing.

.5 Electrical contractor to provide disconnects, starters and power wiring to unit junction boxes. If variable speed drives are used Electrical shall wire to disconnect switches (could be integral on VSD) and from disconnect switches to VSDs and from VSDs to motor junction boxes. If disconnect is placed between VSD and motor, auxiliary sets of contacts are required to let VSD know it has been shut off.

.6 Provide power connections from each fan motor to VSDs and to junction boxes on outside of unit casing for indoor units.

2.2 Outdoor Air Handling Units (AHU-2 and AHU-3)

.1 General:

.1 Factory assembled airtight modular components as scheduled.

.2 Refer to drawings for specific dimensions, duct connections and general arrangement.

.3 Standard of Acceptance: Trane, Engineering Air, McQuay, York, Scott Springfield, Haakon

.2 Casing:

.1 Unit casing and plenum shall be unitary design for outdoor use with airtight modular components. Unit casing shall be of minimum 1.6 mm satin coat galvanized sheet metal finished inside and out with rust-resistant baked enamel over prime coat. Provide structural steel frame to mount components and support exterior steel panels. Panels shall be reinforced and braced for rigidity and shall not show signs of visible deflection on start-up. Provide continuously piano hinged fully lined doors for inspection and servicing, minimum size 450 mm x 450 mm with Lever locks for access sections to internal components

.2 16 ga (1.61 mm) galvanized steel reinforced and braced for rigidity, minimum panel thickness equal to 2" (50 mm) double walled foamed insulation unless specified otherwise.

.3 Where not galvanized, steel parts to be painted with corrosion resistant paint.

.4 Casings shall be supported on welded structural channel supports designed for support of entire unit without deflection. Provide integral lifting lugs for hoisting of air handling units. Construct casing to meet seismic requirements. Provide secure attachment points for seismic anchoring.

.5 Provide marine lights wired to switches outside access doors for fan section and mixing section.

.3 Piping Vestibules:

.1 Provide accessible insulated piping vestibules at heating and cooling coil locations. Piping vestibule is to be designed to allow installation of piping, serviced from space below. Vestibule is to be sized to allow for proper mounting of insulated pipes, valves and controls accessories.

.4 Drain Pans:

.1 Provide integral unit drain pans under cooling coils, minimum 2" (50 mm) deep with welded corners and coated with asphaltic water-proofing compound. Each side of pan shall be provided with 1-¼" (32 mm) NPS drain connection. Cap unused drain pipes.

.2 Units with sprayed coil section or humidifier shall have drain pan under entire fan section to drain water carried over from coil or humidifier.

.5 Insulation:

.1 Insulate internal surface of panels with 1" 3 lb/ft³ (25 mm 48 kg/m³) neoprene coated flexible duct liner. Use 2" (50 mm) thick insulation where scheduled or indicated on drawings.

.2 Apply with 100% coverage of adhesive with clip pins.

.3 Cover insulation on bottom of unit with galvanized sheet metal.

.4 Seal joints and raw edges with fibrous glass reinforcing fabric and insulation sealer.

.6 Fans:

.1 Free standing AMCA-rated **Direct Drive** centrifugal fans with airfoil wheels. Stable pressure curve and low sound power. Factory wired to on board variable speed frequency drive. VSD to meet requirements of 23 05 14

.2 Heavy duty, self-aligning bearings. Extend lubrication fittings to exterior of fan casing.

.3 Provide variable sheaves for motors 7.5 hp (5.6 KW) and under and fixed sheaves for 10 hp (7.5 KW) and over.

.4 Motors powered by variable speed drive controllers shall be EEMAC Class B with Type F insulation, shall have 1.15 service factor and shall be suitable to be driven by PWM variable speed drive controllers. Motor Manufacturer shall submit in writing confirmation that motors are designed to withstand voltage peaks of 1400V and voltage rate of rise of 2000V/microsecond at frequency of 20 kHz.

.7 Variable Volume Control:

.1 Unit supplier to provide integral variable frequency drive for controlling motor speed, factory mounted and wired complete with SCA stamps, through single point power supply. VSD to meet requirements of 23 05 14

.8 Filter Boxes:

.1 Material to match casing.

.2 Filters and arrangement as scheduled. Standard size filters shall be used. Use of odd-sized filters is not permitted.

.3 Flat or angled filter section to limit filter velocity, based on gross area to less than 400 ft/min (2.0 m/s).

.4 Access to filters through hinged door with suitable hardware.

.5 Provide external mounted filter gauge gauges across filter banks to meet requirements of 23 41 00

.6 Final filters to meet the requirements of specification section 23 41 00

.7 Carbon filters to meet the requirements of specification section 23 41 00

.9 Mixing Boxes:

.1 Material to match casing. Mixing box to control mixed air temperature within 9°F (5.5°C) across face to outlet.

.2 Control dampers for mixing boxes shall be provided by unit Manufacturer to the quality equivalent to specified in Controls Section.

.3 Damper motors to be provided by Controls Section.

.10 Coils:

.1 To be supplied by unit Manufacturer as scheduled.

.1 Coil Casings: Material to match unit casing. Provide insulated sheet metal housings over cooling coil return bends. Blank-off plates as required.

.2 Heating coils: ARI tested to 250 psi (1,725 kPa) as per AHRI Test Code. Pitched in unit casing for drainage. Copper tube mechanically expanded into aluminum fins. Performance as scheduled.

.3 Cooling coils: Tested to 250 psi (1,725 kPa) as per AHRI test code. Copper tube mechanically expanded into aluminum fins. Performance as scheduled.

.11 Access Doors

.1 Provide access doors as indicated on drawings, and to the following sections:

.1 Supply and return fan sections.

.2 Mixing section.

.3 Filter casing section.

.4 Heating / Cooling coil section(s).

.2 Access doors shall be hinged, gasketted, insulated double panel sandwich construction, free from warping and buckling, complete with doorframe.

.3 Access doors shall be complete with heavy-duty safety handles operable from either side.

.12 Vibration Isolation:

.1 Internally isolate fan/motor assembly with flexible connection between fan and cabinet. Isolators provided by unit Manufacturer and shall meet requirements of Section 23 05 48 for seismic restraint.

.13 Electrical

.1 Field wiring access to be provided through unit base into isolated enclosure with removable cover.

.2 Power wiring to be single point connection.

.3 Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.

.4 Factory mount and wire unit main power disconnect device overcurrent and SCCA rated for total unit power connection.

.5 Factory installed safety barrier shall isolate all high voltage components, mounted inside electrical compartment, to protect service personnel from incidental contact.

.6 Factory mount and wire line-to-120 volt convenience outlet transformer. Field wiring of convenience outlet not acceptable.

.7 Provide one 120 V/1 Phase connection to junction box for marine lights.

.8 Factory to mount and wire optional 120 volt convenience outlet. Field wiring of conveniences outlet not acceptable.

.14 Low Voltage

.1 Factory mount and wire 24 volt control system complete with required transformers and fusing.

.2 Wiring shall be factory CSA approved.

.3 Complete factory power wiring in EMT conduit from motoes and lights to point power connections.

.4 Provide power connections from each fan motor to junction boxes on outside of unit casing.

.5 Electrical contractor to provide disconnects, starters and power wiring to unit junction boxes. If variable speed drives are used Electrical shall wire to disconnect switches (could be integral on VSD) and from disconnect switches to VSDs and from VSDs to motor junction boxes. If disconnect is placed between VSD and motor, auxiliary sets of contacts are required to let VSD know it has been shut off.

.6 Provide power connections from each fan motor to VSDs and to junction boxes on outside of unit casing for indoor units.

.15 Roof Curb

.1 Contractor shall provide factory supplied roof curb, 18 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship knocked down and provided with instructions for easy assembly.

Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

Part 3 Execution

3.1 Air Handling Units

.1 Install units in accordance with Manufacturer's instructions and as indicated.

.2 Assemble on housekeeping pads. Bolt sections together with gaskets at joints.

.3 Provide fan sheaves required for final air balance.

.4 Provide flexible connections at inlet and outlet of fan sections unless fan is internally isolated by unit Manufacturer.

.5 Install deep seal P-traps on drain pan lines.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and are to be read, interpreted and coordinated with other parts.

1.2 Warranty

.1 Refrigeration compressors to be warrantied for five years.

Part 2 Products

2.1 Heat Pumps Units – Water-to-Water

.1 Standard of Acceptance: Artic Chiller, Climaflex, ClimateMaster, Florida Heat Pump (FHP), Multistack, Water Furnace

.2 Water-to-water (fluid to fluid) extended range units, suitable for ground source heat pump application.

.3 General:

- .1 AHRI 320 Water Source Heat Pumps certification, UL and CSA approvals.
- .2 Rated in compliance with the AHRI/ISO Standard 13256-2 Water to Water and Brine to Water Heat Pumps – Testing and Rating for Performance.
- .3 Units to be in compliance with the applicable codes and standards, including NFPA 70 - National Electric Code, meet or exceed applicable Underwriters'' Laboratories safety requirements, ASHRAE 90 A - "Energy Conservation in New Building Design"..
- .4 Factory packaged, self-contained and pre-wired.
- .5 Unit and refrigeration components shall be rated for use with environmentally friendly refrigerant (R-134a, R-407C, R-401A). CFC and HCFC refrigerants subject to Montreal Protocol are not acceptable. Field conversion of refrigerants will not be acceptable.
- .6 Heat pumps shall be guaranteed to produce average Energy Efficiency Ratio (EER) of 16.0 or better and a weighted average Coefficient of Performance (COP) of 3.4 or better when tested in accordance with AHRI/ISO Standard 13256-1.
- .7 Heat pumps shall be hooked up to water and functionally tested at factory, including safety controls, and operation over voltage tolerance range.
- .8 Entire refrigeration circuit shall be warrantied against defects in material and workmanship for period of five years.
- .9 Cabinet:
  - .1 Heavy gauge galvanized steel finished with baked enamel or powder coat paint.
  - .2 10 ga (3.51 mm) welded steel frame.
  - .3 ½" (12 mm) thick high density and coated cabinet insulation, insulated access panels for inspection and access to internal components, insulated partition between blower and compressor compartments.

.4 Galvanized steel condensate drain pan. Pan insulated and pitched for drainage.

~~.4~~.5 If the mechanical contractor submits an alternate WSHP, the contractor is responsible for ensuring that all additional sensors/controls required to meet the sequence of operations (such as external flow sensors if not included in the alternate product) are installed.

.10 Compressor:

.1 Heat pump duty hermetic, internally sprung and externally isolated.

.2 Thermal overload protection.

.3 Thermal expansion device to meter refrigerant between air and water coils. Capillary tubes not acceptable.

.4 Compressor motor overload protection.

.5 Capability to reset compressor lockout circuit at either remote thermostat or circuit breaker.

.6 Insulated compressor (high density sound attenuating blanket) for noise attenuation.

.11 Refrigerant Loop and Reversing Valve:

.1 Factory-sealed refrigeration system, insulated with minimum $\frac{3}{8}$" (10 mm) elastomeric insulation.

.2 Schrader access valves on high and low pressure lines.

.3 Insulated refrigerant loop to prevent condensation at low temperatures.

.4 Liquid line filter dryers in each refrigerant circuit.

.5 High and low temperature cut-outs.

.6 Hermetic construction with replaceable external electrical solenoid coil.

.7 Reversing valve shall be pilot operated sliding piston type with replaceable encapsulated magnetic coil.

.12 Water Coil:

.1 Axial tube-in-tube type with water flowing through inner serpentine copper coil, with cupronickel inner tube designed for low water pressure drop and low water flow, or brazed plate type heat exchangers with 316 stainless steel plates capable of withstanding 650 psi (4,480 kPa) working pressure on refrigerant side and 450 psi (3,105 kPa) on water side.

.2 Insulated to prevent condensation. Insulation shall be manufactured without use of CFCs or HCFs.

.13 Control Panel:

.1 Controls shall interface with BMS via acceptable approved gateway – BACnet or equal. BMS shall monitor room temperature and provide start stop signal, and supply air temperature re-set signal.

.2 Factory wired and mounted control circuit complete with compressor contactor, 24 V transformer and blower relay.

.3 Controls shall include high pressure and freeze protectors.

.4 Relays and transformers suitable for 24 V remote control.

.5 Lock-out relay reset from BMS.

.6 Status and alarm monitoring through BMS.

.4 Accessories:

.1 Hanger/vibration isolator kit complete with brackets.

.2 Controller capable supporting building DDC system protocol.

.3 Hose kits - hose kits shall include two 12" (300 mm) long flexible reinforced rubber hoses (rated at 200 psi (1,380 kPa) working pressure) with brass pipe connections (swivel on one end).

.4 One spare set of filters for each unit.

Part 3 Execution

3.1 General

.1 Install units as indicated and to Manufacturer's recommendations.

.2 For all water or glycol cooled units, the connecting hose kit shall be complete with autoflow controlled flow valve, supply and return isolation valves, wye strainer on supply side pipe (minimum of 60 mesh), P+T ports and local drain on terminal side of isolation valves for unit maintenance.

3.2 Equipment Preparation and Start-Up

.1 Provide services of Manufacturer's Field Engineer to set and adjust equipment for operation as specified.

3.3 Heat Pump Unit Installation

.1 Install in accordance with Manufacturer's recommendations.

.2 Piping connections to units shall be flexible hoses.

.3 P/T plugs shall be provided on supply and return piping connections to each unit.

.4 Install temporary bypass piping arrangement, using flexible hoses, before piping is chemically cleaned. Replace permanent connections after piping has been flushed out.

.5 Manufacturer's Representative to check out and start-up units.

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Specification Section forms part of Contract Documents and are to be read, interpreted and coordinated with other parts.

.2 This section includes the following equipment:

.1 Coils (DH-1, RH-1 and RH-2)

.2 Convector Heaters

.3 Perimeter Radiation (RAD-1 to RAD-8)

.4 Fin tube – Bare Elements (Crawlspace)

.5 Unit heaters. (UH-1 and UH-2)

1.2 Standard of Acceptance

.1 Acceptable products are listed in each product section where required.

Part 2 Products

2.1 Coils – Liquid

.1 Ratings: AHRI Standard 410 Forced Circulation Air Cooling and Air Heating Coils certified.

.2 Fins: Aluminum fins continuous across entire coil width, with full fin collars for maximum fin-tube contact and even spacing. Fins mechanically bonded to tubes. Fins not to exceed 12 per 1" (25 mm).

.3 Tubes: ⅝" (16 mm) OD seamless copper tubes with return bends brazed into tube ends.

.4 Headers: Cast-iron or steel pipe.

.5 Casing: Galvanized steel, formed end supports and top and bottom channels with additional centre support on coils over 42" (1,070 mm).

.6 Casing (Cooling Coils): Coil frames shall be 304 SS.

.7 Connections: Drain and vent treaded plug connections.

.8 Testing: Factory air pressure test under water to 250 psi (1,725 kPa) and hydraulic tested to 125 psi (860 kPa).

.9 Glycol Coils: suitable for use with glycol at scheduled percentage by volume.

.10 Standard of Acceptance: Trane, Engineered Air, McQuay, York

2.2 Convector Heaters

.1 Heating Element: Heavy wall seamless copper tubing mechanically expanded into aluminum fins and cast-iron universal type headers, steel side plates and supports.

.2 Cabinet: Type as indicated on drawings. Cold rolled steel, 16 ga (1.61 mm) minimum thickness. Braced and reinforced for rigidity. Panel front with integral grilles to be easily removable.

.3 Finish: Prime coated internally and externally.

.4 Accessories: Knob operated dampers.

.5 Selection Criteria: Hot water units selection basis, 200°F (93°C) entering water temperature with 20°F (11°C) water temperature drop and 65°F (18°C) entering air temperature.

.6 Standard of Acceptance: Trane, Engineered Air, Slant/Fin

2.3 Perimeter Radiation

.1 Casing: galvanized steel 1 mm thick complete with intermediate support brackets. Finished to be clear anodized. Cases to be provided with bottom or side connections to match drawings. Refer to equipment schedule for casing sizing.

.2 Heat Exchanger: Seamless copper tubes with corrugated aluminum fins. Heat exchanger to be lacquered with dirt repellent and dust proof grey epoxy polyester RAL-7024. To be complete with 3 mm air vents and 12 mm drain cock.

.3 Frame: Frame to be pre-mounted to case and shall be provided with finish matching grille.

.4 Grille: Grille to be RSS grille constructed of stainless steel with heal proof space slats.

.5 Units to be pre-assembled for site installation.

.6 Warranty to be of 10 years for the duct, 30 years for the heat exchanger and 10 years for the frame.

.7 Acceptable Products: Jaga (type as scheduled on drawings)

2.4 Fin-Tube - Bare Elements

.1 Application: Suspended in **crawl spaces** as indicated on drawings.

.2 Elements: NPS 1-¼ steel tubing mechanically expanded into evenly spaced, 4" (100 mm) x 4" (100 mm) fins, 32 fins/ft (105 fins/m).

.3 Selection Criteria: Hot water units selected on basis of 180°F (82°C) entering water temperature with 20°F (11°C) water temperature drop and 65°F (18°C) entering air temperature.

2.5 Unit Heaters - Hot Water

.1 Application: Horizontal or vertical arrangement as scheduled on drawings.

.2 Casing: 18 ga (1.31 mm) thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.

.3 Coils: Seamless copper tubing, silver brazed to steel headers and with evenly spaced aluminum fins mechanically bonded to tubing

.4 Fan: Direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard on horizontal units.

.5 Motor: speed as indicated, continuous duty, built-in overload protection, and resilient motor supports.

.6 Air Outlet:

  .1 Horizontal Unit: 2-way adjustable louvres.

.7 Standard of Acceptance: Trane, Zehnder Rittling.

Part 3 Execution

3.1 Coils - Installation

.1 Provide airtight seal between coil and duct or unit cabinets.

.2 Cooling coil supports shall use Type 304 stainless steel.

.3 Bolts and fastenings shall be stainless steel.

.4 Connect water supply to bottom of supply header and return water connection to top in order to provide self-venting and reverse return arrangement.

.5 Provide coil drain pans under coils, not just cooling coils. Drain lines for coils other than cooling coils may be capped outside of unit casing.

.6 Ensure coils and fins and flanges are not damaged. Replace loose and damaged fins. Combs out bent fins unless they need to be replaced.

.7 Drain line from drain pans shall be minimum NPS 1-¼

.8 Pipe drain lines to floor drain with deep seal trap and trap primer.

.9 Provide ¼" (6 mm) petcock cracked open for continuous air venting

3.2 Heating Units Installation

.1 Install according to piping layout. Provide for pipe movement during normal operation.

.2 Refer to Manufacturer's installation drawings. Provide installation warrantee for complete connection assembly where dissimilar materials are used.

.3 Verify electrical service work with characteristics stamped on unit.

.4 Venting:

- .1 On up-fed units provide screw driver vent on convectors and standard air vent with cock on continuous wall convectors.
- .2 On unit heaters and cabinet unit heaters, provide standard air cent with cock unless piping is installed above units and is self-venting into mains.
- .3 Pitch heating elements to assist air venting.

.5 Valves:

- .1 Install isolating gate valve on supply and lock shield globe valve on return, together with control valve indicated on drawings or specified in Controls Section.
- .2 In public areas use lock shield type on supply and return for isolation.

.6 Install, where required, NPS 1-¼, copper flexible expansion compensator.

.7 Check for correct element lengths in heating cabinets as work progresses. Scheduled length is actual finned length.

.8 Field measure for lengths of convector, wall fin or other cabinetry prior to manufacture. Install cabinets and fins, including supports, as recommended by Manufacturer.

.9 Install unit heaters at heights indicated by architect. Where not indicated, follow Consultant's instruction. Set discharge pattern required.

.10 Provide supplementary suspension steel as required.

.11 Touch up scratches in factory paint finishes on units.

END OF SECTION

Part 1 General

1.1 Conformance

.1 All Sections of Mechanical Specifications form part of Contract Documents and are to be read, interpreted and coordinate with all parts. Conform to General Conditions and Division 00, 01, instructions to Bidders, Contract General Conditions and Supplements thereto form part of this Division and contain items related to mechanical work.

1.2 Work Included

.1 Complete system of automatic controls.

.2 Electronic facilities management/DDC control system.

.3 Control devices, components, wiring and material.

.4 Instructions to Owner.

.5 Provide all system source Codes (programming) to Owner.

.6 Bidders shall provide compliance/non-compliance and partial compliance statement for each item in this specification and sign off on each item of the specified items. Where non-compliant, the bidder shall provide an explanation and date on alternative provisions.

1.3 Quality Assurance

.1 Provide a complete system of automatic controls for mechanical systems by firms employing certified journeymen who specialize in this type of work and have proof of completing five projects of similar size and complexity.

.2 It is the Contractor’s responsibility to provide all items required to complete the installation, including but not limited to, all computer software and hardware, operator input/output devices, remote panels, sensors, controls, required to meet the performance requirements as set forth in this Section. The Contractor shall provide all wring piping, raceways, conduit, installation supervision and labour, including calibration, adjustments and checkouts necessary for a complete and operational system. Acceptable Controls Vendors are as follows:

   .1 ESC Delta

   .2 Houle Controls

   .3 Reliable Controls

   .4 Johnson Controls

1.4 Submittals

.1 Submit shop drawings in accordance with Section 23 05 00.

.2 Provide damper shop drawings which include data such as location, arrangement, velocities and static pressure drops for each system. Provide data for all control valve sizing including pressure drops with control valve shop drawing submission.

.3 Include complete operating data, component setpoints, system drawings, wiring diagrams, installed program flow charts and program listing, written detailed sequences of operation and engineering data on each control system component. Include sizing as requested. Components are to be labelled and identified as to use. Submit to Mechanical Contractor for inclusion in Operating and Maintenance Manuals.

.4 Provide, in addition to shop drawing submittals, a detailed list of maintenance instructions including daily, weekly, monthly and annual maintenance requirements for each component of the automatic control system. Copy to be included in the Mechanical Maintenance Manuals in the Maintenance and Lubrication Tab.

.5 Label components on drawings and identify as to function.

.6 Submit CDs, including backup CDs, with up-to-date programs in each controller. Provide original program CDs for each software package complete with validated registrations.

1.5 Substantial Completion Test Procedures

.1 Before the seven day acceptance test may begin, the DDC system must be completely operational including the following:

.1 Every point shall be checked end-to-end to ensure accuracy and integrity of the system. Each point shall appear on a points list (to be prepared by the Contractor) and be signed off by both persons involved in the commissioning procedure.

.2 Basic control strategies shall be written in user-friendly control language. Major system problems preventing accurate control shall be reported in writing by the Contractor.

.3 Provide program flow charts for installed program.

.4 The measured variable, controlled variable and setpoint if calculated of each control loop should be placed on a 15 minute continuous trend for at least 24 hours to prove stability of loop.

.5 Each space sensor should be placed on a three hour trend for 100 samples.

.6 Run time totalizer should be set on all digital outputs.

.7 Load/save of panel programs must be demonstrated.

.8 All features of system shall be exercised

.9 Operator shall be briefed on operation of system, using a minimum of one 8 hour work day.

.10 A trend in one panel will be set up for a point from another panel. This point should also be trended in its own panel for the same intervals. Comparison of the two trends will indicate if any communication problems are occurring during the seven day test.

.11 Related binary inputs/outputs and related status points shall be connected to show alarm condition.

1.6 Documentation

.1 The following documentation must be in place before completion of the test and substantial acceptance is granted:

.1 Panel layout sheets complete with point name, point address and wire identification number. One copy attached to each respective panel door.

.2 All points tagged with point name, point address and panel number.

.3 As-built control drawings.

.4 As-built Eclipse program flow charts.

.5 As-built ladder wiring diagrams showing all hardware interlocks.

.6 Complete Operator's Manual.

.7 Apparatus and Maintenance Manual for all sensors, transducers, solid state relays, etc.

.8 Electrical approval certificate.

.9 All of the above information with the exception of No.2 (point tags) shall be bound and presented in manuals, which are to be handed over to the Owner together with the Operating and Maintenance Manuals.

.2 Once the above basic requirements are met and all other features of the system are complete and acceptable, substantial completion shall be granted. A deficiency list shall be prepared and holdbacks applied. All deficiencies shall be corrected prior to total acceptance. Warranty shall start from total acceptance.

1.7 Owner Orientation

.1 At completion, provide minimum of 4 day instruction period for operating personnel split into 2 sessions, 2 weeks apart regarding control operation, calibration and unit operation. Instruction shall include but not limited to the following, user must be able to access all menus, change setpoints and ratios, acknowledge alarms and maintenance time reminders, access one panel from another, and follow program flow charts. This is in addition to Section 23 05 00 requirements.

.2 The training session shall not be part of the system commissioning.

.3 Submit training program to Consultants four weeks prior to substantial completion for their review and comments.

.4 At the end of all the training sessions, obtain training completion form from Owner and submit report to Consultants.

1.8 Warranty

.1 On completion of mechanical system installation, Controls Contractor shall warranty complete control system as specified from defective material and workmanship for a period of one year.

.2 In addition to the service required for call-backs, the Controls Contractor shall provide four complete inspections, consisting of a minimum of one 8 hour/day times four seasonal visits and as required for post occupancy adjustments. One in each session to adjust the controls as required with written reports submitted to the Engineer. Provide notification of when inspections are to be done.

.3 Check and recalibrate all thermostats, sensors, damper and valve stroke and transducers at final year end inspection.

1.9 System Activation

.1 Submit control calibration check sheets. Check sheets to include unit identification, DDC panel tag number, controlled point tag number, sensed point tag number, actuator controlled setpoint, ratio, reset settings, interlock devices (i.e., limiting relays) and respective settings.

.2 Provide attendance as required by Balancing and Commissioning Agents to set damper linkages; adjust to and set variable volume control and tracking devices and static pressure controls. Verify outdoor air flow rate at eight damper positions to ensure damper position corresponds to flow rate. Control calibrate algorithm to match air flow and damper position.

.3 Adjust and calibrate all room sensors. Confirm proper operation of all terminal box and radiation valve control and sequencing.

Part 2 Products

2.1 General

.1 Provide control systems consisting of operator's devices, indicating devices, interface equipment and other apparatus required to operate mechanical system and to perform functions specified. Identify all components in field by plastic nameplate, and/or non-rip point baggage tags.

.2 Provide materials and field work necessary to connect control components factory supplied as part of packaged equipment.

.3 Unless specified otherwise, provide fully proportional components.

.4 Provide labelled terminal strip connection in each unit and panel connection to external controls.

2.2 Electrical Components, Wiring and Conduit

.1 Wiring and Conduit:

- .1 By Electrical Trade:
  - .1 All power supply wiring to mechanical equipment.
  - .2 All power supply wiring and conduit to main control panels.
  - .3 All smoke detectors and wiring associated with life safety shut-down and start-up of air handling systems.
- .2 By Mechanical Trade:
  - .1 All control system low voltage wiring.
  - .2 Conduits for control wiring and components associated with the mechanical work. All low and line voltage control wiring shall be in EMT conduit in accordance with Electrical specifications.
  - .3 All low and line voltage control wiring and conduit for specified motor interlocks.
  - .4 Power wiring from electrical panel to control transformers distributed round the building.

.2 Components

- .1 By Electrical Trade:
  - .1 All disconnect switches except as specified in Mechanical Equipment Schedules.
  - .2 All motor protection switches, magnetic starters and contactors.
  - .3 All line voltage relays to power and control mechanical equipment.
  - .4 All wiring to and from variable speed drives supplied by mechanical trade.

.2 By Mechanical Trade:

.1 All temperature control systems components and packaged equipment controls, relays and transformers.

.2 All disconnect switches, relays, transformers as specified in Mechanical Equipment Schedules.

.3 All thermostats, dampers, damper motors, timer clocks and control panels.

.4 All low voltage transformers to power mechanical equipment controls.

.5 All power wiring (120 V/1 Ph) to controls transformers, control panels and control devices requiring 120 V/1 Ph power wiring (infrared flush meters etc.)

.3 Minimum Wiring Requirements:

.1 All exposed wiring and wiring located above removable, acoustic ceiling tiles shall be run in plenum rated, 18 gauge, two wire, twisted, shielded pair. Two wire twisted pair shall be acceptable for sensor wiring or output; coaxial cable shall be acceptable for transmission wiring. Plenum rated wiring not in EMT conduit shall be run neatly bunched in J-hooks in a rectilinear fashion, running parallel to building. Cable lines must be run at least 12" (300 mm) above ceiling. Where controls cables and wiring is run through, or in "exposed ceilings", all wiring and cables shall be run in conduit. Where permission has been gained to run in a cable tray, only then can conduit be deleted, except for branches from the cable and individual run-outs.

.2 Alternating current wiring over 24 V, both line and low voltage, shall not be run in the same conduit or cable with direct current signals. Direct current signals include communications wiring, analog input wiring, digital input wiring and analog output wiring. 24 V AC and 0-10 V DC may be run together.

.3 Low voltage direct curring wiring shall be 2-wire shielded, twisted pair, minimum 18 gauge.

.4 Line voltage alternating current wiring shall be copper conductor, minimum 16 gauge.

.5 Low voltage alternating current wiring shall be copper conductor, minimum 18 gauge.

.6 Under no circumstances shall the Mechanical Controls Trade run controls cabling or wiring in the Electrical cable tray system without prior written permission from the Electrical Consultant and the Electrical Contractor. Unless otherwise agreed or directed, all control cabling and wiring shall be run independently in conduits and/or separate raceways to be provided by the Controls Trade for their own use.

2.3 Controllers

.1 The standalone digital control panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors capable of operating independently of other controllers in the network. All unitary controllers, air handling unit controllers and VAV controllers shall operate as stand alone controllers.

.2 Each standalone panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supply and input/output modules. All plug-in printed circuit boards shall allow flexibility in application and rapid repair. All wiring within the standalone panels shall be labelled and run in raceway to accommodate servicing. The control panel shall contain a battery backed real time clock synchronized with other real time clocks in the network.

.3 Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard 587-1980.

.4 Analog to digital and digital to analog conversions shall have a minimum of 12 bit resolution.

.5 All input points shall be universal in nature, allowing their individual function definition to be assigned through the application software. All unused input points must be available as universally definable at the discretion of the Owner. If the input points are not fully universal in nature, unused points must be equal in quantity between analog inputs and digital inputs.

.6 Allow 10% minimum 10% spare capacity in each DDC 'Building Controller', and 'Application Specific Controllers' control panels for all point types.

.7 All control sequences programmed into the standalone digital controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the stand alone digital controller memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database.

.8 Any mechanical equipment which is required to operate on emergency power shall be controlled by a controller that is supplied by emergency power circuit connected to backed up generator and UPS power. The UPS power shall be provided by the Controls Contractor unless specifically noted otherwise in Electrical documentation. The DDC system shall monitor the generator and transfer switch so that appropriate action can be taken to the DDC system in the event of emergency power operation. Allow for all Electrical equipment.

.9 All sensing inputs shall be provided via the following industry standards:

- .1 0 to 10 VDC
- .2 4 to 20 mA.
- .3 Resistance signals (1000 ohms, 10k Thermistor – nickel or platinum RTD's).
- .4 Binary inputs shall be provided with filtering to eliminate false signals resulting from input bouncing.
- .5 Counter inputs shall monitor dry contact pulses with an input resolution of 1 Hz minimum.

.10 Digital outputs shall provide SPDT output contracts and be capable of directly switching the following voltages:

- .1 24 VAC at 36 VA operating/360 VA inrush.
- .2 102 VAC at 180 VA operating/1800 VA inrush.
- .3 240 VAC at 180 VA operation/1800 VA inrush.

.11 Digital outputs shall be optically isolated from the controller's electronic circuit.

.12 Control panel diagnostics shall consist of built-in, continuous operational and board level tests, software control sequence analysis and alarm exception logging. Light emitting diodes and/or the alphanumeric display shall annunciate hardware failures and control program errors or problems.

.13 Provide one individual standalone control panel for every mechanical system. Where mechanical equipment items provide system redundancy, failure of the panel shall not result in failure of control of multiple mechanical equipment items.

.14 The standalone control panels shall interface to additional panels of equipment as required to meet the performance specification. Each standalone panel shall be provided with an interface port for the hand held operator's terminal.

.15 Any remote panel malfunction shall not affect the proper operation of the system or other remote panels.

.16 All stand-alone control panels shall give full access to programming while communicating from a remote location (over the Internet/Intranet).

2.4 Field Control Devices

.1 Temperature Sensors:

.1 Shall be resistance type and shall be either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD or 10K thermister type. Sensor shall have service tool communicating jack for interface with laptop computer service tool for adjustment and troubleshooting.

.2 Shall be available for room, duct, outside or well mounting with proper ranges to suit application.

.3 Shall give an end-to-end accuracy of not less that ±32.45°F (±0.25°C).

.4 All room sensors shall be surface mount and complete with integral LCD display (room temperature, setpoint temperature, occupancy mode and fan status where override is specified), ±37.4°F (±3°C) setpoint adjustment and occupancy mode override push button and service tool communication jack for interface with laptop computer or service tool for adjustment and troubleshooting.

.5 Outdoor air sensor shall be provided with solar shields and perforated plate to minimize solar and wind effects and transmitter shall be NEMA 3R construction.

.6 Duct sensors shall be in insertion type complete with locking nut and mounting plate. Mounting box shall be weatherproof for all outdoor applications. Where duct dimension is greater than 48" (1,200 mm) averaging sensors complete with capillary support shall be used.

.7 Immersion wells shall be of stainless steel materials for domestic water systems and brass for other applications. Heat transfer compound shall be compatible with sensor. Sensor to be spring loaded construction with compression fitting for (20 mm) stainless steel sheathed construction.

.8 HVAC Dual-Temp analogue temperature gauge and electrical temperature well: in lieu of providing separate analogue pipe temperature gauges thermowells and DDC pipe temperature thermowells, the controls contractor shall supply Wika brand dual-temp thermometer/transmitter, Model TR40/TW15 complete with TI.52 dial gauge. Supplier contact: JB5A, 604-590-8866, www.wika.ca

.2 Motor Current Sensors:

.1 Shall have linear output proportional to the motor current draw.

.2 Sensor shall connect to the controller by means of a 2-wire cable.

.3 Sensor shall have dual HI/LO range selector.

.4 Sensor shall have an accuracy of 1% of full scale, maximum response time of 100 milliseconds and a loading error not greater than .25% with a 1 megaohm load.

.3 Differential Pressure Sensors:

.1 Shall vary the output voltage with changes in differential pressure.

.2 Shall connect to the controller by means of a 2-wire cable.

.3 Shall have an end-to-end accuracy of not less than ±1% of span including non-linearity and hysteresis.

.4 Static Pressure Sensors Shall:

.1 Vary the output voltage with changes in static pressure.

.2 Connect to the controller by means of a 2-wire cable.

.3 Have an end-to-end accuracy of not less than ±1% of span including non-linearity and hysteresis.

.5 Humidity Sensors Shall:

.1 Be equipped with non-interactive span and zero adjustment complete with 2-wire isolated loop powered 4-20 mA 0-100% linear proportional output. Sensing probe shall be constructed of Type 304 stainless steel.

.2 Have a control range of 20% to 80%.

.3 Have an accuracy of plus or minus 3% RH over an ambient temperature range of 70°F (21°C) to 80.6°F (27°C).

.6 Airflow Measuring Stations Shall:

.1 Vary the output voltage with changes in supply and return airflow. The airflow traverse probe, which shall be capable of producing steady non-pulsating signals, consists of multiple total and static pressure sensors placed at equal distances as per ASHRAE Standards for duct traversing.

.2 Connect to the controller by means of a 2-wire cable.

.3 Have end-to-end accuracy for variable volume control of not less than ±0.05% of the airflow.

.4 Acceptable Manufacturers: Air Monitor Corp., Tek-Air Systems Inc., Ebtron Gold Series - G7x116 P+, or Ebtron Elf for ≤ 14" (350 mm) Ø ducts.

.7 Room Occupancy Sensors – Wattstopper C1-12, C1-24 Passive Infrared HVAC/BAS Ceiling Sensor or Equal

.1 12 VDC or 24 VAC/VDC supply power, UL/ULC listed.

.2 Complete with five (5) year warranty, dual element, temperature compensated pyro-electric sensor.

.3 Complete with time delay adjustment 30 seconds to 30 minutes.

2.5 Line Filters

.1 The line filter shall be rated at 3A, 250 VAC, 50/60 Hz and shall be capable of filtering out electromagnetic interference.

2.6 Control Valves

.1 Provide valves in accordance with general valve specification with maximum 3 psi (21 kPa) pressure drop.

.2 Valves shall "fail-safe", spring return to normal position. 2-way and 3-way valves for liquids shall have either equal percentage or linear characteristics. Size 2-way valve operators to close against maximum pump shutoff head. Control valve coefficient shall be determined with the valve in the 100% open position. Control valves using a limited stroke to create the required flow coefficient shall not be acceptable.

.3 All control valves shall be threaded type. All valve bodies shall have a replaceable packing gland.

.4 Control valves shall be globe type with modulating electronic actuator. Actuators for valves on larger coils in air handlers shall have spring return to normal position. 2-way and 3-way valves for liquids shall have equal percentage characteristic. Maximum shut off head leakage shall not exceed 1% of full design flow.

.1 Acceptable Product: Griswold Automizer, Belimo CCV Characterized Control Valve.

2.7 Pressure Independent Control Valves (PIV's)

.1 Provide valves in accordance with general valve specification with maximum 3 psi (20 kPa) pressure drop.

.2 Valves shall 'fail-safe', spring return to normal position. 2-way and 3-way valves for liquids shall have either equal percentage or linear characteristics. Size 2-way valve operators to close against maximum pump shutoff head. Control valve coefficient shall be determined with the valve in the 100% open position. Control valves using a limited stroke to create the required flow coefficient shall not be acceptable.

.3 All control valves shall be threaded type. All valve bodies shall have a replaceable packing gland.

.4 Control valves shall be pressure independent against a differential pressure of 5-50PSI with modulating electronic actuator.

.5 Acceptable product: Belimo PICV, Griswold PICV and Tour and Anderson PICV

2.8 Dampers

.1 Automatic dampers shall be 14 ga (1.63 mm) extruded aluminum multiple blade mounted to 4" (100 mm) extruded aluminum flanged frame. Frame shall be installed with polystyrene on all four sides. Frame seals shall be of extruded TPE. Individual blades shall be internally insulated thermally broken extruded aluminum not exceeding 8" (200 mm) in width or in length with interlocking edges and compressible seals. Blade gaskets shall be of extruded EPDM. Provide oil impregnated bronze or nylon bearings with additional thrust bearings for vertical blades. Dampers exposed to outside air or used as exterior isolation dampers shall be AMCA rated for leakage less than 4 cfm per ft2 (21 l/s per m2) against 4" w.g. (1,000 Pa) static pressure differential. Dampers exposed to outside air or used as exterior isolation dampers shall be equal to TAMCO Series 9000. Dampers for return or recirculating air shall be AMCA rated for leakage less than 10.3 cfm per ft2 (52 l/s per m2) against 4" w.g. (1,000 Pa) static pressure differential. Dampers shall be equal to TAMCO Series 1000.

.2 Mixing dampers of parallel blade construction arranged to mix streams.

.3 Dampers have less than ½% leakage and be equal to Ruskin CD-36.

2.9 Damper Operators

.1 Piston or gear driving type damper operators with spring return to "fail-safe" in normally open or normally closed position. Non-mechanical forms of fail-safe operation are not acceptable.

.2 Damper actuators shall be electronic direct-coupled over the shaft. Actuators shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator. Mechanical end switches and magnetic clutches are not acceptable.

.3 Proportional actuators shall accept a 0-10 VDC or 0-20 mA control input signals and shall provide a 2-10 VDC or 4-20 mA position feedback signals. Pulse width modulating control is acceptable.

.4 All modulating actuators shall have an external built-in switch to allow the reversing of direction of rotation.

2.10 Variable Air Volume Terminal Unit Digital Controllers

.1 Digital controllers shall be configurable, standalone, networked direct digital controllers consisting of a microprocessor, power supply, actuator, integral dead-ended differential pressure transducer and operation/application system software in a single integrated package complete with manual positioning. The digital controllers shall utilize proportional plus integration algorithm for the space temperature control drops.

.2 Digital controllers shall comply with ASHRAE Standard 90.1 and shall include compliant interface for ASHRAE Standards 62.1 -2007.

2.11 Special Gas Monitoring System

.1 CO/Propane/Gasoline Sensors:

.1 General: Dual channel, self-contained gas detection system for the monitoring of carbon monoxide and propane/gasoline vapours, housed in a wall mount, drip-proof PVC enclosure with hinged, secured door. System power shall be 24 VDC or 24 VAC (nominal). A CSA certified, totally enclosed step down transformer shall be supplied as required to reduce voltage from 120 V.

.2 Sensors: The system shall have one integral electrochemical CO sensor and one remote analog transmitter with a solid-state combustible gas sensor. The measurement range shall be 0 – 200 ppm CO in air and 0-50% LEL C3H8 (Propane) in air. Area of monitoring coverage is up to 5,000 ft2 (464.51 m2) to 7,000 ft2 (650 m2) per sensor.

.3 Monitors: The monitor shall provide a tri-colour indicating light for power, low alarm, high alarm and fault condition, audible alarm with silence push-button and two SPDT dry contact alarm relays rated 5 amps at 240 VAC each. There shall be a LED digital display of concentration. The system must meet WCB workplace hazardous gas exposure standards. System controller shall be capable of supporting up to 128 digital transmitters on a RS-485 communication bus. System shall support analog output modules (eight 4-20 mA outputs per module) and relay output modules (eight 5 A SPDT relays per digital network (two low voltage power wires and a twisted pair for the communication bus). System power requirement is 100 to 240 VAC, 47 to 63 Hz. The controller shall provide a circuit test button to allow the user to confirm system operation and exhaust fan control from the panel. The controller shall also provide a push-button to allow the user to override the system control and operate exhaust fans continuously for 15-minute segments to evacuate air from specific parts of the building. The controller shall automatically test the electrochemical CO sensor failure. The controller shall provide automatic “calibration due” notification to the end user. Connect to DDC system to provide alarms.

.4 System Operation: System relays are normally energized in non-gas-alarm state so they act in fail-safe operation. Upon detection of 25 ppm CO in air or 10% LEL C3H8, the system shall illuminate the Low alarm LED and any relays programmed to respond to low gas alarm shall de-energize activating single-speed exhaust fans or low speed of 2-speed exhaust fans plus makeup air fans. Upon detection of 75 ppm CO in air or 20% LEL C3H8, the system shall illuminate the high alarm LED, the system audible alarm will be activated and any relays programmed to respond to high gas alarm shall de-energize activating high speed of 2-speed exhaust fans or remote alarm devices. Audible alarm can be silenced from the from panel push button. In the event of a fail condition, the system audible alarm shall be activated and the fail LED on the front panel shall flash red.

.2 Provide QEL Model QTS-2000 CSA approved carbon dioxide gas monitoring system with remote solid state carbon dioxide sensors. The system shall consist of a central control monitor panel in a wall mount NEMA 12 enclosure with slide-out control modules and corresponding remote mount solid-state sensors completely with protective guard.

.1 Acceptable Products: QEL, Armstrong Monitoring Corp.

.3 Monitoring Panel:

.1 Panel shall be complete with:

.2 Dual alarm trip points.

.3 Relays for alarm actuation and control of ventilation fans and auxiliary alarms.

.4 Indicating light for power on, low/high alarms of failure and an audible alarm with silence button.

.5 Manual test capability by push button.

.6 Alarms shall have adjustable time delay from five to ten minutes before activation.

.7 Alarms shall have dead band to ensure CO, NO2, O2 or gas levels have dropped below trip point before auto reset.

.8 Units shall operate on 120 volt AC power supply.

.4 The remote sensor shall receive power from the control monitor panel and send:

.1 4-20 mA signal corresponding to 0-500 ppm CO with an accuracy of 5 ppm,

.2 4-20 mA signal corresponding to 0-2500 ppm CO2 to the control panel; and,

.3 4-20 mA signal corresponding to 0-5 ppm NO2 to the control panel.

.5 The control panel shall provide status LED display and two levels of alarm for each sensor with the following alarms:

.1 Low Carbon Monoxide Alarm set at 25 ppm CO.

.2 Low Nitrogen Dioxide Alarm set at 0.7 ppm NO2.

.3 High Carbon Monoxide Alarm set at 100 ppm CO.

.4 High Nitrogen Dioxide Alarm set at 1.0 ppm NO2.

.5 High Carbon Dioxide Alarm set at **1000** ppm CO2

.6 The alarm signals shall activate the following relays to:

.1 Energize exhaust fans when low CO, and low NO2 alarms occur.

.2 Energize exhaust fans and audible alarm when high CO, and high NO2 alarms occur.

.7 The system shall energize the exhaust fans on sensing loss of signal from sensor and/or under range signal from the fail relay.

.8 Sensors shall be warrantied for two years and sensor life shall be three years.

.9 Install system in complete accord with Manufacturer's recommendations.

2.12 Energy Meters

.1 BTU meters shall be tamper-proof and equal to ISTA Energy meter complete with building DDC system interface for monitoring heating and or cooling consumption. The system shall consist of temperature sensors, flowmeters and electronic calculating unit. System shall be rated for 3 VDC with power convertors connected to 24 VAC. Battery shall be rated for a minimum operating life of six years. Provide individual meter analogue output and trending for rach meter

  .1 Acceptable Products: Badger Meter, Kamstrup, Danfoss, Onicon.

.2 Temperature sensing thermal element shall be made out of platinum for fast response time with resistance at 500 ohms at 32°F (0°C) and 700 ohms at 212°F (100°C).

.3 Flow meters shall be multi-wing turbine type with pulse output and rate for 250 psi (1,720 kPa) at 205°F (96°C), with a minimum accuracy requirement of ±1.0% at low end of flow range.

.4 Electronic calculating units shall be solid state fluid density compensated calculation module, complete with non-resettable LCD display and stepping switch for flow, temperature, kW and kWh readings.

.5 Energy meters shall be calibrated and commissioned in accordance with the Government of Canada Weights and Measures Requirements, and comply with EU Standard EN1434.

.6 Energy Dashboard

  .1 Compare generation and consumption for electrical, gas, and water resources.
  .2 Instantly translate energy and water use into dollars and CO2 emissions and savings.
  .3 Showcase building green features alongside real-time resource use data.
  .4 Show real-time weather conditions.
  .5 Display introductory or explanatory text and Client/Owner logo welcoming visitors to the dashboard.
  .6 Display photographs pertaining to the building featured in the dashboard.
  .7 Automatically and randomly transition between photographs at specified intervals, ensuring that the dashboard is constantly changing during every visit.
  .8 Compare current consumption with past consumption on the same screen.
  .9 Display 50 automatically rotating, randomly displayed green "tips" (with an input from the Owner). Green "tips" will be short, to-the-point messages accompanied by a large image relevant to the featured "tip". Green "tips" will focus primarily on the building related resource use, but will also include references to land, transportation, and waste related environmental concerns.
  .10 Showcase building and building's green features via the dashboard.
  .11 Enable users to select features from intuitive thumbnail-based menu screen, or display features by automatic rotation.

2.13 Alarm Annunciator

.1 Provide alarm panel with ~~individual~~ one indication and horn (that direct the operator to the DDC alarm screen), silence acknowledge switch and test switch. Alarm panel to be hardware in addition to software alarms as specified in this section. At alarm condition indicator light shall flash and alarm sound. Depressing acknowledge switch shall stop horn, but alarm condition indicated by continuous light until trouble condition cleared. Should second alarm occur before first has cleared, sound alarm again.

.2 Locate panels in locations as described below to serve duplicate functions of primary alarms:

- .1 Building Managers Office

.3 Provide alarm points complete with required initiating equipment for signalling to alarm panel for the following conditions:

- .1 No water (glycol) flow.
- .2 Low air temperature.
- .3 Boiler failure (common point for multiple boilers).
- .4 Heat Pump failure (common point for multiple boilers).
- .5 Low heating water (glycol) temperature.
- .6 Expansion tank low level/low pressure/high pressure.
- .7 No flow on air systems (air heating systems).
- .8 Off normal temperature.
- .9 Alarm points indicated in 25 90 02 points list

.4 Provide dry contacts for common alarm initiating point for use by others.

.5 Alarm panel wiring shall be in tray or neatly placed and securely fastened.

2.14 Carbon Dioxide Monitoring and Detection System for Indoor Air Quality (ISO-9002 Certified Sensors)

.1 Provide UL and CSA labelled Vulcan VA-201T series Model 90DM3 infrared cell type carbon dioxide transmitter with LCD Display and connected to DDC system. Provide one sensor per VAV control box (where required by the sequence of operations) and supply air modulating control damper **with final installation location to be established at time of construction.** Allow for connection of sensor to DDC system architecture and provide 24 volt transformer and low voltage wiring from nearest VAV or fan coil unit electrical junction box.

.2 The remote sensor shall receive 24 volt power and send 4-20 mA signal corresponding to 0-2000 ppm CO_2 to the DDC system.

.3 Sensor shall be warrantied for five years.

.4 Install system in complete accord with Manufacturer's recommendations. Manufacturer's agent shall provide complete commissioning of sensors.

Part 3 Facilities Management System (DDC System)

3.1 General Description

.1 The facilities management system shall be comprised of a distributed control network of independent standalone digital controllers (DDC) interconnected in a communicating network to provide facility wide access and sharing of information.

.2 The distributed network shall be a modular design. Network expansion shall be accomplished by adding standalone control modules to the network.

.3 A local area network (LAN) shall be provided for high-speed data transmission.

.4 At each building entry and exit point, the wire communications trunk wiring shall be protected with a transient surge protection device. Transient surge protection is not necessary if the communication trunk, external to the building, is fibre optic in nature.

3.2 Communications

.1 The local area network (LAN) shall be a peer-to-peer, token passing network, utilizing packetized transmissions, error checking and distributed error recovery. Single or multiple standalone control panel failures shall not cause loss of communication between active control panels connected on the LAN. Full communications shall be sustained as long there are at least two operational standalone control panels active on the LAN.

.2 Each LAN-connected control panel shall be equipped with a communications watchdog to automatically shut-down the control panel in the event that it is monopolizing communications. Removal of a control panel from the LAN shall be annunciated and logged to as an exception report. Error recovery and communication initialization routines shall be resident in each connected device.

.3 The primary local area network shall be capable of operating at data transmission rates greater than 10MB Ethernet between primary mechanical system controller and the operator interfaces. Unitary controllers may run on RS 485 or MS/TP network.

.4 Network communications with video display terminals, host computers, printers and auto-answer/auto-dial telephone shall be provided through a RS-232C standard interface port.

3.3 Software

.1 Provide standalone panel containing a complete software development system. The software development system shall consist of a graphical programming language containing complete libraries of control algorithms for DDC, Energy Management and Facilities Management functions. These resident libraries of algorithms shall be drawn from for the creation of the application programming of each individual standalone control panel. The programming environment shall provide context-sensitive help menus and instructions for all operations and applications.

.2 Multi-level user access shall be provided with user access codes available at each level.

.3 Point names shall be defined using alphanumeric characters expandable to 32 characters to provide an English language description to the point function.

.4 All point names shall be acceptable to the operating personnel.

.5 The stand along control panel shall be capable of generating sorted alarm, trend log, energy management, maintenance time reminder and exception log reports on a prioritized basis. Segregated report generation shall be invoked by manual request, time of day, calendar, and accumulated run time or event occurrence.

.6 Provide enough data storage and memory capacity in the operator workstation to accommodate a minimum of 1 year worth of trend logs for all rooms, main HVAC plant equipment and special points as listed in the sequence of operation or as listed in 25 90 02 points list.

3.4 Operator Interface

.1 The minimum requirements for the PC computer are as follows:

.1 Computer shall be minimum Intel I5 Core processor with 4 GB RAM.

.2 22" (560 mm) v.i.s. LCD screen.

.3 Full 105 key keyboard complete with numeric keypad and optical mouse.

.4 R/W DVD Drive.

.5 16-bit Sound Card and Speakers.

.6 One 1,000 GB Hard Drive.

.7 Wireless LAN

.2 Alternatively access to the BAS could be provided by a hosted software service (in lieu of locally resident software)

3.5 Hard Copy Printer

.1 The minimum requirements for the hard copy printer are as follows:

.1 Equal to Hewlett Packard color capable Inkjet complete with USB and network capabilities capable of 30 pages.

3.6 DDC Control

.1 The network of standalone control panels shall individually perform setpoint reset, ramping functions, 2-position ON/OFF control, PID loop control, linear sequencing, rotating sequencing, binary sequencing, HI/LO/AVE selection, energy dead band and thermostat controls as required to control their connected systems of equipment.

3.7 Energy Management Control

.1 The network of standalone control panels shall individually perform time of day scheduling, optimum start/stop, enthalpy optimization and all control optimization strategies, such as supply air reset and soft start ramp-up, for their connected systems of equipment.

.2 Coordination of strategies involving multiple systems of equipment shall be performed by sharing of necessary data between the stand alone control panels on the communicating network.

3.8 Facilities Management Control

.1 The Owner shall be provided the ability to read-out temperature and other values and to adjust specific items from localized, as well as remote centralized location.

.2 Maintenance time reminders based on totalized run time, calendar date, exception occurrence or manual request.

.3 Facility Diagnostics: The facilities management system shall provide diagnostic reports of the following types, for specific systems of equipment as specified:

.1 Alarm Occurrence Status: When specified alarm conditions occur, provide a report printout listing the status of specific items associated with the equipment generating the alarm. Report shall be routed to a specific printer or combination of printers. Report shall record the time the status information was taken and shall allow operational personnel to use this information to diagnose the alarm situation.

.2 Alarm Occurrence Development Report: For specific systems of equipment the facilities management system shall record a continuous log of the values of selected variables. Upon occurrence of an alarm, or some specific combination of performance conditions, the report will be printed, showing the status of each of these variables for each of the 15 minutes immediately prior to the occurrence of the triggering condition.

.4 Telecommunications Support

.1 The entire facilities management system network shall be able to share one or multiple auto-dial/auto-answer modems for automatic dial out reporting of alarms, exception and report information via the dial up telephone network.

.2 Provide and implement an auto-dial/auto-answer modem in the system of control panels for purposes of remote diagnostics and notification of desired exceptions and alarms. Dial-up telephone line shall be provided by the Owner. Modem shall provide for the following functions:

.1 Access to the entire facility control system by the Contractor to provide service and diagnostic support.

.2 Access by the Owner from off-site for similar purposes and for remote operation, monitoring and adjustment of facility functions.

.3 Auto-dial-out of desired exceptions to a remote site, or to an Owner-specified set of phone numbers for business-hours or off-hours reporting.

3.9 Distributed Access

.1 The Owner shall be provided with facilities management system information through the following methods:

.1 Simultaneous multi-user operation.

.2 Distributed access – at every control panel.

.3 Distributed documentation.

.4 Historical documentation logging-printer or disk for exceptions.

.5 Facility-wide access-LAN connected standalone control panels.

.6 Facility operation documentation.

.7 Overrides logging.

.8 System log-in documentation.

.9 System database modification documentation.

.10 Local historical alarm documentation.

3.10 DDC Database Upload/Download

.1 The system shall have the capability of uploading and downloading the entire facilities Management System database on the system hard drive. This shall be accomplished via direct connection or a modem link.

.2 The information shall be easily uploaded to the controllers in the event of a catastrophic memory failure. Database uploads shall be easily accomplished through menu selections and shall NOT require the operator to understand this system's operating system.

.3 Downloading of database information shall be accomplished in the same manner as a database upload.

.4 Monitor: Point values, current status, time schedules and any other definable point attribute such as setpoint, throttling range, etc. shall be accessible and displayable on the CRT.

.5 Change: Current states, setpoint and any other definable point attribute shall be accessible and have the capability of being changed using the computer keyboard.

.6 Provide a historian software and enough storage media to accommodate up to 1000 trend logs of at least 2 weeks duration.

3.11 Override

.1 Setting: Current states and setpoints shall have the capability of being overridden for a certain user defined time periods by a user with the correct access level. The override period shall be user selectable to start/stop at any time up to one year in advance. The user shall have the ability to program multiple overrides for the same or different zones or points. Overrides shall be verified (in real time) and read back to the user to positive confirmation of the setting.

.2 Call-back: The user shall have the option of entering a telephone number for each individual override where the system can call to confirm the expiration of the override. This feature shall allow the user the option of extending the override interval without interruption of equipment operation or comfort levels.

3.12 Graphics Software

.1 The system shall be provided with a complete user-friendly graphics interface system for each mechanical unit on DDC control. Provide Owner with one registered copy of the graphics software.

.2 The Colour CRT Library: Shall contain Contractor prepared, dynamically updated displays for each schematic and each control systems' program flowchart included in the point schedule. A library of standard symbols shall be included with the following as a minimum:

Heat Pump	Pump	Boiler
CO2 Sensor	2-way control valve	3-way control valve
Damper	Check Valve	Motor
Fan	Coil	Filter
Damper motor	Pipe	Duct
Switch	Sensor	Air measuring device
Air quality sensor	Average duct sensor	Temperature sensor

.3 Dynamic Updating: Online data displayed as an integral part of a schematic shall be updated not less than every five seconds with the exception of alarm/'change of state information, which shall be updated upon its receipt at the operator's terminal. Critical alarms shall be annunciated at the operator's terminal with both an audible alarm and a "pop-up" graphical display which interrupts the current operation.

.4 Information Screen Display: Individual schematics and control, program flowcharts shall include where applicable:

.1 Status of monitored and controlled on/off points.

.2 Current value of analog input.

.3 Current value of the setpoint and the DDC output for each control loop.

.4 Identification for each point.

.5 Current state of each control loop (computer auto/computer manual).

.6 Schematic and systems identification.

.7 Alarm/normal indication.

.8 Point alarm lock-out status.

.9 Equipment symbolic information (pump, fan, etc.).

.10 All points pertinent to one system shall be show on one screen.

.11 Symbols shall have the ability to change colour depending on the status.

.5 Online Directory: A directory of schematics and symbols shall be available to the operator.

.6 Trending: Shall be provided to collect and store samples of the value of a point (i.e., temperature). The operator shall be able to create up to 250 trend logs containing up to 4 points. The sample frequency shall be selectable for each trend log between 15 seconds and 99 hours. The ability to graphically display up to 8 points on the screen simultaneously, print a log or store on disk in an ASCII format that can be imported into a standard spreadsheet program shall be provided. The ability to indefinitely retain the contents of a trend log in the controller or automatically transfer the contents of a trend log to a disk storage or printer shall be provided.

.7 Command from Graphic: Shall be provided to directly issue commands to a point identified by a mouse on the graphics screen.

.8 Provide interface with City water meter to DDC system for water flow measurement.

Part 4 Web-based Operator Interface

4.1 It is the desire of the Owner to achieve seamless integration with selected building system and subsystems on a TCP/IP high speed bandwidth network which must be able to receive BACnet information from the control system BACnet server. IN this regard it will be the responsibility of the Mechanical Controls Contractor to include all needed equipment, material, software, installation and programming, start-up and debugging labour for a fully functioning DDC acting as the integrating head end with the following minimum functions and capabilities as part of the base tender price.

4.2 For building operator interface, the DDC shall provide a web-based graphical interface that allows operator access to the DDC date via the Internet, Extranet or Intranet. The interface shall use the HTML based ASP pages to send and receive data from the DDC to the browser. Tenant interface (unique to each user) shall be provided through activation of a desktop application dialogue (DAD) residing on the taskbar in the system tray which connects to the web server providing the following features:

.1 Zone temperature and zone setpoint adjustments.

.2 Zone fan coil unit override capability including enabling primary plant (heat pump, pumps, ventilation controls system).

.3 On/off control of lighting in the overridden zone as an expandable option.

.4 Automatic calculation and display of the Tenant's billing amounts which will be charged by the Landlord for implementation of the Tenant's override command. Tenant to be prompted to "Proceed" or "Cancel Request" before implementing override function.

4.3 The web server pages will use the same graphics for the server database. The web server HTML web pages shall not be created separately.

4.4 A separate web server computer will be supplied. The web server shall use Microsoft's IIS server 4.0 with Windows NTS, or IIS 5.0 with Windows 2000 and support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).

4.5 A separate web server computer, similar to the minimum requirements as specified under 3.5 "Central Server" to be provided.

4.6 All information exchanged over the Internet shall be optionally encrypt and secure via SSL.

4.7 Access to the web interface must be password protected. A user's rights and privileges to points and graphics will be the same as those assigned at the DDC workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the DDC workstation.

4.8 Commissioning of the web interface shall not require modifications or creation of HTML or ASP pages. All graphics available at the DDC graphical workstation shall be available to users via a web browser.

4.9 The web-based interface shall provide the following functionality to users, based on their access and privilege rights as a minimum:

.1 Logon Screen: Allows the user to enter their user name, password and domain name for logging into the web server, thus providing fully integrated security access and privileges with DDC workstation.

.2 Alarm Display: A display of current DDC alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the DDC central workstation activity log.

.3 Graphic Display: Display of system graphics available in the DDC workstation will be available for viewing over the web browser. Software that requires creation of "web" graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.

.4 Point Details: Users will have access to point detail information including operational status, operational priority, physical address and alarm limits, for point objects to which they have access rights.

.5 Point Commanding: Users will be able to override and command points they have access to via the web browsers interface. Any commands or override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the DDC central workstation activity log.

4.10 The web server licensing options will allow concurrent use by minimum 100 but expandable to 500 browsers connections.

4.11 Internet connections, IS services, shall be provided by the Owner as required to support the web access feature.

4.12 The TCP/IP Network: It is unknown at this time if the Owner wishes the DDC Web server to reside on their TCP/IP company Internet/Intranet network. Therefore, the Tendering Controls Contractors are to show a separate credit for possible exclusion of the TCP/IP network. In the event that the Owners do provide this network for the Controls Contractors to utilize, it will not absolve this Contractor from assuming full responsibility for achieving systems integration functionality as herein specified:

.1 The TCP/IP network shall include a PC Windows 2000 service complete with PC 600 MHz processor, 512 MB Ram, 300 MB plus of publishing space, all CAT 5 cabling, in all Routers, 3COM or Cisco Hardware Firewall, Network 100 MB + Bandwidth 100 MB Active Hub with expansion capabilities (to handle PCs on system).

.2 No more than 20 Workstation Clients per subnet.

4.13 Capabilities of Integration: Subject to the building systems and subsystems and equipment selected by the Owner, it will be possible as a minimum for the integrated DDC system to establish (locally or remotely via the web) Lighting Schedules, execute on/off lighting control, or to observe lighting status. Security access system will be able to exercise zone lighting or HVAC equipment run times by simply swiping a card. View digital CCTB images of selectable locations. The DDC web interface will be able to create transactional logs for Tenant billing purposes based on equipment run times and usage allocations. Connected to the buildings' energy meter, run utility consumption text and graphical generate reports for direct tenant billings.

4.14 Give the large volume of information integrated systems generated; provide a comprehensive software method of automatically managing the collection, sorting and purge of historical relational systems' information. If this capability is not normally provided within the functionality of the base DDC tender, then provide this capability as part of the standalone PC software subsystem connected to the TCP/IP network.

Part 5 Execution

5.1 General

.1 Check and verify location of exposed control sensors with the drawings and room finish details before installation.

.2 All temperature control and interlock wiring shall be installed in conduit unless otherwise noted on the plans. Power or interlock wiring shall be run in separate conduit from sensor and communications wiring.

.3 Control sensors or thermostats located in public areas, change rooms or washrooms shall be a bland stainless steel cover type. Where noted, thermostats in suites shall have concealed setpoint adjustment without thermometer.

.4 Low limit and freeze protection thermostats shall be hardwired to the fan motor starter. The vapour tension element shall be installed in a serpentine pattern across the complete coil face. For larger coil areas use two thermostats wired in series.

.5 All thermostat bulbs in water lines shall be installed in separable wells, packed with heat conductive compound.

.6 Install damper motors on the outside of the ducts. Do not install motors in the outside air stream.

.7 Install line filters on all DDC control panel power supplies.

.8 Provide a standalone DDC controller for each mechanical system (each air handling unit, boiler system, etc.).

END OF SECTION

Part 1 General

1.1 Related Work

.1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 Definitions and Abbreviations

.1 The following are abbreviations used throughout the section defining computerized control systems specified herein or defined on plans:

.1 BAS Building Automation System

.2 SAP Stand Alone Panel – generic term that applies to BC, AAC, ASC

.3 DI Digital Input

.4 DO Digital Output

.5 AI Analog Input

.6 AO Analog Output

.7 HVAC Heating, Ventilation, Air Conditioning

.8 MCC Motor Control Centre

.9 DDC Direct Digital Control

.10 LAN Local Area Network

.11 OS Operating System

.12 OT Operating Terminal

.13 PC Personal Computer

.14 OWS BACnet Operator Work Station – same as B-OWS

.15 Native Native BACnet

.16 BC BACnet Building Controller – same as B-BC

.17 AAC BACnet Custom Application Controller – same as B-AAC

.18 ASC BACnet Application Specific Controller – same as B-ASC

.19 SS BACnet Smart Sensor – same as B-SSEthernet – BACnet TCP/IP Ethernet

.20 MS/TP BACnet Master-Slave/Token Passing

.21 PTP BACnet Point-to Point Protocol

.22 Gateway BACnet Gateway

.23 Micropanel Generic term that applies to AAC and ASC

1.3 References

.1 Canadian Standards Association – CSA C22.2no.205-M1983, Signal Equipment.

.2 Institute of Electrical and Electronic Engineers – IEEE 472, IEEE 587.

.3 National Institute of Standards and Technology – NISTIR 6392 GSA Guide to Specifying Interoperable Building Automation and Control Systems Using ANSI/ASHRAE Standard 135-1995, BACnet.

.4 Native BACnet – Native BACnet means that no translation software will be used internal to the OWS, BC, AAC, and ASC to convert from a proprietary protocol to BACnet Standard Object Types, Standard Application Services and devices. Gateways are not native BACnet.

.5 BACnet Gateways.

1.4 Scope of Work

.1 Supply, installation and mounting of all hardware (unless specifically stated otherwise).

.2 Supply and mounting of sensor elements and associated hardware, wiring or piping connecting sensors to SAPs.

.3 Wiring connecting to SAPs to transducers, fire alarm and smoke control.

.4 Supply and wiring connection of solid state relays and relays to terminal connections at MCCs and to SAPs.

.5 Supply and installation of SA's comprising of BC's, AAC's, and ASC's.

.6 The Controls Sub-Contractor will do the complete installation of all sensors, associated control panels, relays, transducers, actuators, flow switches, gauges, air receivers, SAP computer board, associated power supplies, conduit, wiring, tubing, and all other control devices including isolation room panels, and all terminations.

.7 The Controls Sub-Contractor will participate and provide coordination required between the Client, the Consultant, and other Sub-Contractors where controls are involved and the Commissioning Agent.

.8 The Controls Sub-Contractor will provide verification and commissioning as follows:

  .1 End to end continuity checks will be performed on all wiring and control tubing.

  .2 All sensors, transducers, relays, actuators, control valves and dampers will be calibrated and operationally checked by this Sub-Contractor.

  .3 Provide a point checkout sheet for verification of system. This Sub-Contractor to initial each point as it is verified.

.9 The controls Sub-Contractor will test the SAP computer hardware and operator consoles.

Part 2 Products

2.1 System Description

.1 A complete, fully tested, commissioned and operational Native BACnet Building Automation Systems (BAS) utilizing fully electronic Direct Digital Control (DDC_ to meet the requirements described herein and in complete accordance with applicable codes and ordinances.

.2 Unless specified otherwise, provided proportional plus integral electronic components.

.3 The design, installation, supervision and labour services, calibration, software programming and de-bugging, checkout and commissioning required for the BAS.

.4 Supply and installation of electronic packaged zone controllers for terminal unit control.

.5 Devices, components, wiring and materials as required for a fully operating control system.

.6 Include full graphics operating package with modification of existing site graphics and navigation sequences via customized software programming.

.7 Instruction to the Facility's maintenance and operating personnel.

.8 Complete system documentation including:

.1 As-built site diagrams showing location of wiring and panels and system architecture.

.2 Operating and Maintenance Manuals.

2.2 Cable

.1 Primary Data transmission cable shall be CAT 5 Ethernet cable.

2.3 Electronic Terminal Equipment (AAC) Controllers

.1 Each zone controller will be microprocessor-based, multi-tasking, real-time digital control processor. The zone controllers will monitor space temperature sensors and control operation of terminal air valves, air valve reheat coils, fan coil units, and perimeter radiant panels in the corresponding zone.

.2 Each zone controller will have sufficient memory to support its own operating system and data base including:

.1 Control functions.

.2 Energy management applications.

.3 Interface with operator portable personal computer.

.3 Zone controller panels will have the following features:

.1 Setpoint adjustments

.2 Modify gain and offset constants.

.3 Program parameter adjustments

.4 Trend log displays edit/create trend logs through DDC system main panels.

.4 Zone controllers shall NOT be mounted in ceiling spaces.

2.4 Electronic Air Valve Controls, Sensors and Actuators

.1 Control Sub-Contractor shall include for the supply and installation of pressure sensors, operators and standalone controllers for the air valves.

.2 Control components shall be pre-assembled for testing and performance verification prior to arrival on site.

.3 Multipoint cross flow sensors shall be supplied by air valve Manufacturer.

.4 Flow transducer shall be a full differential pressure unit not hot wire or thermister type.

.5 Electronic operators shall be provided for air valve dampers with piston or gear driven type damper operators.

.6 Air valve damper motors shall be Belimo LM24-T floating control or approved equal.

.7 Damper operators shall operate with floating point signal for full modulation.

.8 Damper operators shall be rigidly attached to the support structure and linkage shall have no "slop".

.9 These control components shall be field tested with air valve for testing and performance verification.

.10 Submit written test data for the terminal unit controllers for each size of air valve and fan coil unit.

.11 Supply air temperature measurement shall be provided on each air valve with reheat coils.

2.5 DDC System Functions

.1 The DDC system shall utilize "BACnet open architecture" and have as proven Operator Control Language (OCL), which will be capable of reading the value, and/or status of all control devices from any other user defined combination of calculations and logical expressions.

.2 All Sap's and BACnet Gateways shall conform to the BACnet Protocol Implementation Conformance Specification.

.3 Other mandatory monitoring and control features of the DDC system are:

- .1 Provide two level security system access with passwords.
  - .1 Level 1: To allow assignment of Level 1 and Level 2 passwords. Creation of new system operators, ability to create, delete and modify system components, modify selected system components, and alarm levels, and generally full system access.
  - .2 Level 2: To allow command and override of system components, alarm acknowledgement, monitor system, display information including alarm messages, graphics, points log, help menus.
- .2 Operator defined digital and analog alarms and automatic alarm condition reporting.
- .3 Auto lockout of alarms when alarmed system is shut-down.
- .4 Direct keyboard override of all digital and analog outputs, with an indication of the display of any point that is operating under keyboard override.
- .5 Addition, detection, definition and modification of points and point types from operator keyboard.
- .6 Trend log graphing of user selected points and times.
- .7 Run time totalization.

.4 The DDC system shall have the capability to be taken off line in the event of failure or for maintenance and returned to operation without the need for entering any portion of the software program manually. To accomplish this, an off-line disk storage device shall be utilized to provide software backup and reload.

.5 On-site backup and verification of the entire system, with full applications software, shall be less than 10 seconds per SAP.

.6 The DDC system shall be provided with automatic protection from any power failure of up to 72 hours duration.

.7 The protection shall at a minimum include continuous real-time clock operation and automatic system restart-upon power return. System will be tested to confirm rated hours.

.8 Panel replacement shall be possible without any hardware notification. Describe replacement procedure in technical date submitted.

.9 Any panel malfunction shall not affect the operation of the multi-panel system.

.10 Indicate how points located on one panel can be accessed and utilized by another panel. Explain any limitations of the above.

.11 Each BC and AAC standard panel proposed shall have enough random access memory for all of the following:

.1 Trend Logs – two for each input and output point connected to the panel with 100 samples each.

.2 Controllers – two for each output point connected to the panel.

.3 Variables – three for each output point connected to the panel. Variables are "virtual points" (as opposed to physical points) but which have all the attributes of real or physical points.

.4 Operator Control Language (OCCL) – twenty syntactically correct lines each with at least 4 operators, for each output point connected to the panel, or TEN (1) syntactically correct lines, each with at least four operators, for each output point connected to the panel, if the OCL has the ability to call common routines or use wild card commands.

.5 Descriptor – one for each user definable point, real or virtual, in the panel. In addition, on multi-panel systems, every descriptor in the system must be accessible from a single I/O port.

.6 Time Schedules – one set for every 3 output points connected to the panel.

.7 Totalizers – one for each digital point in the panel.

.12 Processing Speed

.1 Effective Panel Processing Speed – Maximum permissible executions time is half a second. Execution time is defined as the time it takes the stand alone panel CPU to execute all application software in the panel, from some point in the software back to the same point, assuming full memory usage, while simultaneously responding to operator or terminal display requests and carrying out normal inter-panel communications averaged over a one – minute period. This will be done by setting up a counter in each panel and monitoring the counting rate.

.2 Effective System Processing Speed – This applies to multi-panel systems only. System processing speed is intended to address inter-panel communication and will be checked by evaluating system display response. This will be done by setting up a display of all panel counters and checking how frequently each countered update on the refreshed display.

.3 Displays shall load real time current values, not stored values, within ten seconds. Every counter shall show an updated value on the display within sixty seconds at the previous update appearing. Provide confirmation that required system processing speed will be achieved.

.13 DDC System Igniter-Panel Communication

.1 Means shall be provided to ensure communication integrity. Provide detail of the system.

.2 To prevent damage to the system, each data highway line shall be provided with a means of isolation, either optically or by some other means. Provide detail of protection system in proposal.

.14 Sensors and Associated Equipment

.1 BAS shall be supplied with all sensors, relays and associated equipment to fully connect the listed DDC points. Field point installation shall be performed in a neat and orderly fashion will all components marked or labelled to correspond with the making or labelling in the as-built drawings.

.2 All sensors and controllers shall be of commercial grade and shall be installed according to the Manufacturer's recommendations. Provide full details of all sensors and controllers proposed, including their range and accuracy.

2.6 System Structure

.1 The Building Automation System (BAS) architecture shall consist of the following installed in communication and main mechanical rooms:

.1 Standalone DDC system main panels.

.2 Standalone DDC system terminal equipment (zone) controllers.

.3 Provide plug-in access for remote or lap-top computer at each panel using the same software as resides on the central workstation.

2.7 DDC System Panels

.1 References:

.1 National Institute of Standards and Technology – NISTIR 6392 GSA Guide to Specifying Interoperable Building Automation and Control Systems Using ANSI/ASHRAE Standard 135-1995, BACnet.

.2 DDC Panel Types:

.1 BC minimum capabilities equivalent to the BACnet Building Controller (B-BC).

.2 AAC Local Control Unit minimum capabilities equivalent to the BACnet Custom Application Specific Controller (B-AAC).

.3 ASC Terminal Control Unit minimum capabilities equivalent to the BACnet Application Specific (B-ASC).

.4 AAC Room Control Unit minimum capabilities equivalent to the BACnet Custom Application Specific Controller (B-AAC).

.5 SS Smart Sensor minimum capabilities equivalent to the BACnet Smart Sensor (B-SS).

.3 DDC Panel Applications – This section describes the mechanical systems that shall be connected to the different DDC panel types.

.1 BC main function is to provide direct control of all main central mechanical systems such as chillers, heat exchangers, domestic hot water, fan systems etc. The BC's shall directly reside on the primary Ethernet LAN.

.2 AAC function is to provide control for miscellaneous HVAC components in remote mechanical rooms such as VAV boxes, etc., AAC's shall reside on the secondary RS485 MS/TP network.

.3 All DDC panels shall meet the minimum requirements set out in this section.

2.8 BC BACnet Overview

.1 A BC (B-BC) is a native BACnet, general purpose, field programmable controller capable of carrying out a variety of building automation and control tasks. It enables the specification of the following:

- .1 Data Sharing:
  - .1 Ability to provide the values of any of its BACnet objects.
  - .2 Ability to retrieve the values of BACnet objects from other devices.
  - .3 Ability to allow modification of all of its BACnet objects by another device.
- .2 Alarm and Event Management:
  - .1 Generation of alarm / event notifications and the ability to direct them to recipients.
  - .2 Maintain a list of unacknowledged alarms / events.
  - .3 Notification of other recipients that the acknowledgement has been received.
  - .4 Adjustment of alarm / event parameters.
- .3 Scheduling:
  - .1 Ability to schedule output actions, both in the local device and in other devices, both binary and analog, based on date and time.
- .4 Trending:
  - .1 Collection of delivery of (time, value) pairs.
- .5 Device of Network Management
  - .1 Ability to respond to information about its status.
  - .2 Ability to respond to requests for information about any of its objects.
  - .3 Ability to respond to communication control messages.
  - .4 Ability to synchronize its internal clock upon request.
  - .5 Ability to perform re-initialization upon request.
  - .6 Ability to upload configuration and allow it to be subsequently restored.
  - .7 Ability to command half-routers to establish and terminate connections.

.2 Provide sufficient number of BC's to fully meet all requirements of this specification plus specified spare point capacity. An Ethernet gateway connecting the WAN to the building BC is NOT acceptable.

.3 BC to be standalone intelligent controller, BC panel to:

- .1 Be microprocessor based, multi-tasking, multi-user, real-time digital control processors capable of supervising other low level programmable controllers through secondary networks.
- .2 Consist of modular hardware with plug-in processors, communication controllers, power supplies, I/O modules.
- .3 Provide MS/TP BACnet LAN port for local AAC/ASC network.
- .4 Provide on-board LAN interface for Ethernet BACnet peer-to-peer communication between BC's and at least **1** RS-232C serial data communication ports to support simultaneous operation of multiple operator I/O devices such as industry standard printers, lap-top work-stations, PC work-stations and BC-mounted or portable OT's. One RS-232C data port will support point-to-point PTP BACnet protocol.

.5 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OT's.

.6 Interface field sensors via local I/O terminations located on BC located in processor cabinet.

.7 In standalone mode execute programmable logic control (direct digital or closed loop process control) of associated HVAC equipment without interacting with other processors or OWS's.

.4 Dial-Up Communications:

.1 Auto-dial/auto-answer communications to allow BC/s to communicate with remote OW's on non-contributions basis via telephone lines.

.2 To analyze and set priorities for all alarms to minimize of calls. Non-critical alarms to be buffered in memory and reported as group or until operator manually requests upload of alarms.

.5 Spare Capacity

.1 Provide 20% spare point capacity on panels with greater than 32 I/O and 10% spare capacity on panels with less than 32 I/O.

.6 Programming and Energy Management Routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start.

.6 Optimal stop.

.7 Supply air reset.

.8 Duty cycling.

.9 Night setback.

.10 Chilled water and condenser water reset.

.11 Heating water reset.

.7 All programs to be executed automatically without need for operator intervention.

.8 Programming languages:

.1 Shall meet requirements specified in Custom Programming Capability Specification Section.

.9 Priority Level:

.1 BC shall provide for 16 levels of priority from all outputs. The priority levels shall conform to the BACnet object specifications.

.10 Trend Logging:

.1 All trend log information shall be stored at BC and not at OWS.

2.9 AAC BACnet Overview

.1 An AAC (B-AAC) is a general purpose, field programmable controller capable of carrying out a variety of building automation and control tasks. It enables the specification of the following:

  .1 Data Sharing:

    .1 Ability to provide the values of any of its BACnet objects.

    .2 Ability to retrieve the values of BACnet objects forms other devices.

    .3 Ability to allow modification of all of its BACnet objects by another device.

  .2 Alarm and Event Management:

    .1 Generation of alarm / event notifications and the ability to direct them to recipients.

    .2 Maintain a list of acknowledged alarms / events.

    .3 Notifying other recipients that the acknowledgement has been received.

    .4 Adjustment of alarm / event parameters.

  .3 Scheduling:

    .1 Ability to schedule output actions, both in the local device and in other devices, both binary and analog, based on date and time.

  .4 Trending:

    .1 Collection and delivery of (time, value) pairs.

  .5 Device and Network Management:

    .1 Ability to respond to information about its status.

    .2 Ability to respond to requests for information about any of its objects.

    .3 Ability to respond to communication control messages.

    .4 Ability to synchronize its internal clock upon request.

    .5 Ability to perform re-initialization upon request.

    .6 Ability to upload its configuration and allow it to be subsequently restored.

    .7 Ability to command half-routers to establish and terminate connections.

.2 Provide sufficient number of AAC's to fully meet all requirements of this specification plus specified spare point capacity.

.3 AAC to be stand-alone intelligent controller. AAC panel to:

  .1 Be microprocessor based, multi-tasking, multi-user, real-time digital control processors capable of supervising other lower level programmable controllers through secondary networks.

  .2 Consist of modular hardware with plug-in processors, communication controllers, power supplies, I/O modules.

.4 Provide MS/TP BACnet Lan port for local ASC network.

.5 Provide on-board LAN interface for MS/TP BACnet peer-to-peer communication between AAC's and at least [1] RS-232C serial data communication port to support operation of operator I/O devices such as industry standard printers, lap-top work-stations, PC work-stations and AAC-mounted or portable OT's. RS-232C data port, will support point to point PTP BACnet protocol.

.6 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OT's.

.7 Interface field sensors directly to I/O terminations located on AAC in processor cabinet.

.8 In standalone mode execute programmable logic control (direct digital or closed loop process control) of associated HVAC equipment without interacting with other processors or OWS's.

.9 Spare Capacity:

- .1 Provide 10% spare point capacity for each AAC without additional cards, terminals or a minimum of one spare input and one spare output.
- .2 If AAC is used for unitary equipment then no spare capacity is required unless identified on points list.

.10 Programming and Energy Management Routines:

- .1 AAC to provide the following energy management routines:
  - .1 Time of day scheduling.
  - .2 Calendar based scheduling.
  - .3 Holiday scheduling.
  - .4 Temporary schedule overrides.
  - .5 Optimal start.
  - .6 Optimal stop.
  - .7 Supply air reset.
  - .8 Duty cycling.
  - .9 Night setback.

.11 All programs to be executed automatically without need for operator intervention.

.12 Programming languages:

- .1 Shall meet requirements specified in Custom Programming Capability Specification Section.

.13 Priority Level:

- .1 AAC shall provide for 16 levels of priority from all outputs. The priority levels shall conform to the BACnet object specifications.

.14 Trend Logging:

- .1 All trend log information shall be stored at AAC and not at BC or OWS.

2.10 ASC BACnet Overview

.1 ASC BACnet overview: An ASC (B-ASC) is a controller with limited resources relative to an AAC. It is intended to use in a specific application and supports limited programmability. It enables specification of the following:

- .1 Data Sharing:
  - .1 Ability to provide the values of any of its BACnet objects.
  - .2 Ability to allow modification of some or all of its BACnet objects by another device.
- .2 Alarm and Event Management:
  - .1 None
- .3 Scheduling:
  - .1 None

.4 Trending:

.1 None.

.5 Device and Network Management:

.1 Ability to respond to information about its status.

.2 ASC to be standalone intelligent controller. ASC panel to:

.1 Be microprocessor based, real-time digital control processors.

.2 Consist of modular hardware with communication controllers, power supplies, I/O modules.

.3 Provide on-board LAN interface for MS/TP BACnet peer-to-peer communication between ASC's and at least 1 RSS-232C serial data communication port to support operation of operator I/O devices such as industry standard printers, lap-top work-stations, PC work-stations and ASC-mounted or portable OTs.

.4 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OTs.

.5 Interface field sensors directly to I/O terminations located on ASC in processor cabinet.

.3 In standalone mode execute programmable logic control (direct digital or closed loop process control) of associated terminal equipment without interacting with other processors or OWS's.

.4 Spare Capacity:

.1 Provide 10% spare point capacity for each ASC without additional cards, terminals.

.2 If ASC is used for terminal equipment then no spare capacity is required unless identified on points list.

.5 Programming and Energy Management Routines:

.1 ASC to provide for the following energy management routines:

.1 Temporary schedule overrides.

.2 Supply air reset.

.3 Night setback.

.2 All programs to be executed automatically without need for operator intervention.

.3 Programming languages:

.1 Firmware based application specific program utilizing full BACnet objects and functionality.

.6 Priority Level:

.1 ASC shall provide for 1 level of priority from all outputs.

.7 Trend Logging:

.1 All trend log information shall be stored at AAC or BC not ASC.

2.11 Custom Programming Capability

.1 Programming Languages:

.1 All GCL General Control Language software to be programmed in general control type or high-level control language supporting full BACnet objects and functionality.

END OF SECTION

Part 1 General

1.1 Summary

.1 Detailed narrative description of Sequence of Operation of each system.

.1 Control Description Logic (CDL) for each system.

.2 Input/Output Point Summary Tables for each system.

1.2 References

.1 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.

.1 MD250005-2009, Energy Management of Control Systems (EMCS) Design Manual, English.

.2 Shared Services BC Client Comfort Design Manual (CCS Manual) – See SSBC Integrated Workspace Solutions (IWS) Standards and Manuals.

1.3 Sequencing

.1 This section defines the sequence of operation for the mechanical systems that are to be executed by the DDC system and shall be read in conjunction with the Controls DDC Section 25 05 01.

.2 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.3 The control sequences shall be interpreted in conjunction with the respective system configuration schematics, layout and details shown on the drawings.

.4 The relationships between the points, systems and building are described in the control sequences.

.5 Not all points are shown on the drawings. All points, sensors and transmitters required to implement the control sequences described herein and/or listed in Section 25 90 02 Point Schedule,, are to be provided regardless of whether shown or not.

.6 Review with the Consultant during the shop drawing stage to finalize control sequences for each system.

1.4 Standard Routines

.1 On a power interruption at a control panel, the equipment controlled by that panel shall turn-off as if to signal to stop equipment had been given. On a return from power failure, the equipment shall restart in an orderly fashion with time delays between each major system. During power failure, the emergency generator starts, power shall be directed to specific equipment. Refer to motor list for mechanical equipment that requires emergency power. Life and safety system shall start first.

.2 If the power interruption has been to multiple control panels, equipment start-up shall be delayed between control panels.

.3 Control sequences shall be executed if the associated equipment is running, whether the sequence is initiated manually (for example, an operator is positioning a motor starter in the hand position) or the DDC system.

.4 The DDC System shall not override any safety interlocks.

1.5 Alarm and Event Messages

.1 System error occurs when the status point does not correspond to the commanded status (or is outside of accepted deviation from setpoints) and generation of an alarm message is required.

.2 When the DDC system identifies a sensor as “failed” it shall disable the input point and place all outputs dependent on the disabled input to a safe state. An alarm message shall be output for each occurrence at the alarm printers.

.3 Coordinate with the Engineer on the wording of event messages to be generated. Provide an alarm data DDC system sheet and complete the specified columns providing information on the point name, alarm type, high limit, low limit and alarm reference conditions.

1.6 Setpoints, Schedules and Hours of Operation

.1 The setpoints, schedules and hours of operation indicated in the sequences of operation are for initial set-up of the system. During the commissioning process and building operation the setpoints and schedules are to adjusted as deemed necessary to optimize system operation.

.2 All setpoints, schedules and hours of operation shall be operator on-line definable.

1.7 Motor Control

.1 When points are utilized for motor run time totalization, either to generate a maintenance alarm or for equipment switchover, a virtual point shall be used and reset to zero after the specified run time.

.2 Programming the Sequence of Operation:

  .1 For operating sequences, the Contractor shall provide an outline of the proposed programming approaches and examples to the Engineer for review.

  .2 Where hydronic pumps are controlled from variable speed drive(s), the minimum speed of the pump shall be ±40% of rated full speed RPM, or as directed by the pump supplier and balancing agent to meet minimum system flow and pressure requirements.

Part 2 Building Specific Sequence of Operations

2.1 Domestic Hot Water

.1 Domestic hot water storage tank heating pumps shall operate continuously. Three-way mixing valves on heating water to each tube bundle shall be modulated to maintain a domestic water temperature in storage tanks of 150°F (65.5°C).

.2 The DDC shall monitor the status of all circulators through a current tap and issue alarm if failure is detected.

.3 The DDC system shall monitor the run time on the circulating pumps and generate maintenance time reminders at the Manufacturers’ recommended frequency levels.

2.2 Hydronic Heating and Cooling Plant

.1 Overview: The Smithers Airport Expansion is served by a central, common, fully automated HVAC system. For the purposes of this section, the HVAC system is considered in four parts:

  .1 **Hydronic Heating and Cooling Plant (this section)**

  .2 Hydronic Heating and Cooling Distribution

  .3 Dedicated Outdoor Air System - Boarding Lounge

  .4 Forced Air Ventilation and Space Cooling System - Remainder of the Building

  .5 Terminal Units

.2 The Hydronic Heating and Cooling Plant is generally comprised of:

  .1 Water Source Heat Pumps (WSHP-1 and WSHP-2) and associated pumps (P-HP-1 and P-HP-2)

  .2 Gas-Fired Condensing Boilers (B-1 and B-2) and associated pumps (P-B-1 and P-B-2)

  .3 Ground Source Heat Exchanger and associated pumps (P-GEO-1 and P-GEO-2)

  .4 Chilled Water Heat Exchanger (HX-1) and associated pumps (P-CW-2)

  .5 Heating Water and Chilled Water Glycol Injection System

.3 Intent: The Hydronic Heating and Cooling Plant provides input heating energy and heat rejection (cooling) to satisfy building demand. In general, this entails:

  .1 Demand required from the plant shall be based on maintaining:

    .1 Heading: minimum HWR temperature from the terminal units.

    .2 Cooling: maximum CHWR temperature from the terminal units.

  .2 The WSHP shall be the primary source of heating and cooling for the building, with HWS/R temperatures of 45°C/35°C and CHWS/R temperatures of 6°C/12°C.

  .3 If the WSHP alone is unable to maintain the minimum HWR temperatures for 15 minutes (adjustable), the condensing boilers are to meet the remaining demand. The WSHP HWS/R temperatures are to be reset to 45ºC/40ºC and the condensing boilers are to provide heating water (at supply temperatures incrementally increasing from 50ºC to 65ºC) in to ensure the minimum HWR temperature is met.

  .4 If the condensing boiler is generating 65ºC HWS, and the minimum HWR temperature is not met for 15 minutes (adjustable), the condensing boiler is to become the sole heat source and the HWS/R temperatures are to be reset to 70ºC/50ºC.

  .5 When possible the ground source heat exchanger is to provide 'free cooling' to the CHW system.

.4 Heat Pump Systems

  .1 Water-to-Water (Geoexchange):

    .1 The heat pump system consists of two water-to water heat pumps (WSHP-1 and WSHP-2) operating in a lead lag arrangement with their associated load side circulation pumps (P-HP-1 and P-HP-2), two source side circulation pump (P-GEO-1 and P-GEO-2) operating in a duty/standby arrangement and two modulating 3 way valves (MV-1 and MV-2) in parallel configuration to control HW or CHW flow.

    .2 The "source side" of the water-to-water heat pump system is configured as a "constant flow" closed loop system.

.3 The heat pump shall be provided with its own internal controls, which controls the load side water temperature, indication of various alarms, status and mode of operation. The heat pump control panels are tied to the SCU, providing the following remote control and monitoring capabilities.

.1 Heat pump start/stop.

.2 Status of heat pump.

.2 Water Loop System:

.1 The heat pump is normally enabled from the DDC. The source side (P-GEO-1 and P-GEO-2) and load side circulation pumps (P-HP-1 and P-HP-2) are started first through DDC. Upon proof of water flow in the respective source side and load side loops the heat pump is enabled.

.2 Heat Pump Operation:

.1 The heat pump operates in cooling-mode and heating mode.

.2 Depending on the cooling or heating demand, the heat pump operates to meet the “load side” primary loop supply water temperature setpoint as calculated by DDC.

.3 Geoexchange Freeze Protection

.1 If the geoexchange return water temperature is 2°C (adjustable) or below, the water source heat pumps (WSHP-1 and WSHP-2) and associated load side pumps, and the source side circulation pumps (P-GEO-1 and P-GEO-2) are to be disabled to prevent the field freezing.

.2 If the source side circulation pups have been disabled the pumps are to be started ever hour after to verify the geoexchange return water temperature.

.5 CHW Heat Exchanger and associated pump

.1 The Glycol CHW circulation pump (P-CW-2) shall be interlocked with the WSHP load side circulation pumps (P-HP-1 and P-HP-2).

.2 If one WSHP is operating, P-CW-2 is to operate at 50% design capacity. If both WSHPs are operating, P-CW-2 is to operate at design capacity.

.6 Boiler Systems – Condensing:

.1 The hot water heating system is configured as “constant flow”. The hot water heating system provides heating capacity for the space heating and ventilation systems.

.2 The hot water heating system consists of:

.1 Two natural gas-fired condensing Boilers (B-1 and B-2).

.2 One circulating pump per boiler (P-B-1 and P-B-2) and two modulating 3-way valves

.3 Boiler controls are provided by Boiler Manufacturer. Provide tie-in points to SCU, as required by the boiler Manufacturer’s controls and as indicated on the Points Schedule.

.4 Provide all safety or operational interlocks to boiler control panels as required.

.5 Boiler enable/disable control is based on heating supply water temperature setpoint from the SCU. Circulating pumps (P-B-1 and P-B-2) are enabled through SCU. Upon proof of water flow the boiler is enabled.

.6 Boiler heating output (i.e., burner output modulation) and heating water temperature setpoint modulates as required to meet the "primary loop supply temperature" setpoint of the radiant slab system. Boiler heating water can be generated in 90°F (32.2°C) to 160°F (70°C) range (adjustable through SCU).

.7 3WV-5 modulates between fully closed and open position (e.g. full bypass or full flow through boiler B-1 circuit) as required to meet the temperature setpoint of the primary loop side of the radiant system.

.8 If an accelerated heating rate of the radiant system is required, the primary loop supply water temperature setpoint can be temporarily increased about 130°F (54.4°C), provided this additional capacity is absorbed by the radiant slabs and the primary loop return water temperature to heat pumps is not allowed to exceed 120°F (48°C)

.7 Temperature Monitoring

.1 BAS shall monitor temperature at the following key system points, in addition to all other locations indicated on drawings and schematics:

.1 Ambient air temperature

.2 Chilled Water Buffer Tank – 4 points

.3 Low Loss Header – 6 ports

.4 B-1 Heating Water Supply and Return

.5 B-2 Heating Water Supply and Return

.6 WSHP-1 Heating Water Supply and Return

.7 WSHP-2 Heating Water Supply and Return

.8 WSHP-1 Chilled Water Supply and Return

.9 WSHP-2 Chilled Water Supply and Return

.10 Chilled Water Heat Exchanger – 4 ports

.8 Differential Pressure Monitoring

.1

.9 System Pressure Monitoring and Glycol Make Up

.1 BAS shall monitor system pressures at expansion tanks for glycol heating system and glycol cooling system.

.2 BAS shall monitor level of glycol storage tank and issue alarm when reservoir fill required.

.3 Glycol injection pumps shall operate automatically to maintain minimum system pressure. BAS shall monitor status of glycol injection pumps.

.10 Trending

.1 The BAS shall log hourly values for all temperature sensors over a minimum of 5 years history.

.2 The BAS shall log cumulative runtime for each plant component over a minimum of 5 year history.

.3 For each alarm event, log the time, date, location/'point name and temperature for a minimum of 5 year history.

.11 Alarms

.1 The BAS shall monitor status of all equipment and issue an alarm on failure.

.2 The BAS shall forward alarms from plant equipment controllers.

.3 The BAS shall issue an alarm when continuous flow of makeup glycol is detected.

.4 The BAS shall issue an alarm when system pressure is detected outside of design minimum and maximum.

.5 The BAS shall issue an alarm on operation of backup boilers.

.6 The BAS shall monitor the status of heat tracing and issue an alarm for failure.

.7 The BAS shall monitor the status of all VFDs and issue an alarm for manual “hand” or “off” position.

.8 The BAS shall monitor the status of all 3-way valves and issue an alarm for failure (valve commanded to 100% A or B position, but end switch not closed)

2.3 Hydronic Heating and Cooling Distribution

.1 Overview: The Smithers Airport Expansion is served by a central, common, fully automated HVAC system. For the purposes of this section, the HVAC system is considered in four parts:

.1 Hydronic Heating and Cooling Plant

.2 **Hydronic Heating and Cooling Distribution (this section)**

.3 Dedicated Outdoor Air System - Boarding Lounge

.4 Forced Air Ventilation and Space Cooling System - Remainder of the Building

.5 Terminal Units

.2 The Hydronic Heating and Cooling Distribution is generally comprised of:

.1 Heating Water Low Loss Header (LLH-1)

.2 Chilled Water Buffer Tank (T-1)

.3 Heating Water Heat Exchanger (HX-2) and Distribution Pumps (Water: P-HW-3 and P-HW-4, Glycol: P-HW-1 and P-HW-2)

.4 Chilled Water Distribution Pumps (P-CW-1)

.5 Makeup Water Feed

.6 Distribution

.3 Intent: The hydronic distribution system operates pumps to satisfy building demand on a per circuit basis. Pumping systems are generally divided by water temperature:

.1 Heating Water “HW” – For all space and ventilation heating

.2 Chilled Water “CHW” – For all space and ventilation cooling

.4 Heating Water Distribution Pumps

.1 Demand for heating or cooling shall be sensed by the BAS based on a call from a terminal unit, AHU or the HRV (i.e. based on space or air temperature sensors). In general pumps are expected to run continuously during occupied periods, however periods during unoccupied set back and/or very low occupancy, this provision will allow pumps to de-energize to conserve electricity.

.2 Pumps are sized at 50% design capacity each and are to operate in lead/lag arrangement.

.3 On call for heating the BAS shall enable to distribution pump for the respective circuit at minimum speed.

.4 The BAS shall modulate the VFD pump speed to maintain the heating water supply pressure at the remote terminal unit.

.5 The BAS shall disable pump when demand for heating is satisfied.

.5 Chilled Water Distribution Pumps

.1 Demand for heating or cooling shall be sensed by the BAS based on a call from a terminal unit, AHU or the HRV (i.e. based on space or air temperature sensors). In general pumps are expected to run continuously during occupied periods, however periods during unoccupied set back and/or very low occupancy, this provision will allow pumps to de-energize to conserve electricity.

.2 Pumps are sized at 50% design capacity each and are to operate in lead/lag arrangement.

.3 On call for chilled the BAS shall enable to distribution pump for the respective circuit at minimum speed.

.4 The BAS shall modulate the VFD pump speed to maintain the chilled water supply pressure at the remote terminal unit.

.5 The BAS shall disable pump when demand for cooling is satisfied.

.6 Temperature Monitoring

.1 BAS shall monitor temperature at the following key system points, in addition to all other locations indicated on drawings and schematics:

.1 Chilled Water Buffer Tank – 4 points

.2 Heating Water Heat Exchanger – 4 ports

.3 Heating water supply and return to terminal units

.4 HWS/R and CHWS/R to the HRV coils

.5 HWS/R and CHWS/R to the AHU coils

.6 Chilled Water Supply and Return to terminal units

.7 Trending

.1 The BAS shall log hourly values for all temperature sensors over a minimum of 5 years history.

.2 The BAS shall log cumulative runtime for each plant component over a minimum of 5 year history.

.3 For each alarm event, log the time, date, location/'point name and temperature for a minimum of 5 year history.

.8 Alarms

.1 The BAS shall monitor status of all pumps and issue an alarm on failure.

.2 The BAS shall issue an alarm when continuous flow of makeup glycol is detected.

.3 The BAS shall issue an alarm when system pressure is detected outside of design minimum and maximum.

.4 The BAS shall monitor the status of heat tracing and issue an alarm for failure.

.5 The BAS shall monitor the status of all VFDs and issue an alarm for manual "hand" or "off" position.

.6 The BAS shall monitor the status of all 3-way valves and issue an alarm for failure (valve commanded to 100% A or B position, but end switch not closed)

2.4 Dedicated Outdoor Air System – Boarding Lounge

.1 Overview: The Smithers Airport Expansion is served by a central, common, fully automated HVAC system. For the purposes of this section, the HVAC system is considered in four parts:

.1 Hydronic Heating and Cooling Plant

.2 Hydronic Heating and Cooling Distribution

.3 **Dedicated Outdoor Air System - Boarding Lounge (this section)**

.4 Forced Air Ventilation and Space Cooling System - Remainder of the Building

.5 Terminal Units

.2 Intent: The Dedicated Outdoor Air System (DOAS) is a "once-through" system with zero return air capacity. The DOAS provides tempered 100% outdoor ventilation air to all the Boarding Lounge, and extracts soiled exhaust and relief air to maintain balanced building pressurization. Heat Recovery Ventilator uses change-over dampers, which automatically reverse airflow between fans and the outdoors, to thermally charge and discharge thermal energy and minimize required input sensible heating capacity. The DOAS also provides dehumidification capacity if required. Space heating is satisfied by radiators and forced-air terminal devices. Space cooling is provided by the Dedicated Outdoor Air System.

2. Soiled exhaust is generally extracted at a minimum constant volume to maintain acceptable air quality in areas with odours or moisture (e.g. washrooms, janitor rooms).
3. Ventilation supply air to occupied spaces is the greater of either:
    1. Variable with minimum setting of 0, modulated in response to CO2 sensors.
    2. Variable with order to meet room space cooling demand.
4. Heat Recovery Ventilators with integral Supply and Return fans modulate air volume to maintain adequate differential pressure across air valves (VAV boxes) for reliable operation. Note: VAV boxes will be controlled based on air volume flowrates and a CFM offset (refer to following sub-section).
5. CO2 sensors within the Boarding Lounge provide feedback for volume control of ventilation air.
6. HRV units has a single heating coil and a single cooling coil. Upon failure of heat recovery and/or damper operation and when outside air temperature is less than 18˚C, HRV supply and exhaust fans shall slow to 30% design capacity. Hydronic heating coil shall operate to maintain minimum 18˚C supply air.

5. General: The DOAS is generally comprised of:

1. Heat Recovery Ventilators, with the following components:
    1. Supply fan(s) with VSD
    2. Exhaust fan(s) with VSD
    3. Cooling/dehumidification coil
    4. Heating/reheating coil
    5. Heat recovery cores (2 per unit)
    6. Changeover/bypass damper
    7. Pre- and final supply filters with digital pressure differential gauges
    8. Integral motorized dampers for outdoor intake/exhaust discharge openings
    9. Airflow Monitoring Stations
    10. Temperature Sensors for Outdoor Air, Supply Air, Return Air, and Exhaust Air

6. Heat Recovery Ventilators:
    1. HRV units shall include on-board controller with BACnet interface for connection to Building Automation System.
    2. Startup: On a signal to start, outdoor air dampers shall open, and damper end switch shall start fans
    3. Supply and Exhaust Fans:
        1. Occupied Hours: Fans shall operate to meet either minimum ventilation rate for CO2 or minimum supply air rate required for cooling demand (whichever is larger).
        2. Unoccupied Hours: Fans shall operate to meet minimum ventilation rate for CO2.
        3. Damper Control: Automated by on-board controller.
        4. Frost Control: Automated by on-board controller.
        5. Cooling Coil: BAS shall modulate coil control valve to maintain 18°C off-coil temperature. Sequencing shall incorporate provision for free-cooling; exact sequence to be developed by Controls Contractor in cooperation with this Consultant.
        6. Heating Coil: BAS shall modulate coil control valve to maintain 18°C supply air temperature downstream of cooling coil (i.e. as primary ventilation heating, or re-heat operation during humid conditions).
        7. Cooling coil freeze protection: The BAS shall monitor on-coil temperature of cooling coil. On detection of temperatures below 5°C (e.g. due to failure of heat recovery dampers, or excessively cold temperatures), the BAS shall reset outdoor air volume to 30% of design volume, enable the respective coil pump to recirculate water through cooling coil as means of freeze protection, and issue a “trouble” alarm and maintain these conditions until on-coil temperature increases above threshold.
        8. Pre-Heat After Unoccupied Setback: For one hour prior to start of scheduled occupied mode, BAS shall operate heating coil control valve to satisfy “occupied” heating setpoint in office spaces (i.e. HRV provides assistance to office terminal heating systems to ramp up space temperature following scheduled unoccupied settings).
    4. Filters:
        1. A differential pressure switch shall be provided across each filter bank and shall provide a dirty filter alarm at the DDC system.
    5. Airflow Monitoring
        1. The BAS shall monitor the instantaneous rate of supply airflow at 10 minute intervals via factory fitted air flow measurement stations. Controls contractor to provide power and communication connection to air flow measurement stations.
    6. Trending
        1. The BAS shall log hourly values for all temperature sensors over a minimum 10 year history.
        2. The BAS shall log hourly instantaneous flow-rates of all airflow monitoring stations over a minimum 10 year history.
        3. The BAS shall log cumulative runtime of each HRV fan over a minimum 10 year history.
        4. For each alarm event, log the time, date, location/point name, and temperature for a minimum 10 year history.
    7. Alarms:
        1. The BAS shall issue an alarm upon detection of airflow less than 15% of the design supply airflow during occupied hours.

2. The BAS shall monitor status of the HRV and issue an alarm on failure of heat recover, any fan or damper.
3. The BAS shall issue an alarm when coil freeze protection sequence occurs.

8. Dampers
   1. Motorized dampers for HRV exhaust fans shall be integral to and packaged with HRV unit, factory mounted tested and lined complete with end switches. DDC shall operate exhaust and supply dampers. Dampers shall be closed when HRV fans are off. Dampers shall modulate according to HRV manufactures recommendations, if required to maintain minimum velocity across heat recovery coils.
   2. Airflow Monitoring Stations shall be provided for the following equipment:
      1. HRV Supply Fans Ebtron GTC116-P+
      2. AHU Supply Fans Ebtron GTC116-P+

2.5 Forced Air Ventilation and Space Cooling System (Remainder of the Building)

.1 Overview: The Smithers Airport Expansion is served by a central, common, fully automated HVAC system. For the purposes of this section, the HVAC system is considered in four parts:

.1 Hydronic Heating and Cooling Plant

.2 Hydronic Heating and Cooling Distribution

.3 Dedicated Outdoor Air System - Boarding Lounge

.4 **Forced Air Ventilation and Space Cooling System - Remainder of the Building (this section)**

Terminal Units

.2 The forced air ventilation and space cooling system is generally comprised of air handling units with the following components

.1 Supply fan

.2 Heating coil

.3 Cooling coil

.4 Pre and final supply filters

.5 Temperature sensors for outdoor air and supply air

.3 Intent: Air handling units (located on the roof and in the mechanical basement plantroom) are to provide conditioned ventilation air and space cooling is provided to the airport (i.e. everywhere outside the Boarding Lounge) via a forced air system.

.4 In general:

.1 The air handling units shall operate during occupied hours.

.2 On a signal to start, outdoor air shutoff damper shall open.

.3 On proof of damper open the fan motor shall be enabled and ramp the fan up to set speed.

.4 Heating/cooling coil control valve shall be stroked to full open.

.5 Supply VAV boxes shall be stroked to the closed position.

.6 If the outside air temperature is below 32°F (0°C) heating coil valve shall be stroked to 50% open.

.7 Supply fan shall be ramped up slowly to achieve the duct static pressure setpoint. Static pressure sensors shall be located approximately two-thirds of the distance to the most remote VAV box. Static pressure setpoint shall be set initially to +150Pa and -150Pa exhaust.

.8 When the static pressure has been achieved, supply VAV boxes shall be modulated to achieve their minimum air flow setpoint and supply fan speed shall be increased to maintain duct static pressure.

.9 Supply air temperature shall be maintained at setpoint by modulating heating/cooling control valve in sequence.

.5 Pressure Control:

.1 The VAV system shall employ a static pressure reset system to minimize fan energy consumption. The DDC system shall continuously scan the damper position of all VAV box dampers. If all are achieving the air flow setpoint, the static pressure shall be decreased in increments of 5 Pascals until one of the VAV boxes fails to meet setpoint. Pressure shall remain at this setpoint until another VAV box fails to meet setpoint at which point the duct static pressure shall be increased in 5 Pascal increments until only one VAV box fails to meet setpoint.

.6 Heating Coil Control:

.1 AHU shall be complete with supply air temperature sensor and heating water two-way, modulating control valve.

.2 Controls to maintain the supply air temperature of 18°C by modulation of heating coil two-way valve.

.7 Freeze Protection

.1 A freeze protection thermostat shall be provided after the heating coil. If the supply air temperature drops below 4°C the AHU shall be shut down and;

.2 Motorized campers shall be closed

.3 Associated distribution pump circulated to ensure that coil does not freeze.

.4 In case of loss of power to AHUs the motorized damper shall close and the two-way valve shall fail closed to pass water through the heating coil.

.8 Cooling Coil Control

.1 AHU shall be complete with supply air temperature sensor and cooling water two-way, modulating control valve.

.2 Controls to maintain the supply air temperature of either 18°C if operating in ventilation mode, or 12.5°C.

2.6 Terminal Units

.1 Overview: The Smithers Airport Expansion is served by a central, common, fully automated HVAC system. For the purposes of this section, the HVAC system is considered in four parts:

.1 Hydronic Heating and Cooling Plant

.2 Hydronic Heating and Cooling Distribution

.3 Dedicated Outdoor Air System (Boarding Lounge)

.4 Ventilation Air Handling Units (Remainder of the Building)

.5 **Terminal Units (this section)**

.2 Intent; Individual units connected to the central hydronic heating and cooling plant shall operate to maintain respective space temperature setpoints.

.3 VAV Boxes

.1 General: The air flow rate of each VAV shall vary between the design maximum and the minimum ventilation rate (as per the mechanical VAV schedule), based on the

.4 Radiators C/W Room Temperature Sensors

.1 Each radiator is controlled by a two-way ON/OFF control valve. Upon the associated room temperature sensor receives a heating call, the two-way valve shall be commanded full open.

.5 Unit Heaters:

.1 Unit heaters will be zoned with primary ventilation systems and will operate in two modes – Occupied/Unoccupied.

.2 Occupancy state shall be determined by either time-of-day schedule.

.1 The fan will be cycled on demand. Heating coil valves will be commanded full open while the fan runs. After the temperature has been satisfied, the fan will turn off and the heating valve will be closed.

.2 In unoccupied mode heating temperature will be set back to 65°F (18°C).

.3 Type thermostats shall be used for common areas, storage areas, warehouse and workshops. There is no local display or local adjustment.

.6 Exhaust Systems

.1 Baggage Exhaust:

.1 Exhaust fan (EF-2) is controlled based on room occupancy sensor

.2 Provide 20 minute run on time.

.7 Sump Pumps

.1 General: sump pump systems shall be supplied with packaged duplex controls specified elsewhere. BAS shall monitor sump pump controller status, status of each pup, forward alarms, and issue maintenance remainders.

.2 Trending

.1 The BAS shall log time of each start and cumulative runtime of each pump over a minimum 5 year history.

.2 For each alarm event, log the time, date and location/point name, for a minimum of 5 year history.

.3 Alarms:

.1 The BAS shall forward alarms from equipment controllers.

.8 Miscellaneous Systems

.1 Door Air Curtains

.1 Door air curtains shall operate based on a door contact on the overhead doors.

Part 3 Execution

3.1 Not Applicable

END OF SECTION

Part 1 General

1.1 General

.1 The following points list indicates the input and output points that shall be connected to the B.A.S. Any additional points that are noted in Division 23 and Division 25 to be under DDC control shall also be included as they were on the points list. All points associated with one mechanical system shall be connected to the same Stand Alone Panel (SAP). All points shall be connected to SAPs unless they are specifically noted otherwise.

.2 Program alarms as specified in the points list and sequences with user adjustable alarm thresholds. Provide descriptors for all programmed alarms which can be accessed via the graphics at the OWS(s).

1.2 Device Legend

.1 Refer to Section 23 09 13 for specification of devices.

.2 RTS = Room Temperature Sensor

.3 DTS = Duct Temperature Sensor

.4 ITS = Immersion Temperature Sensor

.5 ATS = Averaging Duct Temperature Sensor

.6 OTS = Outdoor Temperature Sensor

.7 HS = Humidity Sensor

.8 DPT = Differential Pressure Transmitters

.9 SPT = Static Pressure Transmitter

.10 VPT = Velocity Pressure Transmitter

.11 PSW = Pressure Switch

.12 TSW = Temperature Switch

.13 IPT = Current / Pneumatic Transducer

.14 CR = Current Relay

.15 EPR – Electric / Pneumatic Relay

.16 FSW = Flow Switch

.17 ESW = End Switch

.18 ER = Electric Relay

.19 DME = Damper Actuator Modulating Electronic

.20 DTE = Damper Actuator Two Position Electronic

.21 DMP = Damper Actuator Modulating Pneumatic

.22 DTP = Damper Actuator Two Position Pneumatic

.23 DMI = Damper Actuator Modulating Incremental Control

.24 VME = Valve Actuator Modulating Electronic

.25 VTE = Valve Actuator Two Position Electronic

.26 VMP = Valve Actuator Modulating Pneumatic

.27 VTP = Valve Actuator Two Position Electronic

.28 VMI = Valve Actuator Modulating Incremental Control

.29 MFT = VAV Box Flow Transmitter

.30 FMS = Electronic Flow Measuring Station

.31 WFS – Water Flow Measuring Station

1.3 Table Legend

.1 DI = DIGITAL INPUT; DO = DIGITAL OUTPUT; AI = ANALOG INPUT; AO = ANALOG OUTPUT

1.4 Points Lists:

System	BMS Points								
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Indoor Air Systems (Separate Price)									
Air Handling Unit system (AHU-1, RH-1 and RH-2)) **Separate Price**	SA temp	x							
	SF VFD Speed	x							
	SF VFD Current	x							
	MA temp	x							
	Heating Water Return Temperature (x2 – RH-1 & RH-2)	x							
	Chilled Water Return Temperature	x							
	Main Filter Pressure Differential	x							
	Carbon Filter Pressure Differential	x							
	SA Low Pressure		x						
	SA High Pressure		x						
	Freeze stat		x						x
	SF VFD Speed Control			x					
	Relief Air Damper			x					
	MA Damper			x					
	OA Damper			x					
	Cooling Valve Control			x					
	Cooling Valve Position	x							
	Heating Valve Control (x2 RH-1 & RH-2)			x					
	Heating Valve Position (x2 RH-1 & RH-2)	x							
	SF Variable Speed Drive						x	Refer to VSD BACnet Connection	x
	SF Variable Speed Drive						x	Refer to VSD BACnet Connection	x

System	BMS Points							
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Outdoor Air Systems									
Outdoor Air Handling Units (AHU-2 & 3)	SA temp	x							
	SF VFD Speed	x							
	SF VFD Current	x							
	RA temp	x							
	MA temp	x							
	2/3 Supply air Pressure Transmitter	x							
	CO2 (Location TBD)	x							
	Heating Water Return Temperature	x							
	Chilled Water Return Temperature	x							
	Main Filter Pressure Differential	x							
	Carbon Filter Pressure Differential	x							
	SA Low Pressure		x						
	SA High Pressure		x						
	RA Low Pressure		x						
	RA High Pressure		x						
	Freeze stat		x						x
	SF VFD Speed Control			x					
	Relief Air Damper			x					
	MA Damper			x					
	OA Damper			x					
	Cooling Valve Control			x					
	Cooling Valve Position	x							
	Heating Valve Control			x					
	Heating Valve Position	x							
	SF Variable Speed Drive						x	Refer to VSD BACnet Connection	x

System	BMS Points							
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Heat Recovery Ventilator (HRV-1)	SA temp	x							
	SF VFD Speed	x							
	SF VFD Current	x							
	EA temp	x							
	EF VFD Speed	x							
	EF VFD Current	x							
	OA temp	x							
	2/3 Supply air Pressure Transmitter	x							
	CO2 (Location TBD)	x							
	Heating Water Return Temperature	x							
	Chilled Water Return Temperature	x							
	Main Filter Pressure Differential	x							
	Carbon Filter Pressure Differential	x							
	Heat Exchanger Pressure Differential	x							
	SA Low Pressure		x						
	SA High Pressure		x						
	EA Low Pressure		x						
	EA High Pressure		x						
	Freeze stat		x						x
	SF VFD Speed Control			x					
	RF VFD Speed Control			x					
	EA Damper			x					
	OA Damper			x					
	RA Damper			x					
	SA Damper			x					
	Cooling Valve Control			x					
	Cooling Valve Position	x							
	Heating Valve Control			x					
	Heating Valve	x							

System	BMS Points							
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
	Position								
	SF Variable Speed Drive						x	Refer to VSD BACnet Connection	x
	EF Variable Speed Drive						x	Refer to VSD BACnet Connection	x

System	BMS Points								
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Air Curtain									
Air Curtain	Status/Alarm (current transducer)		x						x
	Fan Speed	x							
	Start/Stop		x						
Plant Equipment									
Boiler (B-1, B-2)	Lonworks Connection						x		
	Boiler Enable				x				
	Status/Alarm		x						x
Water to Water Heat Pump (WWHP-1, WWHP-2)	BACnet Connection						x		
	Heat Pump Enable				x				
	Status/Alarm		x						x
Glycol Makeup Unit	Status/Alarm		x						x
Fans									
Fan with ECM Motor (EF-1 & SF-1)	Fan Speed	x							
	Motor Current	x							
	Fan Speed Control (0-10 V)			x					
	Fan Enable				x				x
	Occupancy Sensor		x						
Fan with VSD	Fan Speed	x							
	Motor Current	x							
	Fan Speed Control (0-10 V)			x					
	Fan Enable				x				x
	Variable Speed Drive						x	Refer to VSD BACnet Connection	x

System	BMS Points								
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Pumps									
Constant Volume Pump	Motor Current	x							
	Pump Status			x					x
	Pump Enable				x				
Pump with ECM Motor	Pump Speed	x							
	Motor Current	x							
	Pump Speed Control (0-10 V)			x					
	Pump Enable				x				x
Pump with VSD	Pump Speed	x							
	Differential Pressure Sensor (remote)	x							
	Pump Speed Control			x					
	VSD Enable		x						x
	Variable Speed Drive						x	Refer to VSD BACnet Connection	x
Dampers									
Control Dampers	Position				x				
	End Switch		x						x
VAV with no re-heat	VAV air flow	x							
	Space temperature	x							x
	Damper Control			x					
VAV with re-heat	VAV air flow	x							
	Space Temperature	x							x
	SA Temp (downstream of coil)	x							
	Damper Control			x					
	Heating Valve			x					
Meters									
CHW / HW Meters	Supply Water Temperature	x							
	Return Water Temperature	x							
	Water Flow Rate	x							
	Power Use (kW)					x			
	kWh					x			
Electrical Meters	Power Use (kW)	x							
	kWh	x							
Water Meters	Water Flow Rate	x							

System	BMS Points								
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Heat Trace									
Heat Trace	Status		x						
	Common alarm		x						x
Domestic Hot Water Tanks									
Domestic Hot Water Tanks (DHWT-1, 2~~, 3~~)	Status (Current Transducer)		x						x
Expansion Tanks									
Expansion Tanks	Pressure Transmitter		x						x
Heat Exchangers									
Plate & Frame Heat Exchanger (HX-1, HX-2)	Load Side Flow	x							x
	Supply Side Flow	x							
	Load S/R Pressure (x2)	x							
	Supply S/R Pressure (x2)								
	Load S/R Temperature (x2)	x							
	Supply S/R Temperature (x2)								
	Differential Pressure Transducer (x2)	x							
Heaters									
Unit Heater (UH-1)	Space temperature sensor	x							x
	Fan Status	x							x
	Heating Valve			x					
Duct Heater (DH-1)	Supply air temperature sensor	x							x
	Common alarm		x						
	Heating Valve			x					
Perimeter Radiation (RAD-1 to 8)	Space temperature sensor	x							x
	Heating Valve (Control)			x					

System	BMS Points								
	Point Name	AI	DI	AO	DO	Virtual Point	BACnet Connection	BACnet Notes	Alarm
Variable Frequency Drive									
Variable Frequency Drive (Common to all VFDs)	VFD Speed	x							
	VFD Current	x							
	VFD Speed Control			x					
	VFD Start / Stop				x				
	BACNet Interface						x	1) Frequency Output 2) Torque 3) Power 4) DC Bus Volt 5) Output Voltage 6) kWh counter 7) Run time 8) Last Fault 9) Hand/Auto 10) Run / Stop 11) Fault 12) TBD 13) TBD 14) TBD 15) TBD	x
Misc.									
Global	Outdoor Air Dry Bulb Temperature	x							
	Outdoor Relative Humidity	x							
	~~Outdoor CO2 level~~	~~x~~	-	-	-	-	-	-	-

END OF SECTION