1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **CODES, REGULATIONS AND STANDARDS**

.1 Comply with municipal and provincial codes, rules and regulations and/or authorities having jurisdiction.

.2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.

.3 Revisions issue: Latest version as amended to date.

1.3 **REFERENCES**

.1 Comply with applicable requirements of the latest issue of the following Standards:

.1 OFC - Ontario Fire Code

.2 NFPA 10 - Portable Fire Extinguishers

.3 SMACNA - Seismic Restraint Manual Guidelines for Mechanical Systems

.4 NFPA - 13 Installation of Sprinkler Systems

.5 ASHRAE - HVAC Applications, Seismic and Wind Restraint Design

.6 CAN/ULC-S508 - Rating and Fire Testing of Fire Extinguishers

.7 NFPA - All relevant sections

1.4 **WORKING DRAWINGS AND DOCUMENTS**

.1 Design Drawing Intent

.1 The design drawings are schematic in arrangement, and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.

.2 The Work is suitably outlined on the drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram except where in certain cases the Drawings may include details giving the exact locations and arrangements required.

.3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.

.4 In order to provide clarity to the arrangement of the Work, not all details including valves, thermometers, pressure gauges, etc. are shown on the Plan Drawings. Refer to Schematic Drawings, standard details and the Specification for these requirements.

.5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the drawings, install to these requirements.

.6 Where standard details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.

.2 Contractor Coordination Responsibilities

.1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this division of the Work, as well as providing coordination with other divisions and/or contracts. This supervisor may be full time or part time on site, as appropriate to the work stage and complexity of the Work, at the discretion of the Owner.

.2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.

.3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.

.4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.

.5 Prepare construction/installation/fabrication drawings, coordinated with other trades and contracts, as required.

.1 Provide sufficient detail to disclose critical interferences of major equipment and services to ensure adequate accessibility.

.2 Specific dimensions for equipment location or access which are shown on the Consultants Drawings.

.3 Indicate sleeves, openings and stress points (such as anchors, guides and inserts).

.4 Indicate deviation in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed which is different from those shown on the design drawings.

.5 Provide these drawings to other trades for coordination with their work.

.6 Update these drawings as part of the As-Built Drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.

.6 The Design Drawings show the major requirements for the installation of equipment based on one manufacturer's requirements, but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.

.7 The construction/installation/fabrication drawings are not to be submitted as Shop Drawings. Make them available for viewing at site when requested by the Consultant.

.3 Review Before Proceeding (HOLD)

.1 Where the word "HOLD" appears on drawings and other Contract Documents, the Work is included in the Contract.

.2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.

1.5 **COORDINATION AND EXAMINATION**

.1 Reference

.1 To Section 01 10 00.

.2 Examination

.1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.

.2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.

.3 Coordination

.1 Coordinate Work of Division 21, 22, 23 and 25 such that items will properly interface with work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.

.2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.

1.6 **EXISTING SERVICE**

.1 Tie-in to Existing Services

.1 Do not shut down or make tie-in connections to any existing service without written permission of the Owner and/or Consultant.

.2 Arrange Work to minimize interruption to physical access to the building.

.3 Include for all costs associated with making connections to existing services, including but not limited to, cutting and patching of existing floors, partitions, ceilings and finishes.

.2 Work in Existing Buildings

.1 Route pipes, conduits and other services to avoid interference with existing installation.

.2 Relocate existing services and equipment to suit installation of new work.

.3 Cut back and cap existing services not being used, so that finished Work presents a neat and clean appearance.

.4 Unless noted to be reused, fixtures and materials being removed become the property of the Contractor and are to be removed from site, unless otherwise noted.

.3 Continuity of Services

.1 Be responsible for any damage to existing systems, including insulation and coverings, when making connections.

.2 Keep existing buildings in operation with minimum length of shut-down periods.

.3 Include overtime work to tie-in piping or wiring at night or on weekends.

1.7 **PROVISION FOR FUTURE**

.1 Future Equipment

.1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.

1.8 **SUBMITTALS**

.1 Shop Drawings

.1 Conform to Section 01 33 00 and the following.

.2 Shop Drawings showing more than one size or model will not be considered unless properly marked up.

.3 For electrically driven, and fuel fired appliances, provide the following information:

.1 Electrical characteristics including voltage, phase, frequency and power rating.

.2 For motors, NEMA, class and efficiency ratings.

.3 Fuel input ratings including flow rates and pressures.

.4 Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.

.4 For other equipment include the following information:

.1 Equipment performance ratings, including flow rates, pressures drops.

.2 Electrical control power requirements.

.5 For all equipment, include the following:

.1 Equipment dimensions and weights.

.2 Itemized product description with optional items clearly marked as being included.

.6 Provide wiring Shop Drawings:

.1 Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.

.2 Wiring diagrams alone are not sufficient; schematic and interconnecting drawings and sequence of operation of equipment are required for review.

.3 Clearly indicate the materials and/or equipment being supplied

.1 Details of construction, finish, accurate dimensions, capacities and performance.

.2 Certify drawings correct for construction by the manufacturer, before submission.

.3 Identify equipment Shop Drawings with designations as shown on the drawings or in the Specifications.

.4 If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.

.4 Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment.

.1 Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.

.7 Shop Drawings shall conform to the requirements of NFPA 13, NFPA 14, NFPA 20, and other relevant sections as necessary.

1.9 **"AS-BUILT" RECORD DRAWINGS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.

1.10 **INSTALLATION AND START-UP INSTRUCTIONS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.

1.11 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 In addition, include the following in the manuals:

.1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.

.2 Operating instructions, including start-up and shut-down procedure.

.3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.

.4 List of spare parts.

.3 All the above applies to component parts of equipment whether they are manufactured by the Supplier of the equipment or are supplied as a component part of an item of equipment.

1.12 CLEANING, TESTING AND APPROVAL RECORDS

.1 Records

.1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/ water concentrations, inspections and approvals by the plumbing inspector.

.2 Forward these tests to the Owner on completion of the Work in accordance with Section 01 33 00.

.3 Forward to Consultant, copy of records on site on completion of each test, cleaning operation, etc.

1.13 DIMENSIONS AND QUANTITIES

.1 Dimensions

.1 Dimensions shown on drawings are approximate.

.2 Verify dimensions by reference to Shop Drawings and field measurement.

.2 Quantities

.1 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.

1.14 TRADE QUALIFICATIONS

.1 Applicable to the following trades

.1 Sprinkler/Fire Protection

.2 Requirements

.1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the work is performed or an interprovincial certificate.

.2 Ratio of journeyman to apprentice not to exceed the defined ratio in the Apprenticeship Act of Ontario.

.3 On award of Contract, submit a list of trade journeyman and apprentices, together with their certificate and registration numbers.

.4 Certificates and registration must be provided to the Consultant on request.

.5 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

2 Products

2.1 **MATERIALS**

.1 Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.

.2 Of Canadian manufacture wherever possible.

.3 Labelled or listed as required code and/or inspection authorities.

.4 Design of mechanical systems has been based on the first listed Supplier and model number/size stated on the equipment schedules on the drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.

2.2 **EQUIPMENT/STRUCTURE COORDINATION**

.1 Locations and dimensions of curbs and roof and floor opening framing, where indicated on the drawings, are based on an arrangement to suit the above named Supplier.

.2 Be responsible to verify the actual size requirements of the openings, and notify the Consultant immediately in case the dimension of the unit supplied and the connecting ductwork/piping, etc. are at variance with the dimensions given on the Drawings.

.3 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.

2.3 **STANDARD SPECIFICATIONS**

.1 Product Quality

.1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard Specifications issued by authorities having jurisdiction.

.2 Do not apply such standard Specifications to decrease the quality of workmanship, Products and services required by the Contract Documents.

2.4 **MANUFACTURER'S NAMEPLATES**

.1 Metal Nameplates

.1 Provided with raised or recessed lettering, on each piece of equipment.

.2 Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.

.3 Mount, on same stand-off, Underwriters Laboratories and/or CSA registration plates.

.2 Nameplate Data

.1 Indicate:

.1 Size

.2 Capacity

.3 Equipment model

.4 Manufacturer's name

.5 Serial number

.6 Voltage

.7 Cycle

.8 Phase and power of motors

2.5 **MOTORS AND WIRING**

.1 In accordance with Section 23 05 13 Motors and Wiring for Mechanical.

2.6 **PIPES, FITTINGS AND VALVES**

.1 In accordance with Section 23 05 23 Pipes, Fittings and Valves.

2.7 **HANGERS AND SUPPORTS**

.1 In accordance with Section 23 05 29 Pipe Hangers and Supports.

2.8 **VIBRATION AND SEISMIC RESTRAINT**

.1 In accordance with Section 23 05 48 Noise and Vibration Control, and Section 23 05 49 Seismic Control.

2.9 **IDENTIFICATION FOR EQUIPMENT AND PIPING**

.1 In accordance with Section 23 05 53 Mechanical Identification.

2.10 **GAUGES**

.1 Pressure Gauge

.1 90 mm dial and overload stops and dial range approximately double the operating pressure, with 1% accuracy.

.2 Polished brass case, phosphor bronze bushed rotary movement, bronze bourdon tube

.3 Needle valve: Round handle, with NPS ¼ connecting piping or tubing with each gauge. Each gauge shall be provided with a snubber.

.4 Acceptable Manufacturers:

.1 Trerice

.2 Ashcroft

.3 Winters

.4 Weksler

.2 Thermometers

.1 225 mm scale, straight adjustable angle tubular glass type with red appearing mercury in lens front tube.

.2 Cast aluminum case, and brass stem complete with separable socket, and combination Celsius/Fahrenheit scale.

.3 Scale range to be approximately double the operating temperature range of the particular system in which thermometers are to be installed.

.4 Stems to be of sufficient length to provide for proper insertion in piping or equipment in which they are installed to ensure correct temperature readings.

.5 Acceptable Manufacturers

.1 Trerice

.2 Ashcroft

.3 Weksler

.4 Winters

.3 Level Gauges

.1 150 mm diameter dial, with graduated scale with minor markings, and numbers at major depth levels.

.2 Scale range to be a minimum of 110% higher than overflow level of tank.

.3 Black finished cast aluminum case, adjustable micrometer type pointer, stainless steel bourdon tube and stainless steel rotary type movement. Dial range to be 0 to 18 m.

.4 Acceptable Manufacturers

.1 Ashcroft

.2 Trerice

.3 Winters

.4 Weksler

2.11 SUPERVISORY SWITCHES

.1 Tamper Switches

.1 120 volt, N.O. switches on riser valves and other isolating valves. Listing: ULC, FM approved.

.2 Acceptable Manufacturers

.1 Potter Electric

.2 System Sensor

.3 Viking

.2 Flow Switches

.1 120 volt, N.O. switches in risers in locations indicated on Drawings. Listing: ULC, FM approved.

.2 Acceptable Manufacturers

.1 Potter Electric

.2 System Sensor

.3 Viking

2.12 **FIRE DEPARTMENT PUMPER (INLET) CONNECTIONS**

.1 Wall Siamese Fittings - Flush Type

.1 Cast brass body, brass plate, brass swivel adapters and brass plugs with polished finish. ULC listed and FM approved.

.2 64 mm "Ontario" standard hose threads with caps and chains

.3 Double inlet clappers

.4 Imprinted escutcheon plate, embossed "SPRINKLER SYSTEM CONNECTION", “STANDPIPE” or “AUTOSPKR AND STANDPIPE” as required.

.5 Ball drip on yard side of Siamese check valve.

.6 Acceptable Manufacturers

.1 National Fire Equipment Ltd.

.2 Wilson and Cousins

.3 Croker

.2 Sidewalk Siamese Fitting - Standpipe Mounted

.1 Free-standing double inlet with 500 gpm capacity, ULC listed and FM approved

.2 Cast brass construction

.3 64 mm "Ontario" standard hose thread with caps and chains

.4 Double inlet clappers

.5 Imprinted escutcheon plate embossed “SPRINKLER SYSTEM CONNECTION”, “STANDPIPE” or “AUTO SPKR AND STANDPIPE” as required.

.6 Acceptable Manufacturers

.1 National Fire Equipment

.2 Wilson and Cousins

.3 Croker

2.13 **PORTABLE FIRE EXTINGUISHING EQUIPMENT**

.1 Portable Fire Extinguishers

.1 Extinguishers to be complete with full operating charge and wall mounting bracket, and of the following class:

.1 Dry Chemical Class ABC 2.3 kg

.2 Acceptable Manufacturers

.1 Levitt (Ansul)/Tyco

.2 National Fire Equipment

.3 Flag Fire Equipment

.2 Fire Extinguisher Cabinets

.1 1.6 mm (16 gauge) steel tub

.2 2.8 mm (12 gauge) hollow channel door and rebated frame

.3 Where flush mounted, return edges by 13 mm or bevel on outer edge of door trim

.4 Semi-concealed piano hinges

.5 Door latch and 5 mm plate glass in door

.6 Cabinet finish: Grey primer to door, trim and full cabinet

.7 Door finish: Polished chrome plated

.8 Acceptable Manufacturers

.1 National Fire Equipment

.2 Herbert Williams

.3 Wilson and Cousins

2.14 **SIGNS**

.1 Enamelled steel with fire department red enamel background, white letters; inscription in accordance with (NFPA) (FM) Standards.

.2 150 mm x 150 mm for automatic control valves and alarm valves.

.3 50 mm x 150 mm for other valves.

.4 Fitted on control valves, shut-off valves, drain valves and test valves.

3 Execution

3.1 **GENERAL**

.1 Execute Work in accordance with requirements specified in the various sections of Division 22.

.2 Lay out Work of each trade so that it does not interfere with work under other divisions of Specifications.

.3 Make good any damage to Owner's property or other trade's work caused by improperly locating or carrying out of Work.

.4 Supply anchor bolts and templates for installation by other divisions.

.5 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided alteration is made before installation.

3.2 **EQUIPMENT INSTALLATION**

.1 Set equipment in place, align, connect and place in operation with:

.1 Controls set for efficient, stable operation.

.2 Initial lubrication and oil sumps filled.

.3 Connections and required safety devices installed.

.2 Protect equipment from damage during and after installation, and on completion of Work ensure that equipment is free from cracks, scratches, discolourations, tool marks, and other defects.

.3 Thoroughly clean finished surfaces before acceptance of Work.

.4 Install heater vents complete with necessary supports, hangers, braces, roof flashing, storm collar, and round top.

3.3 **PROTECTION**

.1 Protect Work and materials before, during and after erection, from weather and other hazards and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

.3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.

.4 Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting and other damage resulting from Work of this Contract.

.1 Place a 19 mm thick plywood underlaid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from, or over, such surfaces.

.2 Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage.

.3 Work damaged due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

3.4 **MAINTENANCE OF BEARINGS**

.1 During Construction

.1 Turn-over rotating equipment at least once a month after delivery;

.1 Run-in sleeve type bearings in accordance with manufacturer's recommendations.

.2 Drain, flush out and refill with new charge of oil or grease.

.3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation.

.4 Provide extended grease nipples for bearing lubrication.

3.5 FIRE EXTINGUISHERS

.1 Provide fire extinguishers as follows:

.1 In each fire hose cabinet

.2 One extinguisher for each 300 m^2 of floor area in an electrical or mechanical service room.

.3 In each extinguisher cabinet and at intervals to comply with the local fire code.

.4 At each fire hose reel, rack or tray, mounted to wall construction with substantial wall brackets provided with extinguishers.

.5 Type: Class ABC unless shown otherwise.

.6 As shown on drawings.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

.2 Section includes, but is not necessarily limited to, the following:

.1 Design of automatic sprinkler systems

.2 Preparation of Working Drawings

.3 Incorporation of facilities and equipment in an overall fire protection system

.4 Connection to buried fire mains 1.5 m outside building wall and buried leads into building and to above floor line including thrust blocks at buried elbows

.5 Exterior pumper connections

.6 Wet pipe sprinkler system(s)

.7 Dry pipe sprinkler system(s)

.8 Excavating, bedding, and backfilling of pipe trenches for buried piping installed under this section

.9 Supervisory switches on riser valves and other isolating valves, waterflow switches and pressure switches on alarm valves and risers

.10 Electrical wiring as noted and/or as shown on Drawings

1.2 **REFERENCE STANDARDS**

.1 Comply with the latest edition of the following:

.1 National Fire Protection Association

.1 NFPA 13 Standard for the Installation of Sprinkler Systems

.2 NFPA 72 National Fire Alarm and Signaling Code

1.3 **DESIGN CRITERIA**

.1 Design Submissions

.1 Prepare complete drawings of fire protection system to include:

.1 Drawings and calculations bearing stamp of a Professional Engineer employed by the fire protection company and who is registered as a member of the Association of Professional Engineers of the Province of Ontario.

.2 Submit six copies of plans, hydraulic design calculation sheets, Shop Drawings and equipment submittals through Owner's fire insurance

broker for approval by designated organization. Shop Drawings shall conform to NFPA 13 requirements.

.3 Submit all copies of drawings, etc., duly approved by Owner's insurance underwriter to Consultant for final review prior to commencement or work.

.4 Submit reviewed Shop Drawings to local municipal authority.

.5 Provide systems in accordance with approved drawings, subject to inspection and testing requirements of Owner's Insurance Underwriter and Consultant.

.2 Underwriters/Owners Approval

.1 Fire protection work requires approval of Owner's fire insurance underwriter and Consultant.

.2 Reviewing organization:

.1 Insurers Advisory Organization

.2 Canadian Industrial Risks Insurers

.3 FM Global

.4 Factory Insurance Association

1.4 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Sprinklers shall be referred to on drawings and Product submittals and be specifically identified by the manufacturer’s listed model or series designation. Trade names and other abbreviated listings are not allowed.

.2 Samples

.1 Submit samples for the following

.1 Each type of sprinkler.

.2 Signs.

.3 Operation and Maintenance Data

.1 Submit printed operating instructions and maintenance data in accordance with Section 01 33 00.

.4 Maintenance Materials

.1 Provide the following materials at Project handover:

.1 Storage cabinet.

.2 Sprinkler wrench.

.3 Spare stock of sprinklers. Include at least one head of each type and temperature rating installed in system.

1.5 **QUALITY ASSURANCE**

.1 Qualifications

.1 An accredited member in good standing of the Canadian Automatic Sprinkler Association.

1.6 **CODES AND REGULATIONS, PERMITS, COSTS AND FEES**

.1 Comply with municipal and provincial codes, rules and regulations and/or authorities having jurisdiction.

.2 Apply for and obtain permits required for this Work and pay costs levied for permits, inspections and fees.

.3 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.

.1 Revisions issue: Latest version as amended to date.

2 Products

2.1 **LINE MATERIALS**

.1 General

.1 Unless otherwise noted, equipment and apparatus to be ULC listed and labelled, and FM approved.

.2 All grooved couplings and fittings, valves and specialties shall be the Products of a single manufacturer. Grooving tools shall be of the same manufacture as the grooved components.

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

2.2 **SPRINKLER HEADS**

.1 Ratings

.1 ULC and FM listed for fire service.

.2 Sprinkler body shall be die-cast, with a hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss.

.3 Standard orifice size: 12 mm diameter orifice or 13 mm diameter orifice.

.4 Standard temperature rating: 57°C to 74°C (135°F to 165°F).

.5 Intermediate and high temperature rating heads to suit local conditions.

.2 Type

.1 Indicated by type in accordance with the following

.2 No ceilings

.1 “U-1”: Upright, bronze body, glass-bulb or link and lever type

.3 Suspended or drop ceilings

.1 “P-1”: Pendent, chrome plated body and escutcheon plate, link and lever type.

.2 “P-2”: Pendent, chrome plated body and escutcheon plate, glass bulb type.

.3 “P-3”: Recessed, chrome plated body ring and cup, glass bulb type.

.4 “P-4”: Flush, concealed with adjustable, diffusable (chrome) (white) (factory painted, colour to be selected) cover plate.

.4 Side wall

.1 “S-1”: Side wall, bronze body and chrome escutcheon plate, glass bulb or fusible solder type.

.2 “S-2”: Side wall, chrome plated body and escutcheon plate, glass bulb or fusible solder type.

.5 Deluge systems

.1 Open type heads, of style to suit location.

.6 Spare heads and cabinet

.1 Each sprinkler system: ULC approved metal cabinet containing required number of spare sprinkler heads of each type and temperature rating.

.2 Wrench for removal and replacement of sprinkler heads.

.7 Acceptable Manufacturers

.1 Victaulic Company

.2 Viking Sprinkler Company

.3 Reliable Automatic Sprinkler Company

.4 Tyco

.5 Or accepted equal

.3 In lieu of rigid pipe offsets or return bends for sprinkler drops, the Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System may be used to locate sprinklers as required by final finished ceiling tiles and walls.

.1 The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel 1” NPT male threaded nipple for connection to branch-line piping, and a zinc-plated steel reducer with a ½” or ¾” NPT female thread for connection to the sprinkler head.

.2 Include a ULC/UL approved Series AH2 braided hose with bend radius to 50 mm to allow for proper installation in confined spaces.

.1 The hose shall be listed for (four bends at 787.5 mm length) (five bends at 915 mm length) (six bends at 1220 mm length) (six bends at 1524 mm length) (seven bends at 1830 mm length). Union joints shall be provided for ease of installation.

.3 The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket.

.1 The bracket shall allow installation before the ceiling tile is in place.

.4 The braided drop system is ULC/UL listed and FM approved for sprinkler services to 1206 kPa (175 psi).

2.3 ALARM CHECK VALVES

.1 General

.1 ULC and FM listed for fire service.

.2 Of same manufacture as specified for sprinkler heads.

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

.2 Wet Sprinkler Systems

.1 Construction

.1 Resiliently seated wet alarm check valve

.2 Fitted with OS & Y gate valves or supervised butterfly valves

.3 Flow and pressure switches

.4 Alarm piping connection to water motor gong

.5 Upstream and downstream pressure gauges

.6 Test connection

.7 Main drain valve

.3 Dry Sprinkler Systems

.1 Construction

.1 Resiliently seated dry alarm check valve with accelerator

.2 Required air pressure shall be 90 kPa (13 psig)

.3 Valve shall be externally resettable.

.4 Fitted with OS & Y gate valves or supervised butterfly valves

.5 Flow and pressure switches

.6 Alarm piping connection to water motor gong

.7 Upstream and downstream pressure gauges

.8 Test connection

.9 Main drain valve

.2 Air compressor

.1 Electric motor drive air compressor.

.2 Complete with piping and controls for automatic operation of compressor to maintain air pressure on downstream side of each dry pipe valve.

.3 Normally Open pressure switches with snubbers on downstream side of each dry pipe valve.

2.4 ANCILLARY EQUIPMENT

.1 Water Gong

.1 Water operated outside alarm bell, weather protected.

.2 Excess Pressure Pump

.1 Construction

.1 Close coupled bronze pump with stainless steel shaft

.2 Motor size, pump size, and head capacity as shown

.3 Pressure switch with pressure differential of 100 kPa (5 psi) to operate excess pressure pump

.4 Shut-off valve and strainer on pump inlet

.5 Relief valve, check valve and shut-off valve on pump discharge connection

.2 Acceptable Manufacturers

.1 Albany

.2 Price Pump Company

.3 Double Check Valves and Backflow Preventers

.1 Construction

.1 ULC and FM listed for fire service

.2 Double check valve assemblies to be in accordance with CSA Standard B64.5, latest edition

.3 Backflow preventer assemblies to be in accordance with CSA Standard B64.4, latest edition

.2 Acceptable Manufacturers

.1 Zurn

.2 Watts

.3 Victaulic

.4 Conbraco

.5 Or accepted equal

3 Execution

3.1 **GENERAL**

.1 Apportionment of the Work

.1 Classify and apportion all materials and the performance of all labour to trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply and as required to efficiently execute the work involved in this Contract.

.2 Measurements and Deviations

.1 Where any parts of the Work are specifically located by dimensions on the Drawings, check and verify these dimensions on the Site prior to installation.

.2 Examine work of other trades or Contractors prior to commencement of fire protection installations. Immediately report in writing to Consultant any discrepancies on the part of any other Contractor which will affect fire protection installations. Failure to report discrepancies shall be considered acceptance of conditions.

.3 Where Site conditions require minor deviations from indicated arrangements or locations, make changes on approval of Consultant without additional cost to Owner.

.4 Should discrepancies occur during installation of fire protection work which will necessitate major revisions, immediately notify Consultant and secure his authorization in writing before proceeding with the Work.

3.2 **INSTALLATION**

.1 Sprinkler Head Selection

.1 Select heads for general areas in accordance with the following:

Exposed - no ceilings	U-1
Suspended or drop ceilings - unless otherwise shown on Drawings	(P-1) (P-2) (P-3) (P-4)
Side wall	(S-1) (S-2)
Installation in column webs	S-1

.2 In T-bar ceilings, locate heads in centre of ceiling tile to present an orderly appearance.

.3 For deluge systems, use open type heads, of style to suit location.

.2 Do not install any sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install any sprinkler with a cracked bulb.

.1 Sprinkler bulb protector shall be removed by hand. Do not use any tools or devices that could damage the bulb.

.3 Test Connections and Drains

.1 Locate inspector's test connections, complete with valve, sight glass, and drain piping either at high points of sprinkler system or at the end of the longest run of sprinkler piping in accordance with NFPA 13.

.4 Flushing of Piping

.1 Flush sprinkler system piping in accordance with NFPA requirements.

.2 Flush underground piping and lead-in connections before connection is made to sprinkler system risers.

3.3 TESTING

.1 Requirements

.1 Execute fire protection systems and equipment tests in accordance with NFPA requirements

.2 Minimum hydrostatic test of not less than 1380 kPa (200 psig) pressure for two hours, or at 345 kPa (50 psi) in excess of maximum static pressure developed in system, if maximum static pressure is in excess of 1034 kPa (150 psig).

.3 Execute tests in presence of Consultant and Owner's authorized representative.

.4 Promptly repair defects which develop during tests, and then re-test system to complete satisfaction of authorized inspectors.

.5 Submit a certificate covering materials and tests to Underwriter's Inspection Authority, together with a request for inspection and approval of complete fire protection system. On receipt of approval, forward certificate to Owner.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section including but not limited to that listed herein.

.2 The terms “mechanical work”, “Mechanical Contractor” or their derivatives includes the Work of Divisions 21, 22, 23, and 25, unless otherwise specified.

.3 Piping systems:

.1 Storm drainage system within building(s) including roof drains and connection to buried storm sewer 1.5 m outside building wall

.2 Sanitary drainage and venting system within building(s) including connection to buried sanitary sewer 1.5 m outside building wall

.3 Domestic cold, hot and recirculating water piping to plumbing fixtures within building

.4 Domestic cold water piping to 1.5 m outside building wall

.5 Natural gas piping

.6 Excavation, bedding, and backfilling of pipe trenches for buried piping inside building and to 1.5 m outside

.4 Equipment:

.1 City water meter

.2 Plumbing specialties

.3 Drainage specialties

.4 Plumbing fixtures and fittings

.5 Hot water storage tank(s) and heater(s)

.6 Pumps

1.2 **CODES, REGULATIONS AND STANDARDS**

.1 Comply with municipal or provincial codes, rules and regulations and/or authorities having jurisdiction.

.2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.

.3 Revisions issue: Latest version as amended to date.

1.3 **PERMITS AND INSPECTIONS**

.1 Material Approvals

.1 Obtain special inspection and approvals by CSA and/or local authorities, for materials where specified.

.2 Obtain such approval for the particular installation with the co-operation of the material Supplier.

.2 Permits

.1 Obtain permits required for the installation of mechanical trades work including:

.1 Plumbing inspection

.2 Electrical inspection

.2 Arrange for inspections and tests and pay all fees and costs for the permits, inspections and tests. Obtain permits immediately after notification of award of Contract.

.3 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.4 WORKING DRAWINGS AND DOCUMENTS

.1 Design Drawing Intent

.1 The design drawings are schematic in arrangement, and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.

.2 The Work is suitably outlined on the Drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram except where in certain cases the Drawings may include details giving the exact locations and arrangements required.

.3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.

.4 In order to provide clarity to the arrangement of the Work, not all details including valves, thermometers, pressure gauges, etc. are shown on the plan drawings. Refer to Schematic Drawings, standard details and the Specification for these requirements.

.5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the Drawings, install to these requirements.

.6 Where standard details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.

.2 Contractor Coordination Responsibilities

.1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this division of the Work, as well as providing coordination with other

divisions and/or contracts. This supervisor may be full time or part time on site, as appropriate to the work stage and complexity of the Work, at the discretion of the Owner.

.2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.

.3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.

.4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.

.5 Prepare construction/installation/fabrication drawings, coordinated with other trades and contracts, as required.

.1 Provide sufficient detail to disclose critical interferences of major equipment and services to ensure adequate accessibility.

.2 Specific dimensions for equipment location or access which are shown on the Consultants Drawings.

.3 Indicate sleeves, openings and stress points (such as anchors, guides and inserts).

.4 Indicate deviation in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed which is different from those show on the Design Drawings.

.5 Provide these Drawings to other trades for coordination with their Work.

.6 Update these Drawings as part of the As-Built Drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.

.6 The Design Drawings show the major requirements for the installation of equipment based on one manufacturer's requirements, but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.

.7 The construction/installation/fabrication Drawings are not to be submitted as Shop Drawings. Make them available for viewing at Site when requested by the Consultant.

.3 Review Before Proceeding (HOLD)

.1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract.

.2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.

1.5 **COORDINATION AND EXAMINATION**

.1 Reference

.1 To Section 01 10 00.

.2 Examination

.1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.

.2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.

.3 Coordination

.1 Coordinate Work of Division 21, 22, 23 and 25 such that items will properly interface with Work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.

.2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.

1.6 **EXISTING SERVICE**

.1 Tie-in to Existing Services

.1 Do not shut down or make tie-in connections to any existing service without written permission of the Owner and/or Consultant.

.2 Arrange Work to minimize interruption to physical access to the building.

.3 Include for all costs associated with making connections to existing services, including but not limited to, cutting and patching of existing floors, partitions, ceilings and finishes.

.2 Work in Existing Buildings

.1 Route pipes, ducts, conduits and other services to avoid interference with existing installation.

.2 Relocate existing services and equipment to suit installation of new work.

.3 Temporarily remove existing plumbing fixtures to suit new construction; reconnect fixtures at completion of the Work.

.1 Do not reuse existing fixtures in new locations.

.4 Cut back and cap existing services not being used, so that finished Work presents a neat and clean appearance.

.5 Unless noted to be reused, fixtures and materials being removed become the property of the Contractor and are to be removed from site, unless otherwise noted.

.3 Continuity of Services

.1 Be responsible for any damage to existing systems, including insulation and coverings, when making connections.

.2 Keep existing buildings in operation with minimum length of shut-down periods.

.3 Include overtime work to tie-in piping or wiring at night or on weekends.

1.7 **PROVISION FOR FUTURE**

.1 Future Equipment

.1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.

1.8 **SUBMITTALS**

.1 Shop Drawings

.1 Conform to Section 01 33 00 and the following:

.2 Shop Drawings showing more than one size or model will not be considered unless properly marked up.

.3 For electrically driven, and fuel fired appliances, provide the following information:

.1 Electrical characteristics including voltage, phase, frequency and power rating.

.2 For motors, NEMA, class and efficiency ratings.

.3 Fuel input ratings, including flow rates and pressures.

.4 Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.

.4 For other equipment include the following information:

.1 Equipment performance ratings, including flow rates, pressures drops.

.2 Electrical control power requirements.

.5 For all equipment, include the following:

.1 Equipment dimensions and weights.

.2 Itemized product description with optional items clearly marked as being included.

.6 Provide wiring Shop Drawings:

.1 Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.

.2 Wiring diagrams alone are not sufficient; schematic and interconnecting drawings, and sequence of operation of equipment are required for review.

.3 Clearly indicate the materials and/or equipment being supplied:

.1 Details of construction, finish, accurate dimensions, capacities and performance.

.2 Certify drawings correct for construction by the manufacturer, before submission.

.3 Identify equipment Shop Drawings with designations as shown on the Drawings or in the Specifications.

.4 If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.

.4 Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment.

.1 Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.

1.9 **AS-BUILT" RECORD DRAWINGS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.

1.10 **INSTALLATION AND START-UP INSTRUCTIONS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.

1.11 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 In addition, include the following in the manuals:

.1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.

.2 Operating instructions, including start-up and shut-down procedure.

.3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.

.4 List of spare parts.

.3 All the above applies to component parts of equipment whether they are manufactured by the Supplier of the equipment or are supplied as a component part of an item of equipment.

1.12 **CLEANING, TESTING AND APPROVAL RECORDS**

.1 Records

.1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/ water concentrations, inspections and approvals by the plumbing inspector.

.2 Forward these tests to the Owner on completion of the Work in accordance with Section 01 33 00.

.3 Forward to Consultant, copy of records on site on completion of each test, cleaning operation, etc.

1.13 **DIMENSIONS AND QUANTITIES**

.1 Dimensions

.1 Dimensions shown on Drawings are approximate.

.2 Verify dimensions by reference to Shop Drawings and field measurement.

.2 Quantities

.1 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.

1.14 **TRADE QUALIFICATIONS**

.1 Applicable to the following trades:

.1 Plumbers

.2 Requirements

.1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the work is performed or an interprovincial certificate.

.2 Ratio of journeyman to apprentice: not to exceed the defined ratio in the Apprenticeship Act of Ontario.

.3 On award of Contract, submit a list of trade journeyman and apprentices, together with their certificate and registration numbers.

.4 Certificates and registration must be provided to the Consultant on request.

.5 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

2 Products

2.1 **MOTORS AND WIRING**

.1 In accordance with Section 23 05 13 Motors and Wiring for Mechanical

2.2 **METERS AND GAUGES**

.1 In accordance with Section 23 05 19 Meters

2.3 **PIPE, FITTINGS AND VALVES**

.1 In accordance with Section 23 05 23 Pipes, Fittings and Valves

2.4 **EXPANSION FITTINGS AND LOOPS**

.1 In accordance with Section 23 05 24 Piping Specialties

2.5 **HANGERS AND SUPPORTS**

.1 In accordance with Section 23 05 29 Pipe Hangers and Supports

2.6 **VIBRATION AND SEISMIC RESTRAINT**

.1 In accordance with Section 23 05 48 Noise and Vibration Control and 23 05 49 Seismic Restraint

2.7 **IDENTIFICATION FOR EQUIPMENT AND PIPING**

.1 In accordance with Section 23 05 53 Mechanical Identification

2.8 **PIPING INSULATION**

.1 In accordance with Section 23 07 19 Piping Insulation

2.9 **MATERIALS**

.1 Use new materials and equipment free from defects impairing strength and durability, as specified or specified equivalent.

.2 Of Canadian manufacture wherever possible.

.3 Labelled or listed as required by code and/or inspection authorities.

.4 Design of mechanical systems has been based on the first listed Supplier and model number/size stated on the equipment schedules on the Drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.

2.10 **EQUIPMENT/STRUCTURE COORDINATION**

.1 Locations and dimensions of curbs and roof and floor opening framing, where indicated on the Drawings, are based on an arrangement to suit the above named Supplier.

.2 Be responsible to verify the actual size requirements of the openings, and notify the Consultant immediately in case the dimension of the unit supplied and the connecting ductwork/piping, etc. are at variance with the dimensions given on the Drawings.

.3 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.

2.11 **STANDARD SPECIFICATIONS**

.1 Product Quality

.1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard Specifications issued by authorities having jurisdiction.

.2 Do not apply such standard Specifications to decrease the quality of workmanship, products and services required by the Contract Documents.

2.12 **MANUFACTURER'S NAMEPLATES**

.1 Metal Nameplates

.1 Provided with raised or recessed lettering, on each piece of equipment.

.2 Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.

.3 Mount on same stand-off Underwriters Laboratories and/or CSA registration plates.

.2 Nameplate Data

.1 Indicate:

.1 Size

.2 Capacity

.3 Equipment model

.4 Manufacturer's name

.5 Serial number

.6 Voltage

.7 Cycle

.8 Phase and power of motors

3 Execution

3.1 **GENERAL**

.1 Execute Work in accordance with requirements specified in the various sections of Division 22.

.2 Lay out work of each trade so that it does not interfere with work under other divisions of Specifications.

.3 Make good any damage to Owner's property or other trade's work caused by improperly locating or carrying out of Work.

.4 Supply anchor bolts and templates for installation by other divisions.

.5 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided alteration is made before installation.

3.2 **INSTALLATION**

.1 General

.1 Install complete plumbing, drainage and vent piping within washrooms, etc. in accordance with the Ontario Building Code, standard trade practice and as specified herein.

.2 Arrange piping within pipe spaces behind washroom fixtures to allow unimpeded access to piping for servicing.

.2 Balancing Valves

.1 Where two or more branches connect to a domestic hot water recirculating line, provide each return branch with a globe or circuit balancing valve.

.3 Air Handling Equipment Drains

.1 Provide drains for fan casings, air handling equipment, and low points in ductwork in locations and in arrangements as indicated on the Drawings, or as required by design.

.2 Drain piping is as specified for sanitary drainage, with deep seal copper trap.

.3 Install trap seal equivalent to not less than one and one-half times the maximum static pressure in duct system.

3.3 EQUIPMENT INSTALLATION

.1 Set equipment in place, align, connect and place in operation with:

.1 Controls set for efficient, stable operation.

.2 Initial lubrication and oil sumps filled.

.3 Connections and required safety devices installed.

.2 Protect equipment from damage during and after installation, and on completion of Work ensure that equipment is free from cracks, scratches, discolourations, tool marks, and other defects.

.3 Thoroughly clean finished surfaces before acceptance of Work.

.4 Install heater vents complete with necessary supports, hangers, braces, roof flashing, storm collar, and round top.

3.4 FLUSHING AND STERILIZATION

.1 Sterilize water piping connected to municipal water supply in accordance with local municipal requirements.

.2 Flush each system after completion by allowing full flow of water through the system for a period of fifteen minutes or longer when directed by the Consultant.

.3 After flushing of the system is completed, perform a twenty-four hour contact sterilization treatment by treating the water with 50 ppm of chlorine as recommended in AWWA Specification C-651.

.4 After sterilization period has elapsed, flush system to reduce chlorine content to an acceptable level, but not less than thirty minutes.

.5 Remove and clean strainer screens after flushing operation is completed. Repeat two weeks after initial operation of systems and within two weeks after Substantial Completion.

3.5 **SPARE PARTS**

.1 Furnish spare parts

.1 One set of packing glands for each size of pump gland.

.2 One casing joint gasket for each size pump.

.3 One head gasket for each heat exchanger.

.4 One glass for each gauge glass.

.5 One set of V-belts for each drive.

.6 One filter cartridge or set of filter media for each filter or filter bank installed.

3.6 **PROTECTION**

.1 Protect work and materials before, during and after erection from weather and other hazards and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

.3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.

.4 Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting and other damage resulting from work of this Contract.

.1 Place a 19 mm thick plywood underlaid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from, or over, such surfaces.

.2 Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage.

.3 Work damaged due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

3.7 **MAINTENANCE OF BEARINGS**

.1 During Construction

.1 Turn-over rotating equipment at least once a month after delivery;

.1 Run-in sleeve type bearings in accordance with manufacturer's recommendations.

.2 Drain, flush out and refill with new charge of oil or grease.

.3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation.

.4 Provide extended grease nipples for bearing lubrication.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

1.3 **REFERENCE STANDARDS**

.1 Back-flow preventers: To CAN/CSA B64 standard series

2 Products

2.1 **BACK FLOW PREVENTERS**

.1 General

.1 Products from Watts have been used as a guide to establish standard of construction. Comparable Products are acceptable from the following manufacturers:

.1 Watts

.2 Honeywell/Braukmann

.3 Zurn Wilkins

.4 Cla-Val

.5 Apollo

.6 Conbraco

.2 Vacuum Breakers, Pressure Type (PVB)

.1 To CSA B64.1.2 for back-siphonage, no back pressure.

.2 Working pressure: To 1000 kPa (150 psig).

.3 Working temperature: To 60°C (140°F).

.4 NPS ½ to NPS 2: Anti-siphon pressure vacuum breaker complete with bronze body and spring loaded single float and disc with independent first check, shut off valves and bronze type test cocks for winterization draining. Springs should be of stainless steel construction.

.3 Double Check Valve Assemblies (DCVA)

.1 To CSA B64.5

.2 Two independent positive seating check valves with captured springs and seat discs. The valve seat and discs shall be replaceable. All internal components shall be serviceable by access cover(s).

.3 Working pressure: To 1200 kPa (175 psig).

.4 Working temperature: To 60°C (140°F).

.5 NPS ½ to NPS 2: Complete with quarter turn shut-off valves, bronze strainer and test cocks.

.6 NPS 2½ to 10: Complete modular check valve assemblies with centre stem guiding, non-rising stem gate valves, test cocks and strainer.

.4 Backflow Preventer with Intermediate Atmospheric Vent (DCAP)

.1 To CSA B64.8.

.2 Two independent check valves with intermediate vacuum breaker and relief vent.

.3 Working pressure: To 1200 kPa (175 psig).

.4 NPS ½ to NPS ¾: All bronze construction complete with integral strainer, union connection on inlet and outlet.

.5 Dual Check Vacuum Breaker for Vending Machines

.1 To CSA B64.8.

.2 Dual check valve, ball check valve and atmospheric vent.

.3 Working pressure: To 1000 kPa (150 psig).

.4 NPS 3/8: Stainless steel body construction.

.6 Reduced Pressure Principle (RPP)

.1 To CSA B64.4.

.2 Two independent check valves with captured springs, access for maintaining internals, replaceable valve seats, intermediate relief valve, shut-off valves and ball type test cocks.

.3 Working pressure: To 1200 kPa (175 psig).

.4 NPS ½ to NPS 2: Complete with quarter turn shut-off valves and bronze strainer.

.5 NPS 2½ to NPS 10: Complete with non-rising stem, shut-off gate valves and strainer.

.6 Backflow preventer test kit: Pressure gauge, colour coded needle valves and hose, adaptors, replaceable hose filters and valve stem seals, carrying case.

2.2 **MISCELLANEOUS EQUIPMENT**

.1 Make-up Water Feeder Valves

.1 Line size, complete with adjustable pressure reducing valve, anti-siphon check and strainer. Products from the following manufacturers are acceptable.

.1 Taco

.2 Armstrong

.3 Watts

.2 Water Pressure Reducing Valve

.1 Spring loaded, field adjustable, strainer, replaceable seat. Access for servicing internal components. Products from the following manufacturers are acceptable.

.1 Watts

.2 Zurn

.3 Conbraco

.3 Shock Absorbers

.1 Water hammer arrestor, sized in accordance with P.D.I.-WH201. Products from the following manufacturers are acceptable.

.1 Watts

.2 Zurn Shoktrol

.3 PPP Inc.

.4 Non-Freeze Wall Hydrants (WH)

.1 “WH-1": Non-freeze box type, flush mounting to wall, with NPS 3/4 hose connection, self-draining, integral hose end vacuum breaker, hinged locking cover, galvanized wall sleeve, ground joint union elbow adapter and operating key. Products from the following manufacturers are acceptable.

.1 Ancon

.2 Zurn

.3 MI Fab

.2 ”WH-2": Non-freeze exposed type, with NPS 3/4 hose connection, self-draining, integral hose end vacuum breaker, galvanized wall sleeve, ground joint union elbow adapter and operating key.

.1 Ancon

.2 Zurn

.3 MI Fab

.5 Hose Bibbs (HB)

.1 Rough brass construction with hose end spout, size as indicated.

.1 Emco

.2 Cambridge Brass

3 Execution

3.1 **INSTALLATION - MISCELLANEOUS**

.1 Back Flow Preventers

.1 Provide backflow preventers selected in conformance to CSA B64.10, where a connection is made between any system conveying potable water and a system carrying non-potable water or any other liquid.

.2 Install backflow preventers where shown on Drawings, in accordance with manufacturers recommendations, and as follows:

.1 Locate RPP devices at 1.2 mm above finished floor.

.2 Locate VBP devices exposed as close to fixture connection as possible.

.3 Provide drain collector at relief valves and NPS 3/4 drain from DCAP and RPP devices and run drain to nearest floor drain.

.3 Testing:

.1 Provide the services of an independent inspection agency to verify operation of all backflow prevention devices provided with testing ports.

.2 Provide inspection tag on each such device.

.3 Submit test results to building plumbing inspector and Consultant.

.2 Make-up Water Valves

.1 Locate in domestic water lines to heating and cooling systems where shown.

.3 Water Pressure Reducing Valves

.1 Locate in domestic water lines as shown, with capacity and pressure reduction ratings as shown.

.2 Provide pressure gauge on downstream side of pressure relief valve, complete with pet-cock.

.3 Provide pressure relief valve suitably sized and pipe to drain.

.4 Shock Absorbers

.1 Locate shock absorbers in hot and cold water lines:

.1 At far ends of mains

.2 At branch lines to each flush valve and quick closing valve

.3 At dead ends of branch piping or to groups of plumbing fixtures

.4 At isolated individual plumbing fixtures

.5 Wall Hydrants

.1 Verify wall thickness at each hydrant to ensure correct hydrant length.

.6 Hose Bibbs

.1 Mount 1050 mm above finished floor.

.2 Provide a line mounted vacuum breaker selected for continuous pressure.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **PUMPS - GENERAL REQUIREMENTS**

.1 The following are minimum construction requirements, unless specified elsewhere.

.2 Pump Casings

.1 Close grained cast iron or cast bronze as specified.

.2 Fitted with casing or impeller wear rings, or both.

.3 Impellers

.1 Enclosed bronze or duralloy.

.2 Dynamically balanced.

.3 Mounted on carbon steel shaft fitted with stainless steel or bronze sleeves.

.4 Seals

.1 Suction pressures less than 640 kPa (100 psi): Fitted with mechanical seals.

.2 Stuffing box pressure in excess of 690 kPa (100 psig): Balanced type seals.

.3 Pumps with packing glands: Fitted with stainless steel shaft sleeves for full length of stuffing box.

.5 Performance

.1 Characteristic curve to be continuously rising from run-out to shut-off.

.2 Select pump to operate within flow range from 30% below point of maximum efficiency to 10% above that point for impeller diameter chosen.

.3 Installed impeller diameter not to exceed 90% of maximum impeller diameter catalogued for pump casing.

.4 Motors to be sized for continuous operation without motor overload at runout condition for impeller size and rotational speed selected.

2.2 **DOMESTIC WATER PUMPS - IN LINE CIRULATORS**

.1 Construction

.1 Working pressure: to 1200 kPa (175 psi).

.2 Bronze fitted or bronze construction with alloy steel shaft.

.3 Shaft with integral thrust collar, mechanical seal, supported by two oil lubricated bronze sleeve bearings.

.4 Resiliently mounted motor.

.2 Manufacturers

.1 S. A. Armstrong Limited

.2 ITT Fluid Products Canada (Bell & Gossett)

.3 Taco

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Set in place, and make piping and electrical connections to pumps in accordance with manufacturer’s instructions.

.2 Check pump rotation.

.3 Set up and adjust controls.

.4 Pipe drain tapping to drain.

.5 Install gauges.

.2 In-line Circulators

.1 Install with fluid flow direction as indicated by flow arrows on pump body.

.2 Support piping and pump at flanges or near unions on connections to unit.

.3 Install with bearing lubrication points accessible.

.4 Check pump rotation.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **DRAINAGE SPECIALTIES**

.1 Acceptable Manufacturers

.1 Watts

.2 Zurn Industries Ltd.

.3 MI Fab

.2 Products from Watts have been used as a guide to establish the standard of construction. Comparable Products are acceptable from the above listed manufacturers. Sizes are as shown on Drawings.

2.2 **FLOOR DRAINS**

.1 General Construction

.1 Drain body to have tapped primer connection.

.2 The type letter allocated to the following list of floor drains identifies that particular drain on the Drawings.

.2 FD-"A"

.1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 13 mm thick, 150 mm diameter polished nickel bronze strainer, and push-on, caulked or "MJ" bottom outlet.

.3 FD-"B"

.1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 13 mm thick, 150 mm diameter polished nickel bronze strainer, sediment bucket, and push-on, caulked or "MJ" bottom outlet.

.4 FD-"D"

.1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 125 diameter nickel bronze combination strainer and 100 mm x 225 mm oval funnel, and push on, caulked or "MJ" bottom outlet.

.5 FD-"E"

.1 Two-piece Dura coated cast iron body with double drainage flange, weep holes, non-puncturing flashing collar, adjustable 100 mm diameter cast iron above floor hub and push-on, caulked or "MJ" bottom outlet.

.6 FD-"F"

.1 Dura coated cast iron body with 300 mm square fixed top, double drainage flange, clamp device, weep holes, heavy duty Dura coated iron grate, removable sediment bucket, and push on, caulked or "MJ" bottom outlet.

.7 FD-"H"

.1 Dura coated cast iron scupper drain with flashing flange, removable bolted brass sloping grate with flange serving as flashing clamp, and ninety degree threaded outlet.

.8 Floor Drain Traps and Primers

.1 Trap seal primer valves: Cast brass body, integral vacuum breaker and NPS ½ sweat connections.

.2 Automatic flush tank for priming of trap: Automatic syphon, tank liner, concealed top cover, bottom supply and screw driver stop.

.3 As an alternative to automatic flush tanks electronic trap seal primer system with air gap and 13 mm solenoid valve.

2.3 DRAINAGE CLEANOUTS

.1 Buried Piping

.1 Flush floor type: Cast iron ferrule with inside caulked or spigot connection outlet, seal plug and nickel brass frame, cover suitable for type of floor in which it is to be installed, e.g. tile, terrazzo, carpet, concrete, etc. and push on, caulked or “MJ” bottom outlet. Provide membrane clamp if installed on membrane floors.

.2 Exposed Piping

.1 Cast iron piping in exposed location or in accessible pipe chases: Cast iron body with straight threaded, coated plug having a tapered shoulder that seats against a lead seal.

.2 Copper stack piping in exposed locations or in accessible pipe chases: Bronze cleanout tee, bronze ferrule and cover, secured to ferrule by bronze cap screws.

.3 Access cover for cleanouts concealed in walls: Type to suit wall surface and construction.

.4 Cover for cleanouts at base of vertical sanitary stacks or rainwater leaders: Bolted type, neoprene gasket, and brass cap screws or bolt studs, unless shown otherwise on Drawings.

2.4 **MISCELLANEOUS PRODUCTS**

.1 Back-Water Valves

.1 Cast iron body with gasketed cover, removable bronze disc and seat, and access cover.

.2 In finished areas, provide nickel bronze frame and round scoriated type cover.

3 Execution

3.1 **INSTALLATION**

.1 Floor Drains

.1 Provide each floor drain installation with a deep seal "P" trap unless otherwise shown, complete with trap primer connection tapping to conform to code requirements.

.2 Floor Drain Primers

.1 Provide each floor drain with a trap seal primer.

.1 Exception: Floor drains located in shower stalls, group showers and other locations where the floor is exposed to water on a daily basis.

.2 Use trap seal primer valves where a domestic cold water line serving a washroom fixture (preferably a water closet) is within 15.25 m of the floor drains.

.1 Above ground floor drains: Provide an NPS ½ Type K copper pipe to primer connection on drain body.

.2 Below ground floor drains: Provide an NPS ½ Type K copper pipe to within 300 mm of the floor line. Provide 9.5 mm white polybutylene tubing from this point and connect to drain body.

.3 Install trap primer in truss space or other accessible location, or as directed by Consultant.

.4 In other areas with remote floor drains, use an automatic flush tank.

.3 Cleanouts

.1 Locate drainage cleanout fittings in drainage piping:

.1 At locations indicated on the Drawings.

.2 At base of each vertical stack.

.3 As required to comply with applicable plumbing code.

.4 Back-Water Valves

.1 Provide where shown.

.5 Expansion Joints

.1 Provide vertical expansion joints near top of drainage pipe risers where total riser height exceeds 10 m from ground level.

.2 Provide horizontal expansion joints on suspended drainage pipe which:

.1 Is welded.

.2 Crosses a building expansion joint, whether the pipe is welded or not.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **PUMP GENERAL REQUIREMENTS**

.1 The following are minimum construction requirements, unless specified elsewhere.

.1 Pump casings:

.1 Close grained cast iron or cast bronze as specified.

.2 Fitted with casing or impeller wear rings, or both.

.2 Impellers:

.1 Enclosed bronze or duralloy.

.2 Dynamically balanced.

.3 Mounted on carbon steel shaft fitted with stainless steel or bronze sleeves.

.3 Seals:

.1 Suction pressures less than 690 kPa (100 psi): Fitted with mechanical seals.

.2 Stuffing box pressure in excess of 690 kPa (100 psig): Balanced type seals.

.3 Pumps with packing glands: Fitted with stainless steel shaft sleeves for full length of stuffing box.

.4 Performance

.1 Characteristic curve to be continuously rising to from run-out to shut-off.

.2 Select pump to operate within flow range from 30% below point of maximum efficiency to 10% above that point for impeller diameter chosen.

.3 Installed impeller diameter not to exceed 90% of maximum impeller diameter catalogued for pump casing.

.4 Motors to be sized for continuous operation without motor overload at runout condition for impeller size and rotational speed selected.

2.2 **SANITARY SUMP PUMPS**

.1 Construction

.1 Simplex (Duplex) pump set.

.2 Centrifugal sewage pump, vertical, shaft driven, single stage, non-clog.

.3 Cast iron casing and cast iron semi-open impeller, alloy steel shaft.

.4 Ball thrust bearing, bronze guide bearings, grease lubrication.

.5 Cast iron motor support.

.6 Motor.

.7 Schedule 40 black steel pump leg and discharge pipe.

.2 Fitments

.1 Aluminum cover plate complete with structural steel curb frame suitable for grouting into a concrete sump, and heavy gasket.

.2 Coordinate delivery of curb frame to meet construction requirements. Frame will be installed by General Trades when pouring concrete sump.

.3 300 x 300 mm inspection cover in the cover plate.

.4 NPS 3 vent tapping.

.5 Sleeved holes for mounting float rods.

.3 Access Ladder

.1 Provide a hot dipped galvanized steel ladder 450 mm wide.

.2 75 x 13 mm stringers.

.3 19 mm diameter rungs at 300 mm o.c.

.4 Provide first step 150 mm below manhole.

.5 Locate steps in concrete formwork before concrete is poured.

.4 Simplex Pump Control

.1 Simplex Pump automatically controlled by liquid level switch mounted on a bracket attached to floor plate.

.2 Complete with brass float rod, limit stops, float rod guide, and seamless copper float.

.3 Single point power supply.

.5 Duplex Pump Control

.1 Duplex pumps automatically controlled by (a mechanical) (an electric) alternator.

.2 Automatically alternates lead pump and operates both pumps on high flow demand.

.3 Provide alternator control assembly complete with starters, mounting bracket, brass float rod, limit stops, float rod guide, copper float and control transformer.

.4 Single (Dual) point power supply.

.6 Manufacturers

.1 S.A. Armstrong

.2 ITT-Goulds

.3 Paco

.4 Aurora

2.3 SUBMERSIBLE SUMP PUMP

.1 Construction

.1 Bronze (Cast iron) construction with semi-open type bronze impeller to pass solids of 32 mm diameter.

.2 Stainless steel shaft.

.3 Integrally cast base and discharge elbow.

.4 Motor with built-in thermal overload protection, and sealed from contact with pumped fluid.

.2 Pump Control

.1 Automatic operation by a diaphragm actuated, factory set, integral liquid level control (floats to be oil resistant).

.2 Complete with 3 m long ULC approved waterproof, three-wire power cable with U-ground moulded plug.

.3 Manufacturers

.1 Xylem Flygt

.2 Goulds

.3 Little Giant

.4 Grundfos

2.4 PROCESS SUMP PUMP CONTROLS

.1 Where Required

.1 Process effluent sump tanks.

.2 Where shown on Drawings.

.2 Level Control

.1 Magentrol Model 103 F EP/VP-TDM-S13-S13 explosion proof electrical liquid level control, Arrangement No. 1.

.2 Suitable for liquid operating conditions of 20°C (68°F) and specific gravity of 0.90 to 1.0.

.3 Level controller to be supplied with 3 m of cable and NPS 4 1035 kPa (150 lb) steel mounting flange.

.4 Install level control inside NPS 8, Schedule 40 steel stilling pipe with NPS 4 flange at top. Cut four 50 mm wide x 300 mm high slots in top and bottom of NPS 8 stilling pipe starting 75 mm above bottom and 75 mm below cover plate.

.3 Sequence of Operation

.1 When level in pit drops to 300 mm above bottom of pit, level controls stop pump.

.2 When level in pit rises to 900 mm above bottom of pit, level controls start pump.

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Make piping and electrical connections to pumps.

.2 Check pump rotation.

.3 Set up and adjust controls.

.4 Pipe drain tapping to drain.

.5 Install gauges.

.2 Sanitary Sump Pumps

.1 Power wiring between starters and pump motors. Line side wiring will be connected to starters under (Division 26) (a separate Electrical Contract).

.2 Provide gate valve and non-slam counterweighted check valve and flexible metal hose just above cover plate, in discharge line from each pump. Set counterweight arm in horizontal position.

.3 Keep discharge piping clear of pumps to facilitate removal from sump.

.4 Align pump assembly after mounting and securing cover plate.

.3 Submersible Sump Pump

.1 Provide check valve just below cover plate in discharge line from each pump.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **DRAINAGE SPECIALTIES**

.1 Acceptable Manufacturers

.1 Watts

.2 Zurn Industries Ltd.

.3 J.R. Smith

.4 MI Fab

.5 ACO (trench drain only)

.2 Product description from Watts is used as a basis to establish standard of construction. Comparable Products from the above listed manufacturers are acceptable.

2.2 **DRAINAGE CLEANOUTS**

.1 Buried Piping

.1 Flush floor type: Cast iron ferrule with inside caulked or spigot connection outlet, seal plug and nickel brass frame and cover suitable for type of floor in which it is to be installed, e.g. tile, terrazzo, carpet, concrete, etc. Provide membrane clamp if installed on membrane floors. Provide heavy duty top for cleanouts installed in heavy duty traffic areas.

.2 Exposed Piping

.1 Cast iron piping in exposed location or in accessible pipe chases: Cast iron body with straight threaded, coated plug having a tapered shoulder that seats against a lead seal.

.2 Copper stack piping in exposed locations or in accessible pipe chases: Bronze cleanout tee, bronze ferrule and cover, secured to ferrule by bronze cap screws.

.3 Access cover for cleanouts concealed in walls: Type to suit wall surface and construction.

.4 Cover for cleanouts at base of vertical sanitary stacks or rainwater leaders: Bolted type, neoprene gasket, and brass cap screws or bolt studs, unless shown otherwise on Drawings.

2.3 **MISCELLANEOUS PRODUCTS**

.1 Back-Water Valves

.1 Cast iron body with gasketed cover, removable bronze valve disc and seat, and access cover. Sizes indicated on Drawings.

.2 In finished areas, provide nickel bronze frame and round scoriated type cover. Sizes indicated on Drawings.

3 Execution

3.1 **INSTALLATION**

.1 Roof Drains

.1 As indicated by architects.

.2 Provide adaptors for connection to roof drain bodies.

.2 Cleanouts

.1 Locate drainage cleanout fittings in drainage piping:

.1 At locations indicated on the Drawings.

.2 At base of each vertical stack or rainwater leader.

.3 As required to comply with applicable plumbing code.

.3 Back-Water Valves

.1 Provide where shown.

.4 Expansion Joints

.1 Provide vertical expansion joints near top of drainage pipe risers where total riser height exceeds 10 m from ground level.

.2 Provide horizontal expansion joints on suspended drainage pipe which:

.1 Is welded.

.2 Crosses a building expansion joint, whether the pipe is welded or not.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **CODES AND REGULATIONS**

.1 Conform to the latest edition of the codes and standards referenced herein.

.2 Pressure Ratings

.1 Suitable for working pressure of 860 kPa (125 psi) (1035 kPa (150 psi))

.3 Efficiency and Stand-by Loss Ratings

.1 To ASHRAE/IES 90.1b

.4 Electric Hot Water Heaters to:

.1 CSA C22.2 No. 110

.2 CSA C191 Series M

.5 Relief Valves

.1 Temperature, pressure and combination: To CAN1-4.4, or ANSI Z21.22

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Provide certification for compliance to ASHRAE 90.1 for efficiency and stand-by loss ratings.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **GENERAL REQUIREMENTS**

.1 Connections up to NPS 3 to be screwed and over NPS 3 to be flanged.

.2 Water heaters to be factory pre-piped and pre-wired, except where devices are specified to be shipped loose to be installed by others.

2.2 **LIGHT COMMERCIAL ELECTRIC TANK-TYPE**

.1 Construction

.1 Glass lined steel tank with replaceable magnesium anode

.2 50 mm mineral wool or foam injected insulation

.3 Baked enamelled steel jacket housing

.4 Zinc plated copper sheathed medium watt immersion elements arranged for flip-flop operation controlled by close tolerance positive snap action thermostats

.5 Manual reset high temperature limit switch

.6 Built-in and factory pre-wired controls including contactors

.7 Hose threaded drain valve

.8 ASME rated temperature and pressure relief valve

.2 Electrical

.1 Capacities to 54 kW

.2 As indicated on Drawings.

.3 Manufacturer

.1 A.O. Smith

.2 J.H Wood

.3 Bradford White

.4 Rheem

2.3 HEAVY DUTY ELECTRIC TANK-TYPE

.1 Construction

.1 Glass lined steel tank with replaceable magnesium anode

.2 R16 50 mm mineral wool or foam injected insulation

.3 Baked enamelled steel jacket housing

.4 Incoloy medium watt immersion elements arranged for flip-flop operation controlled by close tolerance positive snap action thermostats

.5 Manual reset high temperature limit switch

.6 Built-in and factory pre-wired controls including contactors, complete with pilot light and switch, sequencing, time clock, low water cutoff, circuit fusing, alarm bell, modulating step control

.7 Handhold cleanout

.8 Hose threaded drain valve

.9 ASME rated temperature and pressure relief valve

.2 Electrical

.1 As indicated on Drawings.

.3 Manufacturer

.1 A.O.Smith

.2 J.H Wood

.3 Bradford White

.4 Rheem

2.4 HIGH CAPACITY/HIGH STORAGE ELECTRIC TANK

.1 Construction

.1 Glass lined steel tank with replaceable magnesium anode

.2 ASME construction

.3 50 mm fibreglass insulation

.4 Baked enamelled steel jacket housing

.5 Incoloy medium watt immersion elements arranged for flip-flop operation controlled by close tolerance positive snap action thermostats

.6 Manual reset high temperature limit switch

.7 Built-in and factory pre-wired controls including contactors, complete with pilot light and switch, sequencing, time clock, low water cutoff, control and power circuit fusing, alarm bell, modulating step control, terminal blocks, safety door interlock, manual limiting switches

.8 Magnetic contactors UL rated for 100,000 cycles

.9 Handhold cleanout

.10 Hose threaded drain valve

.11 ASME rated temperature and pressure relief valve

.2 Electrical

.1 As indicated on Drawings.

.3 Manufacturer

.1 A.O.Smith

.2 J.H Wood

.3 PVI

.4 Rheem

2.5 INSTANTANEOUS WATER HEATER

.1 Construction

.1 Low watt density, copper sheathed electric heating elements, flange mounted for easy removal.

.2 Hot dipped galvanized steel tank, with minimum of 25 mm thick insulation, and baffles to direct flow of water across all elements.

.3 Full automatic controls and control panel mounted on heater, including manual reset high temperature safety cut-out, thermostat, magnetic contactor and control transformer.

.4 Pressure temperature relief valve.

.2 Manufacturers

.1 Rheem

.2 Patterson-Kelly

.3 Bosch

.4 A.O. Smith

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Provide structural steel for horizontal mounted tanks and for instantaneous heaters.

.2 Provide valved drain from each tank to nearest funnel or hub drain.

.3 Pipe-up T&P relief valve down to floor.

.4 Connect up to cold water supply lines and domestic hot water distribution piping.

.5 Provide thermometer on outlet piping from hot water tank (and as shown).

.2 Electric Hot Water Heaters

.1 Power wiring and unfused disconnected by electrical Division 26.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **CODES AND REGULATIONS**

.1 Conform to the latest edition of the codes and standards referenced herein.

.2 Pressure Ratings

.1 Suitable for working pressure of 860 kPa (125 psi) (1035 kPa 150 psi))

.3 Efficiency and Stand-by Loss Ratings

.1 To ASHRAE/IES 90.1b-1992

.4 Gas Fired Hot Water Heaters to:

.1 CSA 4.1 or CSA 4.3

.2 CGA Certification requirements

.5 Oil Fired Hot Water Heaters to:

.1 CSA B140.12

.6 Relief Valves

.1 Temperature, pressure and combination: To CSA 4.4, or ANSI Z21.22

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Provide certification for compliance to ASHRAE 90.1 for efficiency and stand-by loss ratings.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **GENERAL REQUIREMENTS**

.1 Connections up to NPS 3 to be screwed and over NPS 3 to be flanged.

.2 Water heaters to be factory pre-piped and pre-wired, except where devices are specified to be shipped loose to be installed by others.

.3 Provide gas pressure regulators in gas train to suit gas distribution pressure of 1.7 - 3.5 kPa (7-14 in WG).

2.2 **GAS STORAGE WATER HEATER - POWER BURNER**

.1 Construction

.1 Vertical cylinder tank

.2 Glass lined steel tank with replaceable magnesium anode

.3 ASME construction

.4 50 mm mineral wool or foam injected insulation

.5 Baked enamelled steel jacket housing

.6 Power gas burner for natural gas or propane, 120 V, 1 phase

.7 Hose threaded drain valve

.8 ASME rated temperature and pressure relief valve

.9 Handhold cleanout

.10 Manual reset high temperature safety cut-out

.11 Automatic controls with operating thermostat

.12 Barometric draft damper

.13 Flame inspection port opening

.14 Gas train including gas valve, gas pressure regulator, and 100% safety shut-off

.15 120 VAC, 1 phase complete with transformer

.2 Manufacturer

.1 A.O.Smith

.2 Ruud

.3 J.H.Wood

.4 PVI

.5 Lochinvar

2.3 **ANCILLARY EQUIPMENT**

.1 Vents

.1 Type "A" vent: To CAN/ULC S604 insulated double wall chimney, with stainless steel outer casing and stainless steel inner liner

.2 Type "B" vent: To CAN/ULC S605 double wall construction with annular insulating air space, with galvanized steel outer casing and aluminum inner liner

.3 Vent Fittings

.1 45°F fixed angle, swivel wye, drafthood connectors, vent cap with birdscreen, mounting brackets and hardware, fire stop separators, roof flashing kits with storm collars

.4 Manufacturers

.1 Selkirk-Metalbestos

.2 Ryder

.3 Bell

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Provide structural steel for horizontal mounted tanks and for instantaneous heaters.

.2 Provide valved drain from each tank to nearest funnel or hub drain.

.3 Pipe-up T&P relief valve down to floor.

.4 Connect up to cold water supply lines and domestic hot water distribution piping.

.5 Provide thermometer on outlet piping from hot water tank (and as shown).

.2 Vents

.1 Gas power burners: Type "A" vent.

.2 Gas atmospheric burners: Type B vent.

.3 Vent pipe to extend from vent outlet on heater to a minimum of 1.8 m above roof or as shown on Drawing. Include all necessary supports, hangers, braces, roof flashing, storm collar, and round top.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Products, equipment and services necessary to complete the Work of this section.

.2 General Requirements

.1 The following products will be supplied by NEXT Plumbing Supply (NPS):

.1 Lavatories

.1 L1

.2 L1H (Barrier Free Use)

.3 L2H

.2 Urinals

.1 U1H

.3 Water Closets

.1 W1

.2 W1H

.3 W2

.4 W2H

.5 W3

.6 W3H

.2 As part of the Shop Drawing submittal, Contractor is to submit a by-building order form to the Consultant and Owner listing the items and quantities for each building the equipment is to be installed in. Refer to the Appendices for the Plumbing and Accessories Order Form

.3 Once the shop drawings are reviewed and the order form quantities are verified by the Consultant and Owner, the Owner will submit the order form to NPS for processing as well as pay NPS for the order directly.

.4 The Contractor is to coordinate delivery of supplied items with NPS and store on site as needed prior to installation.

.5 Material defects of the products and equipment are the responsibility of NEXT and the Contractors to coordinate and replace.

.6 Replacement of any equipment or appurtenances listed in section 1.1.2.1 of this specification will be at the expense of the Contractor.

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

.1 AODA - Accessibility for Ontarians with Disabilities Act

.2 TADG - Toronto Accessibility Design Guidelines

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in the form of catalogue cuts and fully illustrating specified materials with description of components, surface finishes, hardware and securement devices.

1.4 **WARRANTY**

.1 Warrant the following Products against defects and deficiencies for a period of two years from date Work is certified as substantially performed in accordance with the general conditions of the Contract:

.2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Product satisfactory to the Consultant and at no expense to the Owner.

2 Products

2.1 **PLUMBING FIXTURES**

.1 General Requirements

.1 CSA approved plumbing fixtures and fittings, of make, type and size specified herein.

.2 Comply with the current water saving ratings of the Ontario Building Code, and ASHRAE/IEEE 90.1.

.1 Lavatories: Maximum 8.3 L/min at 413 kPa (60 psig)

.2 Urinals: Maximum 3.8 L/flush

.3 Water closets: Maximum 6.0 L/flush

.4 Shower heads: Maximum 9.5 L/min

.3 Plumbing supplies and fixture trim material to be of CSA approved plumbing brass with chrome plated finish, and of make and type specified.

.1 Each item to bear name of manufacturer or identifying trademark.

2.2 **LAVATORIES**

.1 Lavatories - Type L1H (Barrier Free Use)

.1 Type: Wall hung, vitreous china.

.2 Lavatory: White, 508 mm x 464 mm for barrier free use, dilled for concealed arm carrier with single faucet hole and overflow.

.1 American Standard "Decorum with EverClean" No. 9024.001EC.020

.3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.

.1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)

.1 Moen AC Conversion Kit - 182538

.2 Moen AC Transformer – 104630

.4 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons and flexible copper risers. Products from the following manufacturers are acceptable.

.1 McGuire Supply Kit - H170LK-BV-RB

.5 Trap: Adjustable durable solid brass “P” trap with 32 mm O.D outlet, adjustable rotation on tube outlet, slip joint inlet and cleanout plug. Products from the following manufacturers are acceptable:

.1 McGuire No. MC-8872CB

.6 Sanitary Covering:

.1 McGuire MC-PW-2000 PW2000 PROWRAP

.7 Waste fitting: Drain with open grid strainer, cast brass one piece top and tailpiece.

.1 McGuire No. 155A

.8 Basin carrier: Heavy duty steel uprights with integral welded feet., concealed arms, wall flanges to attach to backing plate secured in wall with locking device and levelling screws, wall mounted steel plated hardware. Type and model as recommended by manufacturer for each wall hung basin to suit wall construction. Products from the following manufacturers are acceptable.

.1 Watts No. WCA-411-CA-481

.9 Water Mixing Valve

.1 Powers Point of use Under Counter Thermostatic Mixing Valve

.1 LFE480-10

.2 Lavatories Type L1:

.1 Type: Countertop, self-rimming, vitreous china

.2 Lavatory: White, self-rimming, rear/front overflow, drilled for 100 mm supply fitting.

.1 American Standard "Aqualyn" #0475.047.020 518 x 441 mm

.3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.

.1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)

.1 Moen AC Conversion Kit - 182538

.2 Moen AC Transformer - 104630

.3 McGuire Supply Kit - H170LK-BV-RB

.4 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons and flexible copper risers. Products from the following manufacturers are acceptable.

.1 McGuire Supply Kit - H170LK-BV-RB

.5 Trap: Adjustable durable solid brass “P” trap with 32 mm O.D outlet, adjustable rotation on tube outlet, slip joint inlet and cleanout plug. Products from the following manufacturers are acceptable:

.1 McGuire No. MC-8872CB

.6 Waste fitting: Chrome plated drain with open grid strainer with adjustable offset waste connection, cast brass construction.

.1 McGuire No. 155A

.7 Sanitary Covering

.1 McGuire MC-PW-2000 PW2000 PROWRAP.

.8 Trap: NPS 1¼ adjustable tubular chrome plated polished cast brass "P" Trap with cleanout and wall escutcheon. Products from the following manufacturers are acceptable.

.1 McGuire No. 8872CB

.9 Water Mixing Valve

.1 Powers Point of use Under Counter Thermostatic Mixing Valve

.1 LFE480-10

.3 Lavatories Type L2H: (Barrier Free Use):

.1 Type: Countertop, self-rimming with rim sealant, vitreous china

.2 Lavatory: White, for barrier free use, self-rimming with sealant, overflow, drilled for 100 mm supply fitting.

.1 American Standard "Aqualyn" #0475.047.020 518 x 441 mm

.3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.

.1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)

.1 Moen AC Conversion Kit - 182538

.2 Moen AC Transformer - 104630

.3 McGuire Supply Kit - H170LK-BV-RB

.4 Waste fitting: Chrome plated drain with open grid strainer with adjustable offset waste connection, cast brass construction.

.1 McGuire No. 155WC

.5 Trap: NPS 1¼ adjustable tubular chrome plated polished cast brass "P" Trap with cleanout and wall escutcheon. Products from the following manufacturers are acceptable.

.1 McGuire No. 8872CB

.6 Sanitary Covering

.1 McGuire MC-PW-2000 PW2000 PROWRAP.

.7 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons and flexible copper risers. Products from the following manufacturers are acceptable.

.1 McGuire No. H170LK-BVRB

.8 Water Mixing Valve

.1 Powers Point of use Under Counter Thermostatic Mixing Valve

.1 LFE480-10

.4 Lavatories - Type L3H (Barrier Free Use)

.1 Type: Wall hung, vitreous china.

.2 Lavatory: White, 533 mm x 514 mm for barrier free use, dilled for concealed arm carrier with single faucet hole and overflow, complete with semi-pedestal P-trap cover.

.1 American Standard "Decorum with EverClean" No. 9134.001EC/0059.020EC shroud

.3 Supply fitting: Electronic, adjustable infrared sensor-activated faucet, polished chrome finish, single hole mounting, magnetic solenoid valve.

.1 Moen Align Sensor Faucet - 8559 (Electronic No-Touch Hardwired)

.1 Moen AC Conversion Kit - 182538

.2 Moen AC Transformer – 104630

.4 Lavatory supplies: Chrome plated polished brass, ¼ turn ball valve angle stop, convertible ¼ turn/loose key handles, horizontal extension tubes, escutcheons and flexible copper risers. Products from the following manufacturers are acceptable.

.1 McGuire Supply Kit - H170LK-BV-RB

.5 Trap: Adjustable durable solid brass “P” trap with 32 mm O.D outlet, adjustable rotation on tube outlet, slip joint inlet and cleanout plug. Products from the following manufacturers are acceptable:

.1 McGuire No. MC-8872CB

.6 Waste fitting: Drain with open grid strainer, cast brass one piece top and tailpiece.

.1 McGuire No. 155A

.7 Basin carrier: Heavy duty steel uprights with integral welded feet., concealed arms, wall flanges to attach to backing plate secured in wall with locking device and levelling screws, wall mounted steel plated hardware. Type and model as recommended by manufacturer for each wall hung basin to suit wall construction. Products from the following manufacturers are acceptable.

.1 Watts No. WCA-411-CA-481

.8 Water Mixing Valve

.1 Powers Point of use Under Counter Thermostatic Mixing Valve

.1 LFE480-10

2.3 URINALS

.1 Urinals - Type U1H (Barrier Free Use)

.1 Type: Wall hung, exposed electronic "No Touch" automatic flush valve.

.2 Urinal: White, vitreous china, washdown, with integral extended shields, and trap; complete with 19 mm top spud, non-metallic strainer, outlet connection and wall hanger.

.1 American Standard "Washbrook FloWise" No.6590001.020

.3 Automatic flush control: Exposed, chrome plated, 1.9 L factory set flow, quiet action diaphragm type, urinal flushometer complete with infrared sensor with solenoid operated flush controller circuitry, back-check angle stop, vacuum breaker located above urinal.

.1 Moen Sensor Operated WC flush valve – 8315AC05

.1 Moen AC Transormer - 104630

.4 Carrier: Complete Steel hanger plate with epoxy coated steel uprights with welded feet support. Products from the following manufacturers are acceptable.

.1 Watts No. CA-321

.5 Wall cleanout: Urinal cleanout with stainless steel access cover and stainless steel vandal proof securing screw. Products from the following manufacturers are acceptable:

.1 American Standard “WUCO”

2.4 **WATER CLOSETS**

.1 Water Closets - Type W1 - Flushometer Valve

.1 Type: Wall hung, exposed flush valve, vitreous china.

.2 Closet bowl: White, vitreous china with Everclean antimicrobial surface, syphon-jet bowl with elongated bowl, direct-fed siphon jet action, concealed trap and NPS 1½ top spud.

.1 American Standard "Afwall Millennium FloWise " No. 3351.101.020

.3 Flush valve: Exposed, sensor-operated, complete with angle stop, 1½ high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.

.1 Moen Sensor Operated WC flush valve – 8311AC12

.1 Moen AC Transormer - 104630

.4 Closet seat: White, solid plastic elongated open front seat, less cover with reinforced stainless steel check hinge and post nuts and washers.

.1 Centoco – 500STSCC

.5 Closet carrier: Type and model as recommended by manufacturer for each wall hung closet to suit wall construction. Products from the following manufacturers are acceptable.

.1 Watts No. ISCA-101-L/R-M11

.2 Water Closets - Type W1H (Barrier Free Use) - Flush Valve

.1 Type: Wall hung, flushometer valve

.2 Closet bowl: White, vitreous china, direct-fed syphon-jet, elongated bowl and 38 mm top spud, concealed trapway. Bowl height from floor to rim 400 mm - 410 mm.

.1 American Standard "Afwall Millennium FloWise" No. 3351.101.002

.3 Flush valve: Exposed, sensor-operated, complete with angle stop, 1½ high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.

.1 Moen Sensor Operated Flush Valve – 8311AC12

.1 Moen AC Transformer – 104630

.2 Moen 24” Flush Tube - 104585

.4 Toilet seat: White, elongated solid plastic, heavy duty open front, less cover, stainless steel check hinges with gasket,

.1 Centoco 500 Series No. 500STSCC

.5 Toilet Back Rest:

.1 Bobrick – CM-16104

.6 Closet carrier: Type and model as recommended by manufacturer for each wall hung closet to suit wall construction. Products from the following manufacturers are acceptable.

.1 Watts No. ISCA-101-L/R-M11

.3 Water Closets - Type W2 - Flush Valve

.1 Type: Floor mounted, bottom outlet, flush valve.

.2 Closet bowl: White vitreous china, syphon-jet bowl with elongated bowl, condensation channel, bolt caps and 38 mm top spud, and china bolt caps.

.1 American Standard "Madera" No. 3451.001.020

.3 Flush valve: Exposed, sensor-operated, complete with angle stop, 1½ high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.

.1 Moen Sensor Operated Flush Valve – 8311AC12

.1 Moen AC Transformer – 104630

.4 Closet seat: White solid plastic elongated open front seat, less cover, reinforced stainless steel check hinges and post nuts and washers.

.1 Centoco 500 Series No. 500STSCC

.4 Water Closets - Type W2H (Barrier Free Use) - Flush Valve

.1 Type: Floor mounted, bottom outlet, flush valve.

.2 Closet bowl: White vitreous china, syphon-jet bowl with elongated bowl, condensation channel, bolt caps and 38 mm top spud, and china bolt caps.

.1 American Standard "Madera" No. 3461.001.020

.3 Flush valve: Exposed, sensor-operated, complete with angle stop, 38 mm high back pressure vacuum breaker with spud coupling and flange, vandal-resistant cap.

.1 Moen Sensor Operated Flush Valve – 8311AC12

.1 Moen AC Transformer – 104630

.2 Moen 24” Flush Tube - 104585

.4 Closet seat: White solid plastic elongated open front seat, less cover, reinforced stainless steel check hinges and post nuts and washers.

.1 Centoco 500 Series No. 500STSCC

.5 Toilet Back Rest:

.1 Bobrick – CM-16104

.5 Water Closets - Type W3

.1 Type: Floor mounted, back outlet, pressure assist flush tank, low consumption.

.2 Closet combination: White vitreous china, siphon jet flush closet bowl with elongated rim and close coupled vitreous china pressure assisted closet tank complete with fittings.

.1 American Standard "Cadet RH PA Universal Bowl – White

.1 American Standard – PA Tank, 1.1 GPF White

.3 Closet seat: White, heavy duty, solid plastic elongated open front with cover, with stainless steel check hinges and stainless steel posts and nuts.

.1 Centoco No. 820STS

.4 Closet supply: NPS 3/8 with lockshield, rigid copper sweat tube nipples, combination V.P. loose key handle, turn ball angle stop and wall escutcheon and flexible risers. Products from the following manufacturers are acceptable.

.1 McGuire No. MC-H172LK-BV

.6 Water Closets - Type W3H (Barrier Free Use) - Pressure Assist Tank

.1 Type: Floor mounted, back outlet, pressure assist flush tank.

.2 Closet combination: White vitreous china, siphon jet flush trap closet bowl with elongated rim and close coupled vitreous china pressure assisted closet tank complete with fittings.

.1 American Standard "Cadet RH PA Universal Bowl – White

.1 American Standard – PA Tank, 1.1 GPF White

.3 Closet seat: White, heavy duty, solid plastic elongated open front with cover, with stainless steel check hinges and stainless steel posts and nuts.

.1 Centoco No. 500STSCC

.4 Closet supply: 13 mm turn ball valve angle stops, coppers sweat nipples, combination V.P. loose key stop and wall escutcheon and flexible copper risers. Products from the following manufacturers are acceptable.

.1 McGuire No. MC-H172LK-BV

2.5 SERVICE SINK

.1 Mop Sinks - Type M2

.1 Type: Pre-cast terrazzo floor mounted.

.2 Sink: 610 x 610 mm, precast terrazzo with one piece integral stainless steel cap on all four sides and integral drain with strainer. "P" trap under floor.

.1 Stern Williams Serviceptor No. SB-900

.2 Fiat

.3 Or accepted equal

.3 Faucets: Mop sink supply fitting with vacuum breaker, integral stops, cross or lever handles, rigid spout with pail hook, brace to wall, minimum 787 mm hose and stainless steel hanger, adjustable wall flanges and NPS ½ IPS connections.

.1 Chicago Faucets No. 897-RCF-Hose

.2 American Standard

.3 Delta

.4 Zurn

.5 Or accepted equal

.2 Mop Sinks - Type M3

.1 Type: Terrazzo floor mounted corner mop sink.

.2 Sink: Precast terrazzo 711 x 711 x 304 mm deep, floor mounted, with stainless steel cast integral cap on front drop and integral drain with strainer, "P" trap under floor, and two stainless steel wall guards.

.1 Stern Williams No. CRS2200

.2 Fiat

.3 Or accepted equal

.3 Faucets: Mop sink supply fitting with vacuum breaker, integral stops, cross or lever handles, rigid spout with pail hook, brace to wall, 787 mm rubber hose and coupling, adjustable wall flanges and NPS ½ IPS connections.

.1 American Standard No. GL-8344.111-002

.2 Chicago Faucets

.3 Delta

.4 Zurn

.5 Or accepted equal

2.6 STAINLESS STEEL SINKS

.1 Stainless Steel Sinks - Type S1 (Barrier Free Use)

.1 Single compartment: 406 x 533 x 127 mm OD undermount, stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainer and brass tailpiece.

.1 Franke Commercial UCS6105P

.2 Blanko

.3 Kindred Industries Limited

.4 AMI Industries

.2 Faucets: Chrome plated solid cast brass deck type sink supply fitting with 232 mm swing spout, single lever handle and maximum 8.3 L/min flow, water saver aerator, pull-out spray with adjustable spray pattern, lock & turn activation button, 10 mm compression inlets, braided flexible supply hoses.

.1 American Standard No. 7074100.002

.2 Chicago Faucets

.3 Delta

.4 Zurn

.5 Or accepted equal

.2 Stainless Steel Sinks - Type S2 (Barrier Free Use)

.1 Double compartment: 451 x 784 x 127 mm OD undermount stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainers and brass combination tailpiece.

.1 Franke Commercial UCD6405P

.2 Blanko

.3 Kindred Industries Limited

.4 AMI Industries

.2 Faucets: Chrome plated solid cast brass deck type sink supply fitting with 232 mm swing spout, single lever handle and maximum 8.3 L/min flow, water saver aerator, pull-out spray with adjustable spray pattern, lock & turn activation button, 10 mm compression inlets, braided flexible supply hoses.

.1 American Standard No. 7074100.002

.2 Chicago Faucets

.3 Delta

.4 Zurn

.5 Or accepted equal

.3 Stainless Steel Sinks - Type S3 (Barrier Free Use)

.1 Single compartment: 406 x 533 x 127 mm OD undermount, stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainer and brass tailpiece.

.1 Franke Commercial UCS6105P

.2 Blanko

.3 Kindred Industries Limited

.4 AMI Industries

.2 Faucets: Electronic “No-Touch” AC powered faucet, chrome plated finish, cast brass body, high arc spout, single hole only, single lever handle and 5.7 L/min flow, pull-down spray with adjustable spray pattern, 10 mm compression inlets, braided flexible supply hoses.

.1 Moen Align with MotionSense No. 7565EC

.2 American Standard

.3 Chicago Faucets

.4 Delta

.5 Zurn

.6 Or accepted equal

.4 Stainless Steel Sinks - Type S4 (Barrier Free Use)

.1 Double compartment: 451 x 784 x 127 mm OD undermount stainless steel sink drawn from 18-10 Type 304 heavy gauge stainless steel, with undercoating, and complete with 90 mm stainless steel crumb cup strainers and brass combination tailpiece.

.1 Franke Commercial UCD6405P

.2 Blanko

.3 Kindred Industries Limited

.4 AMI Industries

.2 Faucets: Electronic “No-Touch” AC powered faucet, chrome plated finish, cast brass body, high arc spout, single hole only, single lever handle and 5.7 L/min flow, pull-down spray with adjustable spray pattern, 10 mm compression inlets, braided flexible supply hoses.

.1 Moen Align with MotionSense No. 7565EC

.2 American Standard

.3 Chicago Faucets

.4 Delta

.5 Zurn

.6 Or accepted equal

.5 Fittings

.1 Trap: Adjustable cast brass 38 mm "P"-trap 38 mm with cleanout.

.2 Sanitary Covering: PW2000 PROWRAP or accepted equal.

.3 Supplies: Pair 12 mm rough stops with flexible risers.

.1 Acceptable manufacturers for trap and supplies:

.1 McGuire

.2 Zurn

.3 Kohler

.4 Water Mixing Valve

.1 Lawler TMM-1070

.2 Symmons

.3 Powers

.4 Leonard

.5 Zurn

.6 Or accepted equal

.5 Provide tee, adaptors and flexible copper tubing to suit installation.

2.7 **SHOWER**

.1 Individual Showers - Type SH2

.1 Type: Non-scald pressure balance shower valve with lever handle, integral service stops or and check stops, deluxe shower head with adjustable spray pattern and 9.5 L/min at test pressure of 550 kPa flow restrictor, bent arm and escutcheon.

.1 Symmons No. 1-100

The above mentioned manufacturer/trade name/catalogue number has been used as a guide to establish the standard of construction and style. Comparable Products from the following manufacturers are acceptable.

.2 Zurn

.3 Delta

.2 Individual Showers - Type SH2H (Barrier Free Use)

.1 Type: Non-scald pressure balancing shower trim and mixing valve with high temperature limit stop, shower head with flow restrictor, wall mount shower arm and wall flange, hand shower set with 1752 mm flexible hose, vacuum breaker bracket, and wall supply. In-wall 3-way diverter trim and valve kit with single lever handle.

.1 Chicago Faucets No. SH-PB1-13-040

.2 Leonard

.3 Delta

2.8 **MISCELLANEOUS**

.1 Below Deck Mechanical Water Mixing

.1 Type: Bronze body, temperature adjusting dial, high temperature thermostatic limit stop, shut-off valve with automatic reset.

.2 Capacity: 1.9 L/min to 19 L/min at 140 kPa (20 psig) pressure drop, or as shown. Products from the following manufacturers are acceptable:

.1 Lawler Model No. TMM-1070

.2 Symmons

.3 Powers

.4 Leonard

.5 Or accepted equal

3 Execution

3.1 **INSTALLATION**

.1 Water Flow Rate

.1 Flush valve urinals and water closets.

.1 Adjust flush valves to provide specified water flow rate based on manufacturers calibration data for valve open time vs. inlet water pressure

.2 Showers:

.1 Adjust valve so that maximum temperature will be not more than 40°C

.2 Barrier Free Use

.1 Rough-in and install plumbing fixtures and drinking fountains at the recommended height for normal or handicapped use as applicable to location.

.2 Water closets:

.1 Seat located between 400 and 460 mm above the floor

.2 Horizontal position is between 460 and 480 mm between centerline of fixture and at least one adjacent side wall

.3 Lavatory:

.1 Top not more than 840 mm above floor

.2 Horizontal position is not less than 460 mm from centerline of fixture and side wall

.3 Insulate exposed supplies

.4 Showers:

.1 Locate shower head complete with hose and slide rail to be within reach of the seated position

.3 Wall Hung Lavatories and Urinals

.1 Install hanger brackets supplied with fixtures to wall with 10 mm bolt studs welded to steel anchor plates embedded within wall.

.2 In locations where a pipe space is provided behind wall, extend bolt studs through wall and anchor with steel back-plates. Ensure proper placement and positioning of anchor plates and bolt studs during wall construction.

.4 Wall Hung Water Closets

.1 Install chair carriers of type as recommended by manufacturer for each particular installation with due regard to construction and piping details.

.5 Floor Mounted Water Closets

.6 On sloping floors, where the slope exceeds 6 mm from the back to the front of the fixture, level the fixture by grouting the base until the slope is within the above limits.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **REFERENCES**

.1 Comply with applicable requirements of the latest issue of the following references:

.1 ANSI Z358.1-1998 - Emergency Eyewash and Shower Equipment

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **SAFETY STATIONS**

.1 Eyewash Fountain - Type EE1

.1 Eyewash fountain: Complete with stainless steel receptor, two chrome plated aerator heads, separate flow control for each head, mounted on NPS 1½ pipe standard with floor flange (mounted on wall) (mounted in countertop) and NPS ½ supply and (NPS 1½ drain) (NPS 1½ chrome plate waste trap) (connections through countertop) and push-to-operate ball valve.

.2 Pipe standard mounted

.1 Haws No. 7361

.2 Bradley No. S19-210B

.3 Wall mounted

.1 Haws No. 7460 BT

.2 Bradley No. S19-220B

.3 Speakman

.4 Countertop mounted

.1 Haws No. 7301 DM

.2 Bradley No. S19-260

.3 Speakman

.2 Emergency Mixing Valve

.1 Type packaged, mixing cold and hot water to maintain a set outlet temperature of 15-29°C.

.2 Construction: thermostatic mixing valve, failure to close on loss of cold water, failure to close on loss of hot water, cold water by-pass outlet temperature gauge.

.1 Haws No. TWBS.EWE

.2 Leonard

.3 Speakman

.4 Bradley

3 Execution

3.1 **INSTALLATION**

.1 Emergency Eyewash Stations

.1 Install eyewash stations in accordance with manufacturers instructions.

.2 On pipe standards, plug spare tee branches if not used.

.2 Emergency Blending Valve Stations

.1 Mount valve station with top of case at 1.5 m above finished floor.

.2 Provide lock-shield valves on inlet hot and cold water connections. Wire seal the valves in the open position.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Products, equipment and services necessary to complete the Work of this section.

.2 General Requirements

.1 The following product will be supplied by NEXT Plumbing Supply (NPS):

.1 Drinking Fountains:

.1 DFC

.2 As part of the Shop Drawing submittal, Contractor is to submit a by-building order form to the Consultant and Owner listing the items and quantities for each building the equipment is to be installed in. Refer to the Appendices for the Plumbing and Accessories Order Form

.3 Once the shop drawings are reviewed and the order form quantities are verified by the Consultant and Owner, the Owner will submit the order form to NPS for processing as well as pay NPS for the order directly.

.4 The Contractor is to coordinate delivery of supplied items with NPS and store on site as needed prior to installation.

.5 Material defects of the products and equipment are the responsibility of NPS and the Contractor to coordinate and replace as required with no extra expense to the Owner.

.6 Replacement of any equipment or appurtenances listed in section 1.1.2.1 of this specification will be at the expense of the Contractor.

1.2 **REFERENCES**

.1 Conform to the latest edition of the following:

.1 AODA - Accessibility for Ontarians with Disabilities Act

.2 TADG - Toronto Accessibility Design Guidelines

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in the form of catalogue cuts and fully illustrating specified materials with description of components, surface finishes, hardware and securement devices.

1.4 **WARRANTY**

.1 Warrant the following Products against defects and deficiencies for a period of two years from date Work is certified as substantially performed in accordance with the general conditions of the Contract:

.2 Promptly make good defects and deficiencies which become apparent within the Warranty Period by replacing defective Product satisfactory to the Consultant and at no expense to the Owner.

2 Products

2.1 **PLUMBING FIXTURES**

.1 General Requirements

.1 CSA approved plumbing fixtures and fittings, of make, type and size specified herein.

.2 Plumbing supplies and fixture trim material to be of CSA approved plumbing brass with chrome plated finish, and of make and type specified.

.1 Each item to bear name of manufacturer or identifying trademark.

.3 Manufacturer's standard design and material specification as indicated by trade name and/or catalogue number, and as described.

.4 Type number allocated to each style of fixture identifies that particular fixture on Drawings.

2.2 **DRINKING FOUNTAIN COOLERS (DFC)**

.1 Water Cooler - Type DF-2 (Barrier Free Use)

.1 Wall mounted wheelchair type water cooler with stainless steel top, front and side mounted push to operate lever(s), sensor, touchless activation with auto shut off bottle filler, flexi-guard safety bubbler, and trap package.

.1 Elkay (EZH2O) No. EZSDWSLK

.2 Fixture carrier: steel hanger plate, heavy gauge epoxy coated steel uprights with welded feet supports

.1 Watts No. CA-311

.3 Drinking Fountain Supply: chrome plated finish polished brass, straight stops, V.P Loose keys

.1 McGuire No. HST-11LK

.4 Trap: NPS 1¼ adjustable tubular chrome plated polished cast brass "P" Trap with cleanout and wall escutcheon. Products from the following manufacturers are acceptable.

.1 McGuire No. MC-8872CB

3 Execution

3.1 **INSTALLATION**

.1 Barrier Free Use:

.1 Rough-in and install drinking fountains at the recommended height for normal or handicapped use as applicable to location.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

.2 The terms “Mechanical Work”, “Mechanical Contractor” or their derivatives includes the work of Division 21, 22, 23 and 25 unless otherwise specified.

1.2 **CODES, REGULATIONS AND STANDARDS**

.1 Comply with municipal or provincial codes, rules and regulations and/or authorities having jurisdiction.

.2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.

.3 Comply with the Occupational Health and Safety Act and Regulations for Construction Projects, Ontario Regulation 691.

.4 Owners Health and Safety Requirements.

.5 Revisions issue: Latest version as amended to date.

1.3 **PERMITS AND INSPECTIONS**

.1 Material Approvals

.1 Obtain special inspection and approvals by CSA and/or local authorities, for materials where specified.

.2 Obtain such approval for the particular installation with the co-operation of the material Supplier.

.2 Permits

.1 Obtain permits required for the installation of mechanical trades work including:

.1 Plumbing inspection

.2 Pressure vessel inspection

.3 Piping and boiler inspection

.4 Electrical inspection

.2 Arrange for inspections and tests and pay all fees and costs for the permits, inspections and tests. Obtain permits immediately after notification of award of Contract.

.3 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.4 **WORKING DRAWINGS AND DOCUMENTS**

.1 Design Drawing Intent

.1 The Design Drawings are schematic in arrangement, and describe the general design intent but do not show the exact details for the installation. They are not fabrication or installation drawings.

.2 The Work is suitably outlined on the Drawings with regard to sizes, locations, general arrangements and installation details, and has been generally coordinated for routing of services. The routing of ductwork, piping and equipment arrangement are shown more or less in diagram except where in certain cases the Drawings may include details giving the exact locations and arrangements required.

.3 The location of equipment, and the associated arrangement of piping, ductwork, and other material describes the general requirements of the Work. Final location is dependant on the actual equipment supplied. The Consultant reserves the right to make reasonable adjustment of up to 1 m to the location of equipment, floor drains, routing of major piping and ductwork, at no cost to the Owner.

.4 In order to provide clarity to the arrangement of the work, not all details including valves, thermometers, pressure gauges, etc. are shown on the Plan Drawings. Refer to Schematic Drawings, standard details and the Specification for these requirements.

.5 Where specific installation dimensions for location of equipment and access space requirements are indicated on the Drawings, install to these requirements.

.6 Where standard details are provided, these show the general installation requirements, and are applicable to each occurrence in the Work, unless otherwise specified or shown.

.2 Contractor Coordination Responsibilities

.1 Provide the services of a mechanical/electrical coordination supervisor, to coordinate this division of the Work, as well as providing coordination with other divisions and/or contracts. This supervisor may be full time or part time on site, as appropriate to the work stage and complexity of the work, at the discretion of the Owner.

.2 Where multiple trades are required, the mechanical coordinating supervisor shall be the lead coordinator.

.3 The Owner reserves the right to require the coordinating supervisor to increase their attendance at site, at no cost to the Owner, if in the Owner's opinion the current level of coordination is not sufficient for the progress of the Work.

.4 Make changes and modifications as necessary to ensure coordination and to avoid interference and conflicts with other trades.

.5 Prepare Construction/Installation/Fabrication Drawings, coordinated with other trades and contracts, as required.

.1 Provide sufficient detail to disclose critical interferences of major equipment and services to ensure adequate accessibility.

.2 Specific dimensions for equipment location or access which are shown on the Consultants drawings.

.3 Indicate sleeves, openings and stress points (such as anchors, guides and inserts)

.4 Indicate deviation in sizes and weights and also in water, drainage, electric power or other service requirements for all equipment proposed which is different from those shown on the Design Drawings.

.5 Provide these Drawings to other trades for coordination with their Work.

.6 Update these Drawings as part of the As-Built Drawings, showing actual locations of major equipment, services, access doors, shut-off valves, etc.

.6 The Design Drawings show the major requirements for the installation of equipment based on one manufacturer's requirements, but may not show all installation requirements. The Contractor will include as part of the Work the specific manufacturer's installation requirements for the equipment actually provided by the Contractor.

.7 The Construction/Installation/Fabrication Drawings are not to be submitted as Shop Drawings. Make them available for viewing at site when requested by the Consultant.

.3 Review Before Proceeding (HOLD)

.1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract.

.2 Execute such Work only after verification of dimensions, verification of materials and obtaining Consultant's written permission to proceed.

1.5 **COORDINATION AND EXAMINATION**

.1 Reference

.1 To Section 01 10 00.

.2 Examination

.1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.

.2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.

.3 Coordination

.1 Coordinate Work of Mechanical Division such that items will properly interface with Work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.

.2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.

.4 Measurements and Deviations

.1 Where any parts of the mechanical work are specifically located by dimensions on the Drawings, check and verify these dimensions on site prior to installation.

.2 Before installing piping, review Architectural, Structural and Electrical Drawings with Mechanical Drawings

.3 Where interference may occur and departures from arrangements as shown are required, consult with other trades involved, come to agreement as to changed locations or elevations and obtain approval of the Consultant for proposed changes before proceeding with the Work.

.4 Where site conditions require minor deviations from indicated arrangements or locations, make such changes on approval of the Consultant without additional cost to the Owner.

.5 Should any discrepancies occur during installation of mechanical work which will necessitate major revisions to the mechanical trades work or the work of other trades or contractors, notify the Consultant immediately and obtain written authorization before proceeding with the work.

1.6 SCAFFOLDING AND HOISTING EQUIPMENT

.1 References

.1 To Section 01 10 00.

.2 Building Attachments

.1 Obtain prior written Consultant's approval before drilling, cutting or welding of the building steel or building structure for erection of materials or equipment.

.3 Overloading

.1 During installation of mechanical work, do not load any part of the building structure with a load greater than it is capable of bearing.

.2 Should any accident occur or damage result through the violation of this requirement, the contractor shall be held solely responsible.

.3 Design temporary supports used during installation as being equivalent to permanent supports.

.4 Remove temporary supports at completion of Work.

1.7 CUTTING AND PATCHING

.1 Do not cut, remove or burn structural parts or sections of the building, whether they are steel, concrete or masonry without the written authorization of the Consultant.

.2 Should cutting, repairing, and patching of previously finished work of other trades be required to allow installation of mechanical work, pay all costs for the trade concerned to perform the work.

1.8 EXISTING SERVICE

.1 Tie-In to Existing Services

.1 Do not shut down or make tie-in connections to any existing service without written permission of the Owner and/or Consultant.

.2 Arrange work to minimize interruption to physical access to the building.

.3 Include for all costs associated with making connections to existing services, including but not limited to, cutting and patching of existing floors, partitions, ceilings and finishes.

.2 Work in Existing Buildings

.1 Route pipes, ducts, conduits and other services to avoid interference with existing installation.

.2 Relocate existing services and equipment to suit installation of new work.

.3 Cut back and cap existing services not being used, so that finished Work presents a neat and clean appearance.

.4 Unless noted to be reused, fixtures and materials being removed become the property of the Contractor and are to be removed from site, unless otherwise noted.

.3 Continuity of Services

.1 Be responsible for any damage to existing systems, including insulation and coverings, when making connections.

.2 Keep existing buildings in operation with minimum length of shut-down periods.

.3 Include overtime work to tie-in piping or wiring at night or on weekends.

1.9 **PROVISION FOR FUTURE**

.1 Future Equipment

.1 Where indicated as reserved for future equipment or services, leave identified space clear and install services and equipment so that connections can be made in the future.

1.10 **SUBMITTALS**

.1 Shop Drawings

.1 Conform to Section 01 33 00 and the following.

.2 Shop Drawings showing more than one size or model will not be considered unless properly marked up.

.3 For electrically driven, and fuel fired appliances, provide the following information:

.1 Electrical characteristics including voltage, phase, frequency and power rating.

.2 For motors, NEMA, class and efficiency ratings

.3 Fuel input ratings, including flow rates and pressures

.4 Equipment performance ratings, including flow rates, pressures, efficiencies, part load values and/or efficiencies (IPLV's), plotted flow characteristics (pump and fan curves) with operating points clearly plotted.

.4 For other equipment include the following information:

.1 Equipment performance ratings, including flow rates, pressures drops.

.2 Electrical control power requirements.

.5 For all equipment, include the following:

.1 Equipment dimensions and weights.

.2 Itemized product description with optional items clearly marked as being included.

.6 Provide wiring Shop Drawings:

.1 Wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment.

.2 Wiring diagrams alone are not sufficient; schematic and interconnecting drawings, and sequence of operation of equipment are required for review.

.3 Clearly indicate the materials and/or equipment being supplied:

.1 Details of construction, finish, accurate dimensions, capacities and performance.

.2 Certify Drawings correct for construction by the manufacturer, before submission.

.3 Identify Equipment Shop Drawings with designations as shown on the Drawings or in the Specifications.

.4 If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.

.4 Coordinate equipment which attaches to and/or where external wiring provided connects to other equipment.

.1 Do such coordination whether such equipment is supplied under this or other contracts or subcontracts, for which relevant information will be provided by Owner/Consultant.

1.11 **"AS-BUILT" RECORD DRAWINGS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 Maintain an accurate dimensional record of all underground piping and all deviations and changes in aboveground piping and equipment.

1.12 **INSTALLATION AND START-UP INSTRUCTIONS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 Submit copies of installation instructions and copies of start-up instructions for any item of equipment when requested by the Consultant.

1.13 **OPERATING AND MAINTENANCE INSTRUCTION MANUALS**

.1 Reference

.1 Conform to Section 01 33 00.

.2 In addition, include the following in the manuals:

.1 Non-dimensional layout showing location of all electrical devices on mechanical equipment.

.2 Operating instructions, including start-up and shut-down procedure.

.3 Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.

.4 List of spare parts.

.3 All the above applies to component parts of equipment whether they are manufactured by the Supplier of the equipment or are supplied as a component part of an item of equipment.

1.14 **CLEANING, TESTING AND APPROVAL RECORDS**

.1 Records

.1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/water concentrations, inspections and approvals by the plumbing inspector.

.2 Forward these tests to the Owner on completion of the Work in accordance with Section 01 33 00.

.3 Forward to Consultant, copy of records on site on completion of each test, cleaning operation, etc.

1.15 **DIMENSIONS AND QUANTITIES**

.1 Dimensions

.1 Dimensions shown on Drawings are approximate.

.2 Verify dimensions by reference to Shop Drawings and field measurement.

.2 Quantities

.1 Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.

1.16 **TRADE QUALIFICATIONS**

.1 Applicable to the following trades

.1 Sheet metal workers

.2 Plumbers

.3 Steamfitters

.2 Requirements

.1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the Work is performed or an interprovincial certificate.

.2 Ratio of journeyman to apprentice: Not to exceed the defined ratio in the Apprenticeship Act of Ontario.

.3 On award of Contract, submit a list of trade journeyman and apprentices, together with their certificate and registration numbers.

.4 Certificates and registration must be provided to the Consultant on request.

.5 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

2 Products

2.1 **MATERIALS AND EQUIPMENT**

.1 Materials

.1 Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.

.2 Of Canadian manufacture wherever possible.

.3 Labelled or listed as required by code and/or inspection authorities.

.4 Design of mechanical systems has been based on the first listed Supplier and model number/size stated on the equipment schedules on the Drawings. Bear all costs due to physical or performance differences between stated equipment and proposed equipment. These differences include but are not limited to size, layout, arrangement, connection size, location and/or quantity of connections, or performance differences such as noise, power requirements, flow, throw, etc.

.2 Equipment/Structure Coordination

.1 Locations and dimensions of curbs and roof and floor opening framing, where indicated on the Drawings, are based on an arrangement to suit the above named Supplier.

.2 Be responsible to verify the actual size requirements of the openings, and notify the Consultant immediately in case the dimension of the unit supplied and the connecting ductwork/piping, etc. are at variance with the dimensions given on the Drawings.

.3 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Consultant prior to the fabrication or construction of opening framing and curb.

2.2 STANDARD SPECIFICATIONS

.1 Product Quality

.1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard specifications issued by authorities having jurisdiction.

.2 Do not apply such standard specifications to decrease the quality of workmanship, Products and services required by the Contract Documents.

2.3 MANUFACTURER'S NAMEPLATES

.1 Metal Nameplates

.1 Provided with raised or recessed lettering, on each piece of equipment.

.2 Mechanically fasten nameplate on a metal stand-off bracket arranged to clear insulation.

.3 Mount on same stand-off Underwriters Laboratories and/or CSA registration plates.

.2 Nameplate Data

.1 Indicate:

.1 Size

.2 Capacity

.3 Equipment model

.4 Manufacturer's name

.5 Serial number

.6 Voltage

.7 Cycle

.8 Phase and power of motors

2.4 PHASE AND POWER OF BUILDING ATTACHMENTS

.1 Welding Studs

.1 Maximum size: 10 mm for attaching miscellaneous materials and equipment to building steel.

.2 If the weight of materials or equipment require bolts or studs larger than 10 mm diameter, use steel clips or brackets, secured to building steel by (welding or) bolting as approved by the Consultant.

.3 Acceptable Manufacturers:

.1 Graham

.2 Omark

.3 Nelson

.2 Self Drilling Expansion Type Concrete Inserts

.1 To secure miscellaneous equipment and materials to masonry or concrete construction already in place.

.2 Of sufficient number and size to prevent concrete from breaking away.

.3 The use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from the Consultant.

.4 Acceptable Manufacturers:

.1 ITW "Redhead"

.2 Star "SSS"

.3 USM "Parabolt"

.3 Supports For Any Suspended Items

.1 Do not fasten/attach to or extend through steel pan type roofs or through concrete slab roofs.

.4 Beam Clamps

.1 Two-bolt design, and of such type that the rod load is transmitted only concentrically to the beam web centreline.

.2 The use of "C" and "I" beam side clamps, etc., will not be allowed without written consent of the Consultant.

.3 Acceptable Manufacturers:

.1 Grinnell

.2 Myatt

.3 Carpenter & Paterson

.4 Taylor Pipe Supports

2.5 DRIVES AND ACCESSORIES

.1 Drives

.1 V-belt drive selection: 150 percent of the motor size rating.

.2 Sheaves: Cast iron construction with machined grooves.

.1 Sheaves 75 mm size and larger diameter: taper lock bushings.

.2 Multi-belt drives: Matched sets.

.3 Statically and dynamically balance all sheaves as an operating unit.

.3 Adjustable sheaves:

.1 Motors less than 11 kW (15 HP) rating: Adjustable pitch motor sheave with diameter range selected to obtain specified RPM of the driven equipment at approximately the mid-point setting of the sheave.

.4 Fixed sheaves:

.1 Motors of 11 kW (15 HP) and greater: Solid type.

.2 Drive Couplings

.1 Acceptable Manufacturers:

.1 Falk

.2 Fast

.3 Thomas

.3 Lubricating Devices

.1 Equipment to have oil reservoirs with level indicators, or pressure grease fittings.

.2 Inaccessible fittings: Provide extended tubes to an accessible location.

.3 Grease fittings: Zerk or Alemite.

.1 All fittings of one type.

.4 Drive Guards

.1 To OSHA requirements.

.2 Build guards of all welded construction on exposed rotating parts or elements and on all drives including the following:

.1 V-belt drives

.2 Flexible couplings

.3 Gear drives

.3 Construction (except fan drives):

.1 Total enclosure type fabricated of minimum 1.3 mm (18 gauge) black sheet steel.

.2 Hinged side to allow access for lubrication, inspection or removal of the drive parts.

.3 Maximum clearance of openings in guards to rotating parts: Not to exceed 13 mm.

.4 Make provision for slide rail adjustment.

.4 Construction for fan drives:

.1 V-belt drives: Total enclosure type as specified above.

.2 Enclosure sides: 13 mm mesh, 2.7 mm wire screening.

.3 Tachometer holes at shaft centres, reinforced as required to maintain rigidity of guard.

.5 Flexible drive coupling guards:

.1 Location: Between motor and driven equipment.

.2 Minimum 1.3 mm (18 gauge) black sheet steel, securely fastened to the equipment baseplate and readily removable.

.3 Leave a clearance of approximately 13 to 25 mm between the guard and the coupling.

.4 Extend the guard to within 13 mm of both motor and driven equipment housing.

.6 Rework any substandard guards supplied with mechanical equipment to conform to the above requirements.

2.6 SEALANTS, CONCRETE AND GROUTS

.1 Pipe Sleeve Seals

.1 Acceptable Manufacturers:

.1 Thunderline "Link-Seal" Series LS

.2 Concrete

.1 Strength: 25 MPa concrete: to CSA-A23.1/A23.2

.3 Concrete Grouts

.1 Acceptable Manufacturers:

.1 Sternson "M-Bed Standard"

.2 Sika "Sikagrout 212"

.3 Master Builders "Construction Grout"

.4 Meadows "CG-86"

.5 Euclid "Euco NS Grout"

.6 CPD "Non-Shrink Grout"

.4 Bonding Agents

.1 Acceptable Manufacturers:

.1 Sika "Sikadur 32" Hi-Mod

.5 Caulking Compounds

.1 Acceptable Manufacturers:

.1 Denso-Plast

.6 Firestopping

.1 ULC listed firestopping assembly

.2 Rating to suit wall and floor penetrations

.3 Acceptable Manufacturers:

.1 Fire Stop Systems

.2 Dow Corning

.3 3M

.4 Tremco

.5 A/D Fire Protection System

.6 Johns Manville

.7 Hilti

2.7 MISCELLANEOUS

.1 Access Doors

.1 Minimum size: 200 mm x 200 mm size, unless otherwise specified on the Drawings or in other divisions of the Specifications, or as required to replace or repair said equipment.

.2 Material:

.1 Fabricated of 2.5 mm (12 gauge) bonderized steel.

.2 Fabricated of 2.5 mm (12 gauge) stainless steel in areas finished with tile or marble surfaces.

.3 Flush mounted, concealed hinges and screwdriver lock.

.4 Plast lock and anchor straps.

.5 Doors to be of a type and fire rating to suit the particular type of wall or ceiling construction in which they are to be installed.

.3 Acceptable Manufacturers:

.1 E.H. Price

.2 Titus

.3 Controlled Air

.4 Williams (S.M.S.)

.5 Acudor

.2 Isolating Unions

.1 Acceptable manufacturers:

.1 Epco

.2 Marpac "Petro"

.3 Corrosion Service

.3 Fabricated Equipment Supports (Floor Stands and Ceiling or Wall Mounted Supports)

.1 Structural steel members of welded construction or steel pipe and fittings, suitably braced and secured to the floor by mild steel floor pads or pipe flanges with bolts or anchors.

3 Execution

3.1 **GENERAL**

.1 Execute Work in accordance with requirements specified in the various sections of Division 23.

.2 Lay out Work of each trade so that it does not interfere with work under other divisions of Specifications.

.3 Make good any damage to Owner’s property or other trade’s work caused by improperly locating or carrying out of Work.

.4 Supply anchor bolts and templates for installation by other divisions.

.5 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided alteration is made before installation.

3.2 **EQUIPMENT INSTALLATION**

.1 General

.1 Install equipment in a compact, neat and workmanlike manner.

.2 Align, level and adjust for satisfactory operation.

.3 Install in such a manner that connecting and disconnecting of piping and accessories can be made readily and that all parts are easily accessible for inspection, operation, maintenance and repair.

.4 Install and start up items of equipment in accordance with the manufacturer's printed installation and operating instructions.

.2 Noise and Vibration

.1 Noise and vibration levels of equipment and systems shall be within design intent.

.2 If noise or vibration levels created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical work are over the limits, make all necessary changes and additions as approved by the Consultant without additional cost.

.3 Lubrication

.1 Lubricate all equipment prior to start up in accordance with the manufacturer's printed instructions.

.2 Supply all lubrication including sufficient quantity for drainage and refilling of oil sumps, etc., when required by manufacturer's instructions.

3.3 **EQUIPMENT SUPPORTS**

.1 Housekeeping Bases and Pads

.1 Construct bases and pads for all mechanical equipment as required to allow the proper performance of the equipment.

.1 Exception: Bases and pads detailed on the Structural Drawings are for purposes of design intent only.

.2 Construction:

.1 20 m deformed dowel anchors to concrete slabs (six per base or pad).

.2 Drill slabs and grout dowels in place.

.3 Bond pads and bases to floor. Use grout and bonding agent according to manufacturer's printed instructions.

.4 Height of bases and pads: Minimum of 150 mm or as shown.

.5 Width and length: Sufficient to extend 75 mm beyond centreline of anchor bolts, or to extend a minimum of 50 mm beyond equipment base.

.6 Chamfer all upper perimeter edges of base.

.7 On approval of the Consultant, concrete pads of 150 mm maximum thickness may be poured under equipment after equipment is set in place, with concrete fully vibrated into place under the equipment base plate.

.3 Layout coordination:

.1 Verify size of bases shown on Structural Drawings with actual requirements and advise the Consultant and the respective trades if change in size or shape of pad is required.

.4 Anchor bolts:

.1 Supply anchor bolts required for mechanical equipment unless indicated otherwise on the Drawings.

.2 Sleeve anchor bolts.

.3 Supply anchor bolts and sleeves to trade constructing bases in sufficient time for setting in formwork prior to placing concrete and provide anchor bolt location drawing or template for locating anchor bolts.

.4 Check anchor bolt locations for proper position before concrete is poured.

.2 Setting and Alignment of Equipment - Rotating Equipment (fans, pumps, etc):

.1 Use millwrights to set and align to lines established with an engineer's level.

.2 Shim equipment using standard brass or bronze shim stock of suitable thickness to provide proper level and alignment.

.3 Place 25 mm minimum thick grout between equipment base and concrete pad or foundation.

.4 Have Consultant approve equipment settings for equipment mounted on concrete pads or foundations prior to grouting.

.5 Re-check alignment prior to start-up of equipment.

.3 Floor Stands

.1 Provide stands for floor mounted equipment.

.2 Secure to the floor by mild steel floor pads or pipe flanges with bolts or anchors.

.4 Ceiling or Wall Mounting

.1 Where ceiling or wall mounting is indicated or required, provide a suspended platform, bracket or shelf.

.2 Materials: Standard steel members and steel plates of welded construction throughout.

.3 Attach to building steel with rod hangers and beam clamps, or attach to precast structure as the case may be.

.4 Place additional structural steel as required between building steel where beam spacing does not meet requirements.

.5 Do not use inserts unless specifically shown on the Drawings or approved by the Consultant for any particular item of equipment.

.6 Attach brackets or shelves to vertical member or sections of the building structure as hereinbefore specified.

.5 Suspended Equipment Support

.1 Provide double locknuts on suspended equipment supports as follows.

.2 Upper attachment

.1 Beam clamp: Provide a double nut on end of beam clamp tie rod.

.2 Supplemental steel: Double nut all mechanical fasteners fixing supplemental steel to building structural steel.

.3 Middle attachment

.1 Upper load bearing point, to beam clamp: Not applicable.

.2 Upper load bearing point, to supplemental steel: Double nut on top of load bearing point, single locknut on underside of bearing point

.3 Lower load bearing point, all: Double nut on underside of bearing point, single locknut on top of bearing point.

.4 Lower attachment

.1 Trapeze hanger or equipment fastening: Refer to middle attachment requirements above.

.5 Apply Loctite 242 to the second nut (and matchmark both nuts).

3.4 **MISCELLANEOUS STEEL**

.1 Hang or support equipment, piping, ductwork etc., with miscellaneous structural supports, platforms, braces as may be required unless Drawings or other sections of the Specifications state otherwise.

.2 Materials and Fabrication

.1 Conform to:

.1 CAN/CSA-S16.1-M for materials, design of details and execution of the work.

.2 CSA-G40.20/G40.21 grade 300W for structural shapes, plates, etc.

.3 CSA W47.1 for qualification of welders.

.4 CSA W48.1-M for electrodes (only coated rods allowed).

.5 CSA W59-M for design of connections and workmanship.

.6 CSA W117.2 for safety.

.3 Construction

.1 Welded construction wherever practicable.

.2 Chip welds to remove slag, and grind smooth.

.3 Bolted joints allowed for field assembly using high strength steel bolts.

.4 Painting and Cleaning

.1 Clean steel to Steel Structures Painting Council SSPC-SP6, Commercial Blast Cleaning.

.2 Apply one coat of oil alkyd primer conforming to CISC/CPMA 2.75 to all miscellaneous steel.

.3 In the field, touch up all bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as hereinbefore specified.

.4 Apply two coats of primer to all surfaces which will be inaccessible after erection.

.5 Thoroughly remove all foreign matter from steelwork on completion of installation.

3.5 **CONCRETE INSERTS**

.1 Install inserts required for attachment of hangers, either for suspension of piping or equipment.

.2 For masonry or poured concrete construction use expansion type units. Insert into the concrete after concrete has cured. Do not use anchors or inserts installed by explosive means.

3.6 **FLASHINGS**

.1 Flash and counterflash all gas vent stacks through roof, with Thaler Model MEF-4A.

.2 Safety vents, plumbing vents and all other pipes passing through roofs, stack flashings will be supplied and installed by roofing trade, unless otherwise shown on Drawings.

3.7 **FIRE STOPPING**

.1 Submit Shop Drawings, including the following information:

.1 ULC/CUL listing number.

.2 Installation Drawings for each type of penetration.

.3 Installation materials.

.2 General

.1 Seal piping, ductwork, conduits and miscellaneous support steel penetrating fire separations.

.2 Install firestopping in accordance with manufacturer's instructions and ULC listing requirements.

.3 Provide a written report on completion of firestopping, by area or floor if necessary, indicating the Work is completed and ready for inspection. Do not cover over firestopping, including installation of walls and ceilings, until Work is inspected.

3.8 **ACCESS DOORS**

.1 Supply access doors for installation by other trades in walls or ceilings where accessibility is required for the operation and/or maintenance of:

.1 Concealed valves

.2 Traps

.3 Cleanouts

.4 Dampers

.5 VAV boxes

.6 Control equipment

3.9 **SPARE PARTS**

.1 Furnish spare parts

.1 One set of packing glands for each size of pump gland.

.2 One casing joint gasket for each size pump.

.3 One head gasket for each heat exchanger

.4 One glass for each gauge glass

.5 One set of V-belts for each drive

.6 One filter cartridge or set of filter media for each filter or filter bank installed

3.10 **PROTECTION**

.1 Protect Work and materials from weather and other hazards before, during, and after erection, and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

.3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.

.4 Protect finished floor slabs from scuffing, cracking, chipping, staining, cutting and other damage resulting from work of this Contract.

.1 Place a 19 mm thick plywood underlaid with 25 mm thick polystyrene insulation board adhered to same, over floor areas when working from or over, such surfaces.

.2 Provide such protection below hoist rigs, ladders, pallets of material, and in other circumstances where the flooring is exposed to potential damage.

.3 Work damaged due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Owner, at no increase in Contract Price.

3.11 **MAINTENANCE OF BEARINGS**

.1 During Construction

.1 Turn-over rotating equipment at least once a month after delivery;

.1 Run-in sleeve type bearings in accordance with manufacturer's recommendations.

.2 Drain, flush out and refill with new charge of oil or grease.

.3 Protect bearings, shafts and sheaves against damage, corrosion and dust accumulation.

.4 Provide extended grease nipples for bearing lubrication.

3.12 **CONSTRUCTION REVIEW**

.1 The construction review will include milestone and periodic reviews.

.2 Milestone Reviews

.1 Specific milestone reviews will be performed by the Consultant for compliance with the Ontario Building Code, including any or all of the following:

.1 Buried drainage

.2 Before installation of roofing membrane

.3 Before closure of service shafts and pipe chases

.4 Before closure of walls

.5 Before closure of ceilings

.6 Equipment demonstration and training

.7 Substantial Performance and deficiency review

.8 Total Performance

.2 Some or all of these reviews are of portions of the Work which may be concealed. If Work is enclosed before the Consultant can review the installation, the Consultant may direct the Contractor to expose the Work for it to be examined, at no additional cost to the Project, including rework affecting other trades.

.3 If deficiencies are noted during any review where Work will be enclosed, correct noted deficiencies and have them reviewed by the Consultant prior to the Work being enclosed.

.4 Provide a minimum of seven Calendar Days written notice to the Consultant when requesting each review date.

.5 The Consultant will provide a check-list to the Contractor of required milestone reviews which must be completed. Maintain this list on site along with identified test reports, and make available for Consultants review when requested. When completed, include this checklist form with the test reports forms specified in Section 23 08 16.

.3 Periodic Reviews

.1 The Consultant will conduct periodic reviews as required for the Project. These reviews are for the benefit of the Owner to describe the progress and workmanship of the Work and are not intended as any form of quality assurance for the Contractor.

.2 Deficiencies will generally not be reported as part of this review, as the Work has not been reported by the Contractor as being complete. However, deficiencies may be reported where it may not be possible to correct the Work at a later date, or at great expense.

.3 The Contractor shall not relay on these periodic reviews to identify deficiencies during the progress of the Work.

.4 Deficiency Review

.1 The Consultant will conduct a deficiency review only after the Contractor submits an application for Substantial Performance. As part of this application, the Contractor shall submit their own comprehensive deficiency list of incomplete or incorrect work. Failure by the Contractor to list any deficiency does not relieve the Contractor from correcting or completing the Work.

.2 The Consultant shall review the work and any deficiencies noted will be classified as Major or Minor.

.1 Major deficiencies are required to be corrected as part of obtaining Substantial Performance.

.2 Minor deficiencies may be corrected before or after Substantial Performance.

.5 Final Review

.1 The Consultant will conduct a final review only after the Contractor submits a declaration that all of the following has been completed:

.1 Noted deficiencies have been corrected

.2 Final As-Built Drawings have been submitted to the Owner

.3 Final Operating and Maintenance Manuals have been submitted to the Owner

.4 Final test reports, including alternate season tests have been submitted to the Owner.

.2 The Consultant will only review the deficiency list to confirm these deficiencies have been corrected.

3.13 PERFORMANCE TESTING AND BALANCING

.1 Refer to 23 08 00 series.

3.14 ADJUSTMENT AND OPERATION OF SYSTEMS

.1 When the Work is complete:

.1 Adjust equipment items of the various systems for proper operation within the framework of design intent, and the operating characteristics as published by the equipment manufacturer.

.2 Complete additional instructions are specified under the respective sections of Division 23.

.2 The Consultant reserves the right to require the services of an authorized representative of the manufacturer in the event that any item of equipment is not adjusted properly.

.1 Arrange for such services and pay all costs thereof.

.2 After completion of adjustments, place systems in full operating condition and advise Consultant that the Work is ready for acceptance.

3.15 ACCEPTANCE

.1 After all equipment has been installed and adjusted and all systems balanced:

.1 Conduct performance tests in the presence of the Consultant and the Owner.

.2 Arrange the time for these tests at the convenience of the Consultant and Owner.

.3 Conduct tests under climatic circumstances to ensure complete and comprehensive tests and of such a manner and duration as the Consultant may deem necessary.

.2 During these tests:

.1 Demonstrate the correct performance of all equipment items and of the systems they comprise.

.2 Should any system or any equipment item fail to function as required, make such changes, adjustments or replacements necessary to meet performance requirements.

.3 Repeat tests until requirements have been fully satisfied and all systems accepted by the Consultant.

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End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **RELATED SECTIONS**

.1 Division 26: Electrical

.1 Power wiring between the electrical distribution system and motor or equipment.

.2 Motor Control Centres (MCC).

.3 Motor starters including variable frequency drives and soft-start starters, except where specified as an integral component of the mechanical equipment.

.4 Fused or unfused disconnects, except where specified as an integral component of the mechanical equipment.

1.3 **REFERENCE STANDARDS**

.1 Standards

.1 CSA 390 M (motor efficiency ratings).

.2 IEEE 112 (motor efficiency ratings) for three phase motors.

.3 IEEE 114 (motor efficiency ratings) for single phase motors.

1.4 **CODES AND REGULATIONS; PERMITS, COSTS AND FEES**

.1 Codes

.1 Electrical Safety Authority (ESA).

.2 Canadian Electrical Code.

.2 Permits

.1 Obtain electrical permits and inspections and pay all costs for the portion of the Work performed by this division.

1.5 **QUALITY ASSURANCE**

.1 Contractor Qualifications

.1 Electrical wiring for mechanical trades work performed by a specialist firm with an established reputation in this field.

1.6 **SUBMITTALS**

.1 Shop Drawings

.1 Submit in accordance with Section 01 33 00.

.2 Include nameplate data, motor efficiencies, NEMA rating and insulation rating.

2 Products

2.1 **MOTORS**

.1 General

.1 Motor nameplate rating:

.1 Not less than input brake horsepower of driven equipment plus 5%, at specified operating conditions, and

.2 Not less than the scheduled minimum horsepower.

.3 Premium efficiency.

.4 Selected for chemical duty or explosion proof where scheduled.

.5 Service factor: 1.15 minimum for three phase motors.

.2 Single Phase Motors

.1 Continuous duty, resilient mount.

.1 Motor rating: Less than 375 W (1/2 HP).

.2 Voltage, frequency and RPM as scheduled.

.3 Three Phase Motors, 350 W to 525 W (1/2 HP to 3/4 HP)

.1 EEMAC, Class B, Type F insulation, squirrel cage induction, continuous duty, ball bearing.

.1 Voltage, frequency and RPM as scheduled.

.2 Motor type: ODP with 90°C (194°F) temperature rise (TEFC with 80°C (176°F) temperature rise) unless otherwise scheduled.

.3 1800 RPM or as scheduled.

.4 Three Phase Motors, 750 W (1 HP) and Larger

.1 EEMAC, T-Frame, Class B, Type F insulation, squirrel cage induction, continuous duty, ball or sleeve bearing.

.1 Motor efficiency: Premium efficiency.

.2 Voltage and frequency as scheduled.

.3 Motor type: TEFC with 80°C (176°F) temperature rise (ODP with 90°C (194°F) temperature rise) unless otherwise scheduled.

.4 1800 RPM or as scheduled.

.5 Three Phase Motors, 750 W (1 HP) and Larger, Variable Frequency Drive Applications

.1 EEMAC, T-Frame, Class B, Type F triple build, form wound insulation, squirrel cage induction, continuous duty, ball bearing, 40°C (104°F) temperature rise.

.1 Motor efficiency: Premium efficiency.

.2 Inverter duty rated.

.3 Maximum speed turndown: 25%.

.4 Voltage and frequency as scheduled.

.5 Motor type: ODP for variable torque applications, TEFC for constant torque applications.

.6 1800 RPM or as scheduled.

.6 Multiple Speed Motors

.1 For 2:1 speed ratios: Single winding consequent pole (two winding).

.2 For all other speed ratios: Two winding.

.7 Grounding Lug

.1 Motors less than 15 kW (20 HP):

.1 Ground lug on motor terminal box.

.2 Motors 15 kW (20 HP) and larger:

.1 Directly bolted to motor frame.

.2 Located inside terminal box on motor.

.8 Winding Temperature Sensors - RTD's

.1 Where required:

.1 Motors greater than 224 kW (300 HP).

.2 Inverter duty motors greater than 112 kW (150 HP).

.2 Type:

.1 RTD sensor in each winding, wired to separate terminal box on side of motor.

.2 RTD relay/control circuit by others.

.9 Winding Temperature Sensor Protection

.1 Where required:

.1 Motors 37 kW (50 HP) up to 225 kW (300 HP).

.2 Motors 18.6 kW (25 HP) up to 30 kW (40 HP) located in air ducts, plenum chambers or in air stream inside air conditioning equipment.

.2 Type:

.1 Winding temperature sensor wired to disconnect motor on high temperature.

.2 120 V control transformer.

.3 "Push-to-Test" red pilot light (high winding temperature).

.4 Reset button.

.5 Supply control unit to the Contractor under Division 26 for installation in motor starter.

.6 Acceptable Manufacturers:

.1 Siemens Canada Limited - PTC thermistor with 3-UN2131 tripping unit

.10 Winding Temperature Thermostat

.1 Where required:

.1 Single phase, and three phase motors up to 15 kW (20 HP) located in air ducts, plenum chambers or in air stream inside air conditioning equipment.

.2 Type:

.1 Klixon Motor winding thermostats.

2.2 WIRING AND CONDUIT

.1 Wire

.1 RW-90 X-link.

.2 Minimum No. 12 AWG for power.

.3 Colour coded No. 14 AWG for control power, 120 VAC and lower.

.4 Individually identify conductors on each end with slip-on, plastic wire markers. Identification to match wiring diagrams.

.2 Conduit

.1 Thin wall conduit:

.1 Up to 32 mm size in ceilings, furred spaces, in hollow walls and partitions and where not exposed to mechanical injury.

.2 Rigid galvanized steel:

.1 38 mm size and larger.

.2 Any size where located in poured concrete, and where exposed.

2.3 EQUIPMENT SERVICE LIGHTS

.1 Service Lights

.1 LED type with tempered glass globe and wire guard (silicone free).

.2 Acceptable Manufacturers:

.1 Crouse Hinds

.2 Killark

.2 Switches

.1 Twenty ampere, single pole, with pilot light, installed in cast metal box.

.2 Acceptable Manufacturers:

.1 Hubbell

.2 P & S

.3 Arrow Hart

.4 Leviton

2.4 **CORROSION PROTECTION ANODES**

.1 Sacrificial Anode

.1 High grade electrolytic zinc, 99.99% pure: To ASTM B-418 Type II.

.2 Supplied with 5 mm diameter minimum steel core with #8 TWH stranded connecting wire or bolt-on strap connection where required.

3 Execution

3.1 **INSTALLATION**

.1 Motor and Equipment Control

.1 Motor control centre, starters and/or disconnect switch for each motor or electrically connected item: Provided by Electrical Division 26.

.1 Exception: Disconnects which are specified as part of the equipment.

.2 Power Conduit and Wire

.1 Provided by Mechanical Division:

.1 Line voltage thermostats, and wiring from thermostat to fan coil units, unit heaters and cabinet unit heaters.

.2 Hardwire interlock wiring between control devices (pressure switches, temperature switches, limit switches, etc.) and motor starters.

.3 Between junction box provided by Division 26, to switch and equipment service lights.

.2 Provided by Electrical Division 26:

.1 Power wiring at all voltages 120 VAC and higher to motors or equipment.

.2 To junction box on adjacent wall, column or ceiling for equipment service lights (marine lights).

.3 Control Conduit and Wire

.1 Provided by Mechanical Division:

.1 Control wiring, conduit and relays to interlock starters and connect safety and operating controls.

.4 Equipment Service Lights

.1 Mount switches in accessible location on outside of plenum.

.2 Provide one switch for each fan system.

.3 Provide minimum of one marine light per 3 m length of plenum.

.5 Grounding

.1 Ground electrical equipment and wiring in accordance with Electrical Safety Authority and local authority's rules and regulations.

.6 Corrosion Protection Anodes

.1 Provide external corrosion protection anodes for:

.1 Buried ductile iron water mains, fittings, and hydrants

.2 Metallic services as shown.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **DESIGN CRITERIA**

.1 Refer to drawings schedule.

1.3 **REFERENCE STANDARDS**

.1 Gas Meters

.1 CGA approved.

1.4 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **GENERAL**

.1 Sensor Elements

.1 Selected for thermowells designed for 50 mm insulation.

2.2 **FLOW INDICATORS**

.1 Liquids

.1 Construction:

.1 Visual flow indication.

.2 Equipped with a dual flow scale L/s-USgpm.

.3 Protected against accidental breakage of the glass indicator.

.4 In-line type for pipe sizes up to NPS 1½.

.5 By-pass type with isolating valves for larger sizes.

.2 Acceptable Manufacturer:

.1 ITT Bell & Gossett - Thermoflow

2.3 **VOLUME FLOW MEASUREMENT**

.1 Turbine Type

.1 Operating medium:

.1 Water

.2 Primary flow element:

.1 Bidirectional turbine flow meter

.3 Flow transmitter:

.1 Measuring transmitter with 0-10 VDC pulse output

.2 Pulse output: [0.06 L/s] [0.6 L/s] [6.0 L/s]

.3 Digital register (dual) L/s (USGPM)

.4 Maximum pressure drop 7 kPa (1 psi) at full flow

.5 Maximum operating temperature: 95°C (200°F)

.6 Square root extractors

.7 Additional contacts for remote monitoring and/or initiation of system chemical feed pumps after each 200 litres

.8 Accuracy: ±1% of full range

.9 Repeatability: ±0.1%

.10 Power supply: 120VAC

.4 Acceptable Manufacturers:

.1 Neptune

.2 Rotary Type

.1 Operating medium:

.1 Natural gas

.2 Primary flow element:

.1 Rotary positive displacement

.2 Line mounting body style

.3 Contra-rotating impeller

.4 Splash lubricated ball bearing design

.3 Flow transmitter

.1 Microprocessor based flow meter

.2 Alkaline battery operation

.3 Magnetic shaft sensors

.4 Single point temperature calibration/compensation

.5 Liquid crystal display in cubic metres

.6 Four isolated, adjustable output points

.7 Accuracy: ± 0.3°C (± 0.5°F)

.8 Temperature resolution: 0.1°C (± 0.1°F)

.9 Pulse outputs: One non-compensated, two compensated, one alarm

.10 Pulse output range: Refer to Drawings for each meter

.11 NEMA 4X enclosure

.4 Acceptable Manufacturers:

.1 Roots-Dresser M175 Series with VTC Transmitter

.3 Differential Pressure Type

.1 Operating medium:

.1 Water

.2 Natural gas

.2 Primary flow element:

.1 Insertion bar or orifice differential pressure type

.2 Integral three-valve manifold

.3 Pipe size: NPS 2 to NPS 20

.4 Material: Type 316SS

.5 (Designed for “Hot-Tap” installation on existing piping)

.3 Flow rate transmitter:

.1 Simultaneous calibration of flow element and transmitter

.2 Keypad entry and display of information including span and zero

.3 Accuracy: ±1% of reading over a minimum of 10:1 turndown

.4 Repeatability: ±0.1%

.5 Output: 4-20 mA flow rate transmitter with a three valve manifold for isolation and testing

.6 Square root extractors

.7 Remote mounted for systems operating at 93°C (200°F) and over

.8 NEMA 4 housing

.9 Power supply: 120 VAC

.10 HART communication module, overlaid on 4-20 mA wiring)

.4 Acceptable Manufacturers:

.1 Annubar

.2 Elsag Bailey

.3 Rosemount

.4 Foxboro

2.4 **MASS FLOW**

.1 Differential Pressure Type

.1 Operating medium:

.1 Natural gas

.2 Primary flow element:

.1 Insertion bar or orifice differential pressure type

.2 Integral three-valve manifold

.3 Pipe size: NPS 2 to NPS 20

.4 Material: Type 316SS and Inconel

.5 (Designed for “Hot-Tap” installation on existing piping)

.3 Flow rate transmitter:

.1 Simultaneous calibration of flow element and transmitter

.2 Keypad entry and display of information including span and zero

.3 Accuracy: ±1% of reading over a minimum of 10:1 turndown

.4 Repeatability: °±0.1%

.5 Output: 4-20 mA flow rate transmitter with a three valve manifold for isolation and testing

.6 Square root extractors

.7 Remote mounted for systems operating at 93°C (200°F) and over

.8 NEMA 4 housing

.9 Power supply: 120 VAC

.4 Pressure transmitter

.1 Piezo-electric silicon chip sensor

.2 Rangeability: 5:1 turndown

.3 Type 316SS body and drain valves

.4 Electronics housing: NEMA 4

.5 Output: 4-20 mA

.6 Power supply: 120 VAC

.5 Temperature sensor:

.1 Three wire, 100 OHM platinum RTD

.2 4-20 mA output

.3 Accuracy: 0.2% of calibrated span

.4 Aluminum housing

.5 Power supply: 24 VDC

.6 Mass flow rate computer:

.1 Calculates Reynolds numbers, flow profiles, and mass flow rate compensated for temperature and pressure

.2 Adjustable digital flow averaging

.3 Menu-driven software entered through face mounted keypad

.4 Two line x twenty character LCD display

.5 Output: RS-422 serial communication, dry contact, 2x 4-20 mA configurable

.6 Lithium battery back-up

.7 NEMA 4X enclosure

.8 Power supply: 120 VAC

.7 Acceptable Manufacturers:

.1 Annubar

.2 Elsag Bailey

.3 Rosemount

.4 Foxboro

2.5 ENERGY FLOW METERING

.1 Differential Pressure Type

.1 Operating medium:

.1 Hydronic heating and cooling systems

.2 Primary flow element:

.1 Insertion bar or orifice differential pressure type

.2 Matching flanges and pressure taps for orifice plates

.3 Integral three-valve manifold

.4 Pipe size: NPS 2 to NPS 20

.5 Material: Type 316SS and Inconel

.6 (Designed for “Hot-Tap” installation on existing piping)

.3 Flow rate transmitter:

.1 Simultaneous calibration of flow element and transmitter

.2 Keypad entry and display of information including span and zero

.3 Accuracy: ±1% of reading over a minimum of 10:1 turndown

.4 Repeatability: ±0.1%

.5 Output: 4-20 mA flow rate transmitter with a three valve manifold for isolation and testing

.6 Square root extractors

.7 Remote mounted for systems operating at 93°C (200°F) and over

.8 NEMA 4 housing

.9 Power supply: 120 VAC

.4 Temperature sensors:

.1 Quantity: Two

.2 Three wire, 100 OHM platinum RTD

.3 4-20 mA output

.4 Accuracy: 0.2% of calibrated span

.5 Aluminum housing

.6 Power supply: 24 VDC

.5 Energy rate computer:

.1 Calculates Reynolds numbers, flow profiles, and energy flow rate

.2 Adjustable digital flow averaging

.3 Menu-driven software entered through face mounted keypad

.4 Two line x twenty character LCD display

.5 Output: RS-422 serial communication, dry contact, 2x 4-20 mA configurable

.6 Lithium battery back-up

.7 NEMA 4X enclosure

.8 Power supply: 120 VAC

.6 Acceptable Manufacturers:

.1 Annubar

.2 Elsag Bailey

.3 Rosemount

.4 Foxboro

2.6 **AUXILIARY EQUIPMENT**

.1 Chart Recorders

.1 (Wall mounted) (Free standing) flow meter:

.1 Single pen recorder for measuring volume flow for water

.2 Two pen recorder for measuring mass flow and pressure for steam and natural gas

.3 Electronic seven day (circular) (or) (strip) chart

.4 One years supply of charts and ink

.2 Acceptable Manufacturers:

.1 Elsag Bailey Controls Limited

.2 Fisher Controls

.3 Dietrich Standard

3 Execution

3.1 **INSTALLATION**

.1 Metering Devices

.1 Install flow measuring devices in horizontal straight pipe runs, free of valves and fittings.

.2 Provide isolating valve at each connection to transmitter.

.3 Length of straight pipe before and after metering elements.

.1 Not less than 1 m before and 1 m after or,

.2 As recommended by manufacturer.

.4 Mount meters and provide piping and wiring between measuring elements and meters.

.2 Remote Measuring Elements

.1 Where measuring element is located more than 1.8 m above floor level, or is not otherwise readily accessible, locate transmitter at 1.2 m above floor in accessible location.

.2 Run signal lines in Schedule 40 threaded steel pipe, except final connections to transmitter can be in type L copper with silver solder joints. Bronze quarter turn isolating valve may be used in place of a dielectric union to separate the copper and steel pipe.

.3 Provide isolating valve at each connection to transmitter, and provide valved and capped drains at bottom of signal risers.

.4 For remote transmitters on steam service, provide inverted loop from top of flow measuring element, and provide colour dyed water in downcomer leg to transmitter.

.3 Calibration

.1 Provide services of manufacturer's service representative to calibrate and commission the equipment.

.2 Make calibration checks on flow measuring instruments before attempting system balancing.

.3 Return instrument systems failing to meet accuracy and repeatability criteria to the manufacturer for re-calibration and/or repair.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **REFERENCE STANDARDS**

.1 Contractor Certification

.1 Contractors providing Work regulated under O.Reg. 220/01 Boilers and Pressure Vessels are to be holders of a Technical Standards and Safety Authority (TSSA) certificate of authorization to conduct this Work, including:

.1 Pressure piping fabrication and installation

.2 Boiler and pressure vessel repairs and alterations

.2 Registration

.1 Register with the TSSA, and pay associated registration and inspection costs, for pressure piping systems regulated under O.Reg. 220/01 Boilers and Pressure Vessels.

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit valve Shop Drawings in accordance with Section 01 33 00.

2 Products

2.1 **BEDDING AND BACKFILL**

.1 Materials

.1 From bottom of trench to 300 mm above top of pipe:

.1 New Granular "A" material of bank run sand and gravel or crushed stone of non-organic nature.

.2 From 300 mm above top of pipe to underside of gravel sub base or landscaping soil:

.1 New granular material conforming to OPSS 1010 Granular "B" requirements.

.2 Samples

.1 Submit handcarry samples of backfill materials in heavy duty, clear plastic bags to the Consultant at the Job site prior to purchasing.

.2 Material delivered to the Job site will be inspected by the Consultant and any material considered unsuitable will be rejected.

2.2 **ESCUTCHEON PLATES**

.1 Materials

.1 Heavy chrome plated cast brass or stamped metal.

.2 Two-piece construction fitted with substantial hinges and positive latches.

.3 Fit all plates with tempered springs to ensure positive attachment to the pipe.

2.3 **PIPE AND FITTINGS - PRESSURE PIPING - FERROUS**

.1 General

.1 Pressure class and pipe schedules as shown on piping data sheets unless specified herein.

.2 Galvanized pipe and fittings: Where indicated on piping data sheets unless specified herein.

.3 Grooved piping systems - acceptable manufacturers:

.1 Victaulic

.2 Anvill Gruvlok

.3 Shurjoint

.2 Pipe

.1 Carbon steel - general use

.1 Black carbon steel: To ASTM A53 Grade B, seamless or ERW

.2 Black carbon steel, for fire protection systems: To ASTM A795, A53, A135

.3 Bevelled, plain or grooved ends as per piping data sheets

.4 For buried pipe: “Yellow Jacket” polyethylene jacket coating, minimum 22 mil thickness

.2 Carbon steel - grooved - fire protection systems

.1 Black carbon steel: To ASTM A120, seamless or ERW

.2 Grooved ends

.3 Stainless steel

.1 Type 304: To ASTM A312

.2 Bevelled ends

.3 Tubing

.1 Stainless steel

.1 Type 316 seamless, fully annealed and welded, redrawn, fully annealed suitable for bending: To ASTM A269

.2 Maximum hardness: Rockwell B80

.4 Fittings

.1 Threaded

.1 Black banded malleable iron threaded fittings: To ASTM A197 and ANSI B16.3

.2 Black cast iron threaded fittings: To ASTM A126 Class A and ANSI B16.1

.2 Flanged

.1 Galvanized cast iron, flanged flat face: To ASTM A126 Class A and ANSI B16.1

.2 Black cast iron flanged flat face: To ASTM A126 and ANSI B16.4

.3 Drainage

.1 Standard galvanized cast iron drainage fittings: To ANSI B16.12

.4 Socket welded

.1 Forged steel socket welding type: To ASTM A105 Grade 2 and ANSI B16.11

.2 For underground pipe: Protect joints and fittings with Shaw “Shrink-Sleeves” or a coating of Denso Paste wrapped with Denso Tape applied with at least 50% overlap

.5 Butt welded

.1 Seamless carbon steel butt weld fittings, with wall thickness to match pipe: To ASTM A234 WPB and ANSI B16.9

.2 For underground pipe: Protect joints and fittings with Shaw “Shrink-Sleeves” or a coating of Denso Paste wrapped with Denso Tape applied with at least 50% overlap

.3 Long radius elbows

.6 Grooved

.1 NPS 10 and less: Ductile iron to ASTM A536 Grade 65-45-12

.2 NPS 12 and over: Same material as pipe to ASTM A234, with grooved ends to CSA B242-M

.7 Stainless steel (pipe)

.1 Seamless stainless steel type 304/304L butt weld fittings, with wall thickness to match pipe: To ASTM A312 WPW 304/304L

.2 3000# stainless steel socket welded fittings: To ASTM A182

.3 Stainless steel threaded fittings

.4 Grooved Fittings:

.1 ASTM A403 or factory-fabricated from ASTM A312 stainless steel pipe.

.2 NPS 2 and Smaller: Pressure-Sealed, cold drawn stainless steel with elastomer O-ring seals (grade to suit the intended service), suitable for operating pressure to 3450-kPa (500-psi).

.8 Stainless steel (tubing)

.1 Type 316: To ASTM A182

.2 Parker “Triple-Lok” 37 degree flared tube fittings, Swagelock two-ferrule four-piece joint, Union Carbide

.5 Unions

.1 General use

.1 Black malleable iron with brass ground joint and screwed ends: To ASTM A197 and ANSI B2.1

.6 Flanges

.1 Welded

.1 Forged steel raised face slip-on or weld neck type: To ASTM A181 Grade 1 and ANSI B16.5

.2 Provide flat faced flanges for connection to cast iron valves, or equipment having a flat faced flange

.2 Screwed

.1 Cast iron, galvanized, flat face, screwed: To ASTM A126 Class A and ANSI B16.1

.3 Grooved

.1 Hinged, two piece, shouldered or keyed cast ductile iron: To ASTM A536 Grade 65-45-12

.2 Synthetic rubber gaskets, selected for service: To ASTM D2000

.3 Lock bolt

.4 Stainless steel (pipe)

.1 1.6 mm raised face, forged stainless steel: To ASTM A182 and ANSI B16.5

.7 Flange Gaskets

.1 General service water < 94°C (200°F) maximum pressure: 1720 kPa (250 psig)

.1 1.6 mm thick red rubber, ring type for raised face flanges

.2 Full face type for flat faced flanges

.2 Hot water 94°C - 152°C (200°F - 305°F) maximum pressure: 6890 kPa (1000 psig)

.1 1.6 mm thick Garlock No. 3000 with nitrile binder flat ring type, or equivalent asbestos-free material manufactured by Anchor or Phelps

.3 High temperature hot water 153°C - 232°C (306°F - 450°F) maximum pressure: 8200 kPa (1200 psig)

.1 1.6 mm thick Garlock No. 3500 PTFE gasket with silica binder flat ring type, or equivalent asbestos-free material manufactured by Anchor or Phelps

.4 Gas piping, coolant piping, waste oil piping, maximum pressure: 6890 kPa (1000 psig)

.1 1.6 mm thick Garlock No. 3000 with nitrile binder flat ring type, or equivalent asbestos-free material manufactured by Anchor or Phelps

.5 Stainless steel piping

.1 1.6 mm thick graphite with Type 316 stainless steel insert manufactured

.6 For Van Stone flanges increase gasket thickness to 3.2 mmthick.

.8 Flange Bolting

.1 General use

.1 Semi-finished hex head machine bolts, carbon steel: To ASTM A193 Grade B7

.2 Semi-finished hex nuts, carbon steel: To ASTM A194 Grade 2H

.2 High pressure piping

.1 Semi-finished hex head machine bolts, carbon steel: To ASTM A307 Grade A

.2 Semi-finished hex nuts, carbon steel: To ASTM A307 Grade A

.3 Stainless steel flanges

.1 Stainless steel bolt studs, hex head, machine finished: To ASTM A193, Grade B8 and ANSI B18.21

.2 Machine finished stainless steel heavy hex nuts: To ASTM A194, Grade 8 and ANSI B18.22

.9 Couplings

.1 Grooved for Carbon Steel Pipe

.1 Cast segmented ductile iron: To ASTM A536 Grade 65-45-12

.2 Grooved machine type: To CSA B242-M or similar

.3 Oval track-head bolts and heavy hex nuts: To ASTM A183 & A449

.4 Synthetic rubber gaskets, selected for service: To ASTM D2000

.1 Grade EHP EPDM gaskets suitable for water temperatures up to 120°C (250°F).

.5 Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support and hanging in accordance with ANSI B31.1 and B31.9. Installation-Ready for complete installation without field disassembly.

.6 Flexible Type: For use in locations where vibration attenuation and stress relief are required. Standard of Acceptance:

.7 Two-segment couplings for pipe sizes NPS 14 and larger, with lead-in chamfer on housing key.

	At pump connections and concealed piping	Mechanical rooms and exposed piping
Victaulic	Fig 77, 177 or W77	Fig 107N or W07
Anvil (Gruvlok)	Fig 7001	Fig 7401
Shurjoint	Fig 7705	Fig 7771

.2 Grooved for Stainless Steel Pipe:

.1 Housings: Ductile iron to ASTM A536 Grade 65 45 12 or stainless steel to ASTM A351, Grade CF8M.

.3 Grooved machine type: To CSA B242-M or similar

.1 NPS 12 and smaller Schedule 5S or 10S pipe shall be roll grooved using a grooving tool specifically designed for stainless steel pipe.

.4 Rigid: Housing key shall engage the bottom of the groove:

.1 Victaulic Style 89 (ductile iron) or 489 (stainless steel)

.2 Anvil Gruvlok

.3 Shurjoint

.5 Flexible Type: For use in locations where vibration attenuation and stress relief are required:

.1 Victaulic Style 77S and 77-DX

.2 Anvil Gruvlok

.3 Shurjoint

.6 Two-segment couplings for pipe sizes NPS 14 and larger, with wide-width gasket and lead-in chamfer on housing key:

.1 Victaulic Style W89 (rigid)

.2 Anvil Gruvlok

.3 Shurjoint

.10 Miscellaneous

.1 Plugs

.1 Class 3000, threaded, square head, machined from solid steel or forging: To ASTM A105 Grade 2

.2 Closures, welded

.1 Schedule 40 seamless butt welded caps, carbon steel, with wall thickness to match pipe: To ASTM A234 Grade B

.3 Thread compound

.1 General service: Teflon tape or Master metallic compound

.2 Petroleum based fluids service: Teflon base pipe thread compound

.3 Ammonia service: X-Pando or approved equal

.11 Press Fitting System – Stainless Steel

.1 Pipe

.1 Schedule 10S stainless steel: To ASTM A312 Type [304/304L] [316/316L], with plain ends

.2 Size NPS ½ to NPS 2

.2 Fittings, couplings and adapters

.1 Housing: Type 304L [316L] stainless steel, minimum 1.65mm wall thickness

.2 Maximum working pressure 2068kPa (300PSI).

.3 Self contained Grade E EPDM O-ring seals for water services, up to +110°C (+230°F)

.4 Adapter fittings at valves and equipment connections

.5 Certified to NSF 61

.6 Acceptable manufacturers:

.1 Victaulic Vic-Press

.2 Anvil AnvilPress

2.4 **PIPE AND FITTINGS - PRESSURE PIPE - NON FERROUS**

.1 Copper Tubing

.1 Tubing

.1 Type “L” hard drawn copper tubing: To ASTM B88

.2 Fittings

.1 Wrought copper, solder joint, pressure type

.2 Solder to threaded adaptors as screwed valves or equipment

.3 Unions

.1 All bronze construction with ground joint

.2 Either solder joint or screwed ends as required

.3 Grooved Joint: Copper-tube dimensioned couplings, consisting of two ductile iron housings cast with offsetting angle-pattern bolt pads. Installation-Ready, for direct stab installation without field disassembly:

.1 Victaulic Style 607N.

.2 Anvil Gruvlok CTS COPPER SYSTEM

.3 Shurjoint

.2 Copper Pipe

.1 Pipe

.1 Seamless copper pipe standard sizes: To ASTM B42

OR

.2 Seamless red brass pipe standard sizes: To ASTM B43

.2 Fittings

.1 Brass or bronze threaded water fittings: To ANSI B16.15 “Cast Bronze Threaded Fittings (Classes 125 and 250)"

.2 Grooved: Wrought copper to ASME B16.22 or cast bronze to ASME B16.18, manufactured to copper-tube dimensions.

.1 Victaulic Copper Fittings

.2 Anvil Gruvlok CTS COPPER SYSTEM

.3 Shurjoint

.3 Flanges and flange fittings

.1 Brass or bronze flanges and flange fittings: To ANSI B16.24 “Bronze Pipe Flanges and Flanged Fittings (Class 150 and 300)"

.4 Flange gaskets

.1 1.6 mm thick red rubber, full face type

.5 Flange bolting

.1 Semi-finished hex head machine bolts, carbon steel: To ASTM A193 Grade B7

.2 Semi-finished hex nuts, carbon steel: To ASTM A194 Grade 2H

.3 Copper - Refrigerant Piping

.1 Pipe

.1 Type ACR copper tubing, soft annealed or hard drawn

.2 Type ACR copper tubing, hard drawn: To ASTM B280

.3 Deoxidized and dehydrated, with ends factory sealed and identified by the manufacturer as being suitable for refrigeration service

.2 Fittings

.1 Heavy wrought copper, solder joint type

.2 Adapter fittings at screwed connections

.3 On NPS 5/8 and less, flareless compression type

.3 Unions

.1 Rating: 150°C (300°F) maximum temperature rating, 2760 kPa (400 psi) working pressure

.2 Brass tail piece adaptors for copper tubing, forged steel flanges, steel bolts, bronze nuts and asbestos-free fibre gasket

.3 Acceptable manufacturers: Henry Valve Company Type P30

.4 Flexible hose

.1 Bronze construction with braided wire exterior jacket and union connection on one end

.2 Minimum length: Six times the diameter of the hose

.3 Rating: suitable for 150°C (300°F) maximum temperature and 2760 kPa (400 psi) working pressure

.4 Acceptable manufacturers: Flexonics or Anaconda

.5 Coiled section of soft annealed tubing may be used instead of hose on lines not larger than NPS 5/8

.5 Sight glass

.1 Provided in refrigeration piping

.2 Combination moisture and liquid indicator feature and extended ends for solder joint connection

.6 Filter dryer

.1 Provided in refrigeration piping

.2 Replaceable cartridge type

.4 PVC Pipe

.1 Pipe and fittings

.1 PVC with solvent welded socket fittings: To CSA B137.3

.2 Victaulic Company PGS-300 CPVC Piping system may be used on water and chemical services where IPS size Schedule 80 CPVC pipe is approved for use. Pipe and fittings shall be cut grooved to Victaulic's PGS-300 groove specification. Schedule 80 CPVC pipe shall meet the requirements of ASTM F441 and ASTM D1784 - minimum cell classification 23447 Pipe.

.5 Polyethylene Pipe

.1 Pipe and fittings

.1 Flexible polyethylene: Certified to CSA B137.1

2.5 **PIPE AND FITTINGS - PRESSURE - BURIED**

.1 Copper - Buried

.1 Pipe

.1 Type "K" soft annealed tubing: To ASTM B88

.2 Fittings

.1 Wrought copper, solder joint pressure type

.2 Compression type or cold flared fittings as manufactured by Mueller or Emco

.2 Polyethylene - Buried - Water

.1 Pipe

.1 Series 160 psi polyethylene pipe: Certified to CSA B137.1

.2 Smooth finish free of imperfections such as grooves and ripples

.2 Fittings

.1 Nylon insert type, with serrated ends and insert adapters with threaded end where threaded connections are required: To ASTM D2609

.2 Secure pipe to insert fittings by using two stainless steel type clamps over each insert end of fitting

.3 Where water service enters building, provide transition from plastic to copper no more than 450 mm above the floor

.3 Polyethylene - Buried - Gas

.1 Pipe

.1 Series 120 psi polyethylene pipe: Certified to CSA B137.1

.2 Smooth finish free of imperfections such as grooves and ripples

.2 Fittings

.1 Series 125 polyethylene socket welding type: Certified to CSA B137.1

.2 Heat fusion joints, installed in accordance with manufacturer's installation manuals

.3 Install in accordance with CSA Z184-M and Z184S1

.4 PVC - Buried

.1 Pipe

.1 Class 150 PVC DR18 pressure type, PVC resin: To ASTM D1784

.2 Class 200 PVC DR14 pressure type, PVC resin: To ASTM D1784

.2 Fittings

.1 Class 250 cast grey iron or ductile iron, mechanical joint ends to AWWA C110

.2 Tar coated outside

.3 Cement mortar lined: To AWWA C104

.4 Polyethylene encasement: To AWWA C105

.3 Joints

.1 To AWWA C-900 and CAN-B137.3

.2 Maximum working pressure: 1035 kPa at 23°C (150 psi at 74°F)

.5 Glass Fiber Reinforced Epoxy Resin - Buried

.1 Pipe

.1 Type 1 (Filament-Wound) Grade 1 (Glass Fibre Reinforced Epoxy Resin pipe) Class H (Thermoplastic Resin Liner) pipe: to ASTM D2996 classification 11HZ5001

.2 Pipe designed in accordance with ASTM D2992 and D2996

.3 Maximum working pressure: 2413 Pa at 23°C (350 psi at 73°F) or as approved by ULC

.4 Integral bell, push-on type joints

2.6 **PIPE AND FITTINGS - DRAINAGE SYSTEMS**

.1 Cast Iron Soil Pipe

.1 Pipe and fittings

.1 Cast iron soil pipe: To CAN/CSA-B70-M

.2 Plain end pipe and fittings

.2 Joints

.1 Bell and spigot, with lead and oakum joints

.2 NPS 8 and smaller: Neoprene sleeves with stainless steel gear type clamps, where approved by local authorities

.2 Acid Resistant Cast Iron Soil Pipe

.1 Pipe and fittings

.1 High silicon alloy acid resistant cast iron

.2 Sleeve couplings: Inner Teflon sleeve, outer neoprene sleeve and two bolt stainless steel sleeve clamp

.3 Bell and spigot joints, with acid proof rope packing and lead

.4 (Split flange joints with flange bolts) (Bell and spigot joints)

.5 (Gaskets for split flange joints: 1.6 mm thick, Garlock style 3000 with nitrile binder or equivalent asbestos-free material manufactured by Anchor)

.3 PVC Soil Pipe

.1 Pipe - below grade - sanitary and storm drainage

.1 All sizes: To CAN/CSA-B181.2 “PVC Drain, Waste and Vent Pipe and Pipe Fittings”

.2 Bell and spigot ends

.3 Rubber ring gaskets with bell

.2 Pipe - below grade - storm drainage (alternate)

.1 2" to 6": To CSA B182.1-M

.2 8" and up: To CSA B182.2-M

.3 Bell and spigot ends

.4 Rubber ring gaskets with bell

.3 Pipe - above grade - sanitary and storm drainage

.1 All sizes: To CAN/CSA-B181.2 “PVC Drain, Waste and Vent Pipe and Pipe Fittings”

.2 Plain end with solvent weld joints

.3 ABS or PVC solvent cement

.4 Pipe - above grade - storm drainage (alternate)

.1 NPS 2" to 6" ABS: To CSA B182.1-M

.2 8" and up: To CSA B182.2-M

.3 Plain end with solvent weld joints

.4 ABS or PVC solvent cement

.5 Pipe – Concrete Embedded Gravity Drain:

.1 Schedule 40 solvent weld rigid PVC drain, waste and vent pipe and fittings in accordance with CSA B181.2.

.2 Fittings: PVC injection moulded, solvent weld type ends.

.6 Weeping tile (foundation drainage)

.1 Perforated PVC BDS solvent. Weld sewer and drain pipe in accordance with CSA B182.1 [or perforated high density polyethylene (HDPE) per ASTM D 3350].

.2 Minimum stiffness of 210 kPa at 5% deflection per ASTM D2412.

.7 Fire stop seal for combustible pipe

.1 Certification: to CAN4-S115-M tested at a pressure differential of 50 Pa (0.007 psi)

.2 Fire stop rating: Class F

.3 Fire resistance rating: Not less than that of the fire separation being penetrated

.8 Acceptable Manufacturers:

.1 3M - Ultra Plastic Pipe Device

.4 Copper - DWV

.1 Pipe

.1 Hard drawn copper drainage tube (DWV): To ASTM B306

.2 Drainage fittings

.1 Wrought copper solder joint: To ANSI B16.29

.2 Cast brass solder joint: To CSA B158.1

.3 Manufacturer standard heat fusion tool system

2.7 **PIPE AND FITTING – ABOVEGROUND PRESSURIZED DRAIN (PUMP DISCHARGE):**

.1 Galvanized steel:

.1 NPS 2-1/2 and smaller:

.1 Schedule 40 galvanized steel pipe, in accordance with ASTM A53/A53M.

.2 Fittings: Malleable iron galvanized, screwed, in accordance with ANSI/ASME B16.3.

.3 Joints: Threaded, in accordance with ANSI/ASME B1.20.1.

.2 NPS 3 and larger:

.1 Schedule 40 galvanized steel pipe, in accordance with ASTM A53/A53M.

.2 Fittings:

.1 Flanged: Galvanized ductile iron, flanged, in accordance with ANSI/ASME B16.5.

.2 Grooved: Rigid grooved coupling, hot-dip galvanized, flush seal gaskets, and roll grooved piping.

.1 Victaulic Style 107

.2 Anvil Gruvlok, Fig. 7401

.3 Shurjoint

.3 Gasket: Styrene-Butadiene (SBR) or Ethylene - Propylene Diene Monomer (EPDM). [For oily waste use Nitrile].

.2 Copper:

.1 NPS 2 1/2 and smaller:

.1 Copper Type M hard copper pipe, in accordance with ASTM B88.

.2 Fittings: Wrought copper, solder joint, in accordance with ASME B16.29.

.1 Solder material: Lead free solder (tin-antimony or tin-silver).

.2 NPS 3 and larger:

.1 Copper Type M hard copper pipe, in accordance with ASTM B88. Roll grooved.

.2 Fittings: Wrought copper roll grooved

.3 Couplings: Flush seal gasket.

.1 Victaulic Style 606 or 607 Rigid grooved coupling

.2 Anvil Gruvlok, Fig 6400

.3 Shurjoint

.3 Gasket: EPDM. [For oily waste use Nitrile].

.3 PVC

.1 Schedule 40 solvent weld rigid PVC pressure pipe and fittings in accordance with CSA B 137.3, and ASTM D1785 or ASTM D2241.

.2 Fittings: PVC injection molded, solvent weld type ends, and friction fit

2.8 **PIPE AND FITTING – BURIED AND COMCRETE EMBEDDED PRESSURIZED DRAIN (PUMP DISCHARGE):**

.1 PVC

.1 Schedule 40 solvent weld rigid PVC pressure pipe and fittings in accordance with CSA B 137.3, and ASTM D1785 or ASTM D2241.

.2 Fittings: PVC injection molded, solvent weld type ends, and friction fit

2.9 **VACUUM TRUCK CONNECTION:**

.1 Above ground: Galvanized steel pipe, in accordance with ASTM A53/53M.

.1 Fittings:

.1 Flanged: Galvanized ductile iron, flanged, in accordance with ANSI/ASME B16.5.

.2 Grooved: Rigid grooved coupling, hot-dip galvanized, flush seal gaskets, and roll grooved piping.

.3 Couplings:

.1 Victaulic Style 107 hot-dip galvanized couplings

.2 Anvil Gruvlok, Fig. 7401

.3 Shurjoint

.4 Gasket: Nitrile [SBR or EPDM]

.2 Buried and Concrete Embedded PVC

.1 Schedule 40 solvent weld rigid PVC pressure pipe and fittings in accordance with CSA B 137.3, and ASTM D1785 or ASTM D2241.

.2 Fittings: PVC injection molded, solvent weld type ends, and friction fit.

2.10 **VALVES**

.1 General

.1 Gate valves re-packable under pressure, when fully open

.2 Plug valves packed with lubricant suitable for service

.3 Globe and check valves provided with composition discs suitable for type of service

.4 Renewable seats on iron body valves

.5 Materials

ASTM B62	Bronze valves - gate, globe and check - steam rated 125 and 150 psig
ASTM B61	Bronze valves - gate, globe and check - steam rated 200 and 350 psig
ASTM B283 C3770	Brass valves - ball valves
ASTM A126 Class B	Iron valves - gate, globe and check

.6 Markings

MSS-SP-25	Steam or WOG (water, oil and gas) rated pressure, manufacturer's trademark, size

.7 End Connections

ANSI B2-1	Threaded ends
ANSI B16.18	Soldered ends
ANSI B16.10	Face to face dimensions

.8 Testing and Materials

MSS-SP-80	Bronze valves, gate, globe and check
MSS-SP-70	Iron gate valves
MSS-SP-85	Iron globe valves
MSS-SP-71	Iron check valves
MSS-SP-67	Butterfly valves

.2 Gate Valves

.1 GTV 1

.1 Class 125 bronze body, threaded ends, solid or split wedge disc, rising stem

.1	Crane	Fig 428
.2	Jenkins	Fig 990AJ
.3	Nibco	T-111
.4	Toyo Red-White	Fig 293
.5	Kitz	Fig 24

.2 GTV 2

.1 Class 125 iron body, OS&Y bronze mounted, flanged ends

.1	Crane	Fig 465 ½
.2	Jenkins	Fig 454J
.3	Nibco	F-617
.4	Toyo Red-White	Fig 421JA
.5	Kitz	Fig 72

.3 GTV 3

.1 Class 125 bronze body, threaded ends, rising stem, wedge disc, screw-in bonnet

.1	Crane	Fig 428
.2	Jenkins	Fig 990AJ
.3	Nibco	T-111
.4	Toyo Red-White	Fig 293
.5	Kitz	Fig 24

.4 GTV 4

.1 175 psi working pressure, to AWWA C-500, non-rising stem, iron body, bronze mounted, renewable seat rings, stuffing box and packing gland, mechanical joint ends. Valve box to grade, with guide plate and cover identifying the service. Valves and valve box finish: Two heavy coats of coal tar enamel. Provide one extension key for each valve box installed

.2 Valve

.1	MAS	W10-A-NL-FF-B-HW
.2	Jenkins	Fig 2397A

.3 Box

.1	Bibby	VB Series
.2	Canada Valve	Fig 1322
.3	Mueller	Fig A769

.5 GTV 5

.1 175 psi WOG, ULC and FM approved, iron body, bronze mounted, cast iron disc, resilient seat, mechanical joint ends, non-rising stem, square operating nut. Finish: Two heavy coats of coal tar enamel

.1	Clow	
.2	Mueller Canada	
.3	MAS	W10-A-NL-FF-B-HW

.6 GTV 6

.1 175 psi WOG, ULC and FM approved, iron body, bronze mounted, OS&Y, flanged ends

.1	Clow	
.2	Mueller Canada	
.3	Nibco	F-607
.4	MAS	W10-A-RS-FF-B-HW

.7 GTV 7

.1 Class 125, bronze body, wedge disc, non-rising stem, solder ends

.1	Crane	Fig 13240
.2	Jenkins	Fig 993AJ
.3	Toyo Red-White	Fig 281
.4	Kitz	Fig 41
.5	Nibco	S-113

.8 GTV 13

.1 Main stop valve, service box of required length with ribbed cover brought up flush to finished grade or floor, shut-off key

.1 Mueller Corporation

.3 Globe Valves

.1 GLV 1

.1 Class 125 bronze body, threaded ends, solid or split wedge disc, rising stem

.1	Crane	Fig 5TF
.2	Jenkins	Fig 106BJ
.3	Nibco	T-211
.4	Toyo Red-White	Fig 221
.5	Kitz	Fig 09

.2 GLV 2

.1 Class 125 iron body, bronze mounted, yoke bonnet, composition disc, renewable and regrindable bronze set ring, flanged

.1	Crane	Fig 351
.2	Jenkins	Fig 2342J
.3	Nibco	F-718-B
.4	Toyo Red-White	Fig 400
.5	Kitz	Fig 76

.3 GLV 3

.1 Class 125 bronze body, composition disc and solder ends

.1	Crane	Fig 1310
.2	Jenkins	Fig 995AJ
.3	Kitz	Fig 10
.4	Nibco	S-211-Y

.4 GLV 10

.1 Class 450, maximum 3100 kPa (450 psi) working pressure, 135°C (275°F) maximum temperature rating, bronze body, forged brass wing cap seal, back seating, molded ring packing, forged brass bolted bonnet with bonnet seal, solder ends

.1	Henry Valve Co.	Fig 203 – Globe style

.2	Henry Valve Co.	Fig 216 – Angle style

.4 Ball Valves

.1 BV 1

.1 Class 150-600 WOG brass body, threaded ends, Teflon ends, Teflon seats, Teflon packing, bronze or chrome plated, solid ball and lever handle with plastic protector, AGA and CGA approved for gas service

.1	Crane	Fig F9201
.2	Jenkins	Fig 201J
.3	Worcester Econ-O-Mite	Fig 4211T
.4	NCI	TFP600
.5	NCI	TFP601
.6	Neles-Jamesbury	Fig 351
.7	Toyo Red-White	Fig 5044A
.8	Kitz	Fig 58
.9	M.A.S.	Fig B-3
.10	Bray Flow-Tek	SB5

.2 BV 2

.1 Class 150-600 WOG brass body, soldered ends, Teflon ends, Teflon seats, Teflon packing, bronze or chrome plated, solid ball and lever handle with plastic protector, AGA and CGA approved for gas service

.1	Crane	Fig F9202
.2	Jenkins	Fig 202J
.3	Worcester Econ-O-Mite	Fig 4211
.4	NCI	SFP600
.5	NCI	SFP601
.6	Neles-Jamesbury	Fig 341
.7	Toyo Red-White	Fig 5044A or 5049A
.8	Kitz	Fig 58 or 59
.9	Apollo	Fig 77-100 or 77-200
.10	MAS	Fig B-3 or B-4
.11	Bray Flow-Tek	Triad SP

.5 Butterfly Valves

.1 BFV 1

.1 Class 150 full tapped lug type, cast iron body, bronze disc, 304 stainless steel shaft, EPDM seat, notched top plate

.2 Lever lock handle for valve sizes NPS 6 and smaller

.3 Worm gear operator with handwheel for valves NPS 8 and larger

.1	Crane	Fig 44 BXZ
.2	Keystone	Fig FH12-CBJ-2
.3	Jenkins	Fig 2232Elj
.4	Nibco	LD-2000
.5	Nibco	N-200
.6	Centerline	Fig 200 Series
.7	De Zurik	Fig BGS, L1/632
.8	Victaulic	704Vic 300 MasterSeal and AGS
.9	Apollo	Fig Series 143
.10	Bray	Fig 31H-375
.11	Challenger	Fig 20-CS4E
.12	Kitz	Fig 6122EL/G
.13	Toyo	Fig 918BESL/G
.14	MAS	D-Series #LD4AE

.2 BFV 2

.1 175 psi ULC and FM approved full lug, cast iron body, bronze disc, EPDM seat

.2 Lever lock handle for valve sizes NPS 6 and smaller

.3 Worm gear operator with handwheel for valves NPS 8 and larger

.4 Indicator flag painted “safety yellow” and provision for mounting supervisory switch

.1	MAS	W50-A-ED-LL
.2	Grinnell	

.6 Plug Valves

.1 PV 1

.1 Class 175 WOG rating, lubricated plug valve, semi-steel body, tapered plug, screwed ends, wrench operated

.1	Rockwell-Nordstrom	Fig 142
.2	Newman-Milliken	Fig 170M
.3	Walworth	Fig 1796

.2 PV 2

.1 Class 175 WOG rating, lubricated plug valve, semi-steel body, tapered pug, flat faced flanged ends drilled to 862 Pa (125 lb) ANSI

.2 Valves NPS 6 and less: Manual lever operated

.3 Valves NPS 8 and larger: Worm gear operated

.1	Rockwell-Nordstrom	Fig 143
.2	Newman-Milliken	Fig 172M
.3	Walworth	Fig 1797F

.7 Check Valves

.1 CV 1

.1 Class 125 horizontal swing check valve, bronze body, screwed ends, screwed cap and regrindable bronze disc

.1	Crane	Fig 37
.2	Jenkins	Fig 996AJ
.3	Grinnell	Fig 3300
.4	Nibco	T-413
.5	Toyo Red-White	Fig 236
.6	Kitz	Fig 22
.7	Bray Rite	12CBT

.2 CV 2

.1 Class 125 horizontal check valve, iron body, bronze mounted, flat face flanged ends, renewable and regrindable bronze seat ring and disc

.1	Crane	Fig 373
.2	Jenkins	Fig 587J
.3	Grinnell	Fig 6300A
.4	Nibco	F-918
.5	Toyo Red-White	Fig 435JA

.6	Victaulic	Series 715
.7	Gestra	“CB” Series
.8	Kitz	Fig 78
.9	Bray Rite	12CBT

.3 CV 3

.1 Class 125 wafer type non-slam check valve, cast iron body, bronze plates and Buna-N seals

.2 Install between two flat faced flanges as specified for piping NPS 4 and larger

.1	Mission Valve	“Duo-Chek”
.2	Ritepro	“Check Rite”
.3	Gestra	“RK” Series
.4	Crane	Fig R-1-66-4-F-1-X
.5	Centerline	800 Series
.6	Grinnell	Fig 300
.7	Jenkins	Fig R-1-66-4-F-1-X
.8	Nibco	W-920-W
.9	Mueller Steam	71-AHH-3-H
.10	Bray Rite	D15DBZ

.4 CV 4

.1 Class 125 horizontal swing check, bronze body, screwed ends, screwed cap and regrindable bronze disc

.1	Crane	Fig 37
.2	Jenkins	Fig 4092J
.3	Grinnell	Fig 3300
.4	Nibco	S-413
.5	Toyo Red-White	Fig 236
.6	Victaulic	Series 712
.7	Kitz	Fig 22

.5 CV 5

.1 Class 125 ULC and FM approved for 1200 Pa (175 psig) WOG, iron body, bronze mounted, horizontal swing check, bolted cap, flanged ends

.2 For above ground or in valve pit

.1 Clow

.2 Bray Rite 212ULC/FM

.3 MAS W30 Series

.6 CV 19

.1 Class 450, 3100 kPa (450 psi) working pressure, 150°C (300°F) maximum temperature rating, floating piston, Teflon seat disc, bronze body, solder ends.

.1 Henry Valve Co. Fig 205.

3 Execution

3.1 **TRENCHING, BEDDING AND BACKFILL**

.1 General

.1 Extent:

.1 For buried services inside building and to 1.5 m outside building wall.

.2 Trench depth:

.1 To 75 mm(150 mm) below the correct elevation and slope established for the bottom of the pipe.

.3 Bedding:

.1 Refill the bottom elevation of the trench with hand-placed bedding materials.

.2 Thoroughly compact to the approval of the Consultant.

.3 At pipe hubs or couplings, remove bedding in the bottom of the trench as necessary to provide for even and constant support for each length of pipe.

.4 Shoring:

.1 Provide adequate shoring, bracing and sheeting in pipe trenches.

.2 Place barriers and temporary crossings as necessary to ensure support, safety and protection at all times.

.5 Unstable soil conditions:

.1 When encountered, advise the Consultant.

.2 Excavate pipe trenches to a depth as directed by the Consultant and then backfill to the correct grade with bedding material.

.6 Backfill:

.1 Where joints occur, do not backfill until joint testing is approved by Consultant.

.2 Hand place backfill to 300 mm above the top of the pipe in 100 mm layers taking particular care to place and compact the backfill simultaneously on both sides of the pipe.

.3 From 300 mm above the top of the pipe backfill in 150 mm layers and mechanically compact.

.7 Keep excavations dry at all times.

.8 Compaction:

.1 Mechanically tamp and thoroughly compact each layer of new granular bedding and backfill material to 95 percent Modified Proctor Density.

.9 In fill areas, allow a minimum clearance of 100 mm on all sides of the pipe passing under or through building grade beams to prevent possible damage from settling of building. If a greater settlement can be expected, increase the clearance to prevent possible damage.

.10 Remove and dispose of excess excavated material off-site.

3.2 GENERAL PIPING CONSTRUCTION METHODS

.1 General

.1 Standards:

.1 To ANSI sections B31.1 to B31.9 as applicable to service, unless specified otherwise herein.

.2 Do not use soldered joints in compressed air piping.

.2 Inserts, sleeves and anchors:

.1 Avoid unnecessary cutting of masonry.

.2 Supply inserts, sleeves and anchors to other trades for building in as the Work proceeds.

.3 Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical Work.

.3 Inspect pipe and fittings for soundness and clean off all dirt and other foreign matter immediately prior to installation.

.1 Reject all damaged items.

.4 Pipe layout:

.1 Install piping in the most direct, straight and functional manner possible.

.2 Except where otherwise shown, install all vertical lines plumb, and run horizontal lines parallel to building walls.

.3 Install piping close to walls, partitions and ceilings.

.4 On multiple runs of piping, space piping to allow for installation of insulation and for proper servicing of valves.

.5 Conceal piping in finished areas and rooms within walls or ceilings, and in furred spaces elsewhere.

.1 Provide access doors or panels as hereinafter specified for access to concealed piping specialties, etc.

.2 Expansion and Contraction

.1 Installation:

.1 Install all piping free from strain and distortion due to expansion and contraction: to section 6, Chapter 3 of ANSI B31.1, except as hereinafter modified.

.2 Allow for expansion and contraction by offsets, expansion U-bends or loops.

.3 Expansion joints of any type will not be allowed unless specifically indicated on the Drawings or specified under another section of this division for a particular installation.

.2 Expansion/contraction allowance criteria:

.1 Steel pipe: 25 mm movement per 30 m of pipe.

.2 Brass and copper pipe: 38 mm movement per 30 m of pipe

.3 Temperature difference: for each 55°C (100°F) temperature difference from 21°C (70°F) ambient.

.4 Fabricate expansion bends in steel pipe from pipe sections and long radius welding elbows.

.3 Swing and swivel joints:

.1 On steam or hot water heating piping for connections from mains to risers and from risers to radiation and other heating units.

.2 Use at least five fittings from main to riser including tee in main.

.3 Use at least four fittings from riser to heating unit including tee in riser.

.3 Lines, Grades and Slopes

.1 Install piping in conformity with elevations and grades indicated on the Drawings using axis lines and bench marks provided under general construction.

.1 Verify such axis lines and bench marks.

.2 Lay out Work and be responsible for lines, elevations, measurements, etc., required for installation of the Work.

.2 Slopes:

.1 Slope piping drains and sewers as indicated on the Drawings.

.2 Install so that slope between elevations shown on the Drawings is even and constant.

.3 Install liquid and air lines free of pockets and pitch to drain at low points in the line with valves or traps installed as required for drainage of the lines.

.3 Minimum slopes:

.1 As shown on Drawings; if not shown, then as follows.

.2 Drainage piping, NPS 3 and less: 1:50.

.3 Drainage piping, NPS 4 and larger: 1:100.

.1 In special circumstances as provided for under the codes and regulations and the express approval of the Consultant, drains of NPS 4 size and larger may be laid at a lesser slope.

.4 Domestic water lines: pitch to low points so that all lines may be completely drained.

.5 Hot water heating, chilled water and condenser water lines: Slope up 1:500 in direction of flow.

.4 Where pipe slope causes pipe to rise to top of ceiling space, or fall to bottom of structural members, ceiling space or defined service space, provide risers as follows:

.1 Domestic water lines: Provide drain valve at bottom of low point, and Provide riser to increase elevation of piping.

.2 Hot water heating, chilled water and condenser water lines: Provide automatic air vent, complete with drainage piping, at high point, Provide drain valve at bottom of low point and Provide riser to lower elevation of pipes.

.3 Natural gas: Provide a drip pocket with capped end, drain valve and Provide riser to increase elevation of piping. Pocket depth to be the greater of: 75 mm deep or equal to diameter of pipe. Pocket diameter to be the lesser of: NPS 2 or gas main pipe diameter.

.4 Immersion Wells and Sensing Bulbs

.1 Fitting size:

.1 Pipe size NPS 2½ size and less: Increase pipe length for 300 mm to minimum one pipe size larger to maintain equivalent unobstructed cross sectional area.

.2 Pack immersion wells in piping for liquids up to a temperature of 150°C (300°F) with a mineral type grease prior to installation of sensing bulb.

.5 Piping Connections to Mains

.1 Make branch connections to respective horizontal piping of larger diameter to the upper quadrant of the larger pipe.

.2 Water piping:

.1 Make down feed piping connections to horizontal supply and return mains to the bottom quadrant of the mains.

3.3 **SYSTEM REQUIREMENTS**

.1 Plumbing

.1 Install complete plumbing, drainage and vent piping for washrooms, etc, in accordance with the Ontario Building Code.

.2 Size vent lines based on developed pipe length and hydraulic load.

.3 Arrange piping within pipe spaces behind washroom fixtures to allow unimpeded access to piping for servicing.

.2 Gas Piping - Buried - Cathodic Protection

.1 Isolate buried piping between two buildings at both ends with dielectric unions or flanges.

.2 Protect piping by at least one 1 kg magnesium sacrificial anode every 30 m of run, welded to the buried gas pipe, to manufacturer's installation instructions.

.3 Provide dielectric unions on piping NPS 2½ and less and dielectric flanges on piping NPS 3 and larger.

.3 Copper Pipe - Type L

.1 Provide dielectric unions or couplings at all connections between copper tubing and ferrous piping.

.4 Copper Pipe - Buried

.1 Provide dielectric unions at connection between cast iron or ductile iron water main and copper tubing.

.2 When required by municipal authority, provide 900 mm long copper gooseneck after corporation stop at connection to water main. Connection at water main to be at forty-five degrees and gooseneck to have minimum 160 mm radius bend.

.5 Refrigerant Piping

.1 Install piping to conform to applicable requirements of ANSI B31.5 Code for Pressure Piping Section 5 "Refrigeration Piping" and CSA B52-M "Mechanical Refrigeration Code" latest issue.

.2 Make solder type joints with "sil-fos" silver solder or similar high melting point solder having a melting point of at least 538°C (1000°F). Remove all interior parts of refrigerant specialties and valves before applying heat to the joint.

.3 Provide refrigerant hoses on refrigerant line connections to equipment with reciprocating or rotating elements.

.4 Test procedure and evacuation procedures: Conform to ANSI B31.5.

.5 Test pressure: In accordance with CSA Code B52-M.

.6 Provide all refrigerant required for testing and charging of the system.

.7 Purge refrigerant piping with anhydrous nitrogen prior to making connection to pre-evacuated equipment to ensure removal of all moisture and non-condensable gases.

.8 Completely evacuate to 0.5 torr (500 micron), seal and leave for twenty-four hours, re-evacuate to 0.5 torr, and charge all components of refrigeration system not evacuated by manufacturer, in accordance with manufacturer's printed recommendations.

.9 Do not use the refrigeration compressor to evacuate the system under any circumstances. Evacuation the system using a vacuum pump at an ambient temperature not less than 2°C (35°F) to ensure removal of all moisture and non-condensable gases.

.10 After testing, evacuation and charging is completed, allow system to operate under normal conditions for a minimum period of twenty-four hours, at which time, moisture indicator should indicate a dry system. If it does not so indicate, change dryer and operate unit for another twenty-four hours. Repeat this procedure until moisture indicator indicates a thoroughly dry system.

.6 PVC - Buried - Pressure and Drainage Piping

.1 Provide a tracer wire directly over PVC pipe.

.7 PVC Drainage, Waste and Vent Piping

.1 Below grade: Install in accordance with CSA B182.11 and manufacturer’s recommendations.

.2 Above grade: Install in accordance with CSA B181.11 and B181.12 and manufacturer’s recommendations.

.3 Provide fire stop seals on all fire separation penetrations, except at connections through concrete floor slabs to non-combustible water closets.

.4 Do not use combustible piping in return air ceiling plenums or vertical riser shafts.

.8 Polypropylene - Laboratory Drainage

.1 Make heat fusion joints in accordance with manufacturer’s written instructions.

.9 Polyethylene - Laboratory Drainage

.1 Make heat fusion joints in accordance with manufacturer’s written instructions.

.10 Borosilicate Glass - Beaded End

.1 Install and support piping system to manufacturer’s written instructions.

.2 Provide pipe hangers with padding material between hanger and glass pipe.

.11 Borosilicate Glass - Plain End

.1 Install and support piping system to manufacturer’s written instructions.

.2 Provide pipe hangers with padding material between hanger and glass pipe.

3.4 **SLEEVES**

.1 Installation Requirements

.1 Provide where piping passes through foundations, above grade floors and walls.

.2 Materials

.1 Schedule 40 black steel pipe or type "K" copper tubing for installation in foundations or floors

.2 1 mm (20 gauge) galvanized sheet steel where installed in above grade walls.

.3 Terminate sleeves flush with finished ceilings, walls and floors on grade.

.1 For piping passing through floors above grade extend sleeve a minimum of 75 mm above the floor.

.4 Sleeve sizes

.1 Large enough to pass full thickness of pipe covering where same is used.

.2 With sufficient clearance between pipe/insulation and sleeve to allow for any lateral movement of piping due to expansion and contraction.

.5 Assume responsibility for the setting of all sleeves necessary for this Work in masonry walls during construction or in concrete forms before concrete is poured.

.6 Coat exterior surface of all sleeves of ferrous material with a heavy asphalt emulsion.

.2 Foundation Sleeves

.1 For pipes entering structures from below grade, seal the annular space between sleeve and pipe with prefabricated seals.

.3 Firestopping

.1 Provide firestopping on pipes passing through firewalls, fire separation walls or through walls, partitions or floors which are considered as serving as firestops.

.1 Provide at partitions around washrooms.

.2 Seal the space around the pipe, in the sleeve, in accordance with Section 23 05 01 and Section 07 84 00.

.4 Pipe Sleeves Through Roofs

.1 Supplied and installed under other Contracts or under roofing section, unless specifically shown otherwise on the Drawings.

.5 Future Services

.1 Fill sleeves for future use with lime mortar.

.6 Escutcheon Plates

.1 Place escutcheon plates on bare piping passing through finished walls or floors.

3.5 JOINTS, UNIONS, FLANGES AND FITTINGS

.1 Pipe Joints

.1 Preparation

.1 Ream pipe ends and thoroughly clean all dirt, cuttings and foreign matter from pipe after cutting and threading.

.2 Thoroughly clean all fittings, valves and equipment before connections are made.

.3 Cut copper tubing with a tube cutter and clean the joining surfaces of the tubing and fitting with fine emery cloth. Wipe clean with a dry cloth.

.2 Cast iron pipe sleeve joints

.1 For cast iron plain end soil pipe, install sleeve type couplings such as Titan Foundry Type MJ, or Bibby MJ Series 2000 in strict accordance with manufacturer's printed instructions.

.3 Cast iron bell and spigot joints

.1 Make joints either neoprene compression type preformed gaskets such as Bibby "Bi-seal", and caulk in such a manner to produce a permanently tight joint.

.2 Cold caulking compound in cord form such as W.R. Meadows PC4 may also be used.

.3 Assemble preformed neoprene gaskets to manufacturer's printed instructions.

.4 Mechanical joints:

.1 Assemble mechanical joint on ductile iron pressure pipe with cast iron gland, rubber sealing gasket and high strength malleable iron bolts in accordance with the manufacturer's recommendations.

.5 Soldered joints:

.1 Make soldered joints on copper tubing in accordance with the following usage:

Service	Solder Type
Domestic hot and cold water	95/5 with matching flux
Drainage, waste, vent	50/50 with matching flux
Compressed air service	“Sil-Fos” silver solder or brazed

.2 Do not use core type solder.

.6 Threaded joints:

.1 Use Teflon tape or Masters metallic compound with the compound applied to the male threads only and particular care taken to prevent the compound from reaching the interior of the pipe or fittings.

.7 Carbon steel welded joints:

.1 To ANSI B31.1 Section IX for welding.

.2 Fusion welded joints made by electric arc welding, gas metal arc welding, or oxy-acetylene gas welding.

.3 Ensure that supervisory staff, fitters and welders are fully conversant with the requirements laid down by that standard prior to the commencement of welding.

.4 Employ qualified welders holding a current up-to-date provincial certificate for the process and rating involved as required by the provincial regulations.

.5 Unless more stringent methods of inspections are specified the Consultant will visually inspect welded joints for fusion of metal, icicles, alignment, etc.

.1 Remove any defects and remake the joint to his satisfaction.

.6 For welding of materials other than carbon steel, conform to the requirements specified in the relevant section of the Specification.

.8 Grooved end piping systems:

.1 Install couplings, fittings, etc. in accordance with manufacturer's printed instructions.

.2 Unions and Flanges

.1 Provide unions or flanges in the following locations:

.1 For by-passes around equipment or control valves or devices in piping systems.

.2 At connection to steam traps and in by-passes around traps.

.3 At connections to equipment. Locate between shut-off valve and equipment.

.4 In screwed or solder joint drainage tubing at inlet side of trap.

.2 If unions are concealed in walls, partitions or ceilings, build access thereto.

.3 Provide dielectric unions or isolating type companion flanges at all connections between copper tubing and ferrous piping.

.1 Brass body valves between ferrous piping and copper tubing is acceptable as a dielectric union.

.4 Flange joints

.1 Assemble joints with appropriate flanges, gaskets and bolting.

.2 Allow clearance between flange faces such that the connections can be gasketed and bolted tight without undue strain on the piping system, with flange faces parallel and bores concentric.

.3 Centre gaskets on the flange faces so as not to project into the bore.

.4 Lubricate bolts before assembly and provide two hardened steel washers under the head of each unit to assure uniform bolt stressing.

.5 Machine off raised face flanges when joining to a flat companion flange and use a full face gasket.

.6 Follow gasket manufacturer's instructions for correct bolting procedure.

.7 Use calibrated torque wrench and tighten bolts in recommended sequence in four equal steps to required final torque value.

.3 Fittings

.1 Couplings

.1 Minimize couplings on runs of pipes.

.2 Do not use running couplings in any pipeline.

.3 NPS 2 and smaller: Threaded coupling.

.4 NPS 2½ and larger: Welded joints.

.2 Fittings and ancillary items installed in systems operating at pressures in excess of 103 kPa (15 psig):

.1 Register in accordance with CSA B51-M.

.3 Eccentric reducer fittings

.1 To provide proper drainage or venting of the lines.

.2 At change of pipe sizes.

.3 At connections to equipment and control valves.

.4 Do not use bushings.

.4 Tee connections in welded piping

.1 Factory fabricated standard buttweld fittings.

.2 Bonney Forge "Weldolets", "Thredolets" or "Sockolets".

.3 Mitering, notching or direct welding of branches to mains is not permitted.

.5 Change of direction

.1 Use standard pipe fittings.

.2 Use long radius welded steel elbows unless short radius elbows are specifically authorized by the Consultant.

.3 Mitered joints or field fabricated pipe bends are not permitted.

.6 Tees, copper tubing

.1 Direct connection of branch into main using "T-Drill" method may be used where allowed by the code, in lieu of manufactured tee fittings.

3.6 VALVES

.1 Installation

.1 General

.1 Wherever possible, source valves from one manufacturer.

.2 Where required

.1 At locations shown on the Drawings.

.2 At all piping connections to equipment.

.3 At all connections to control valves or control devices.

.4 Where required for sectionalizing a system or floor.

.5 Check valves wherever required to ensure flow of liquid in one direction.

.3 Type

.1 Shut-off service: Gate, butterfly type, and ball (quarter-turn).

.2 Throttling service: Double regulating, globe or plug type for throttling purposes.

.4 Drain valves

.1 Hose thread outlet connection or valve with long nipple on outlet at all low points of each water system and above all riser or branch stop valves for proper drainage of lines.

.5 Valve chains

.1 Provide chain wheel operators and operating chain for valves located more than 2 m above floor or walkway.

.2 Provide chain of sufficient length to extend to within 2 m of operating platform or floor for free handing chains, or to within 1.5 m of floor in locations where chain can be secured to wall or column. Secure chain to wall or column with a wall hook.

.3 Chain wheels using rustproof chain complete with guide and of size recommended by valve manufacturer for proper operation of valve.

3.7 INSPECTION AND TESTING

.1 Pressure Leak Testing

.1 Make specified pressure tests on all piping included in this Contract.

.2 Furnish all pumps, compressors, gauges and connectors necessary for the tests.

.3 Test sections as authorized by Consultant to accommodate construction schedule. However, test complete systems on completion of Work.

.4 Conduct tests in the presence of:

.1 Consultant

.2 Personnel of governing authorities having jurisdiction

.5 Notify above personnel in ample time to permit them to be present.

.6 Conduct tests before piping is painted, covered or concealed.

.7 Disconnect pumps or compressors used for applying the test pressure, during the test period.

.8 Disconnect and/or remove equipment or specialties not designed to withstand the test pressure during the test and reconnect same after completion of test.

.9 Promptly correct any defects that develop through tests and re-test to the complete satisfaction of the Consultant and other parties involved.

.10 Forward copies of all final tests on all pressure and drainage piping and a copy of governing authority approvals to the Consultant immediately on acceptance of tests and/or approvals.

.11 Final payment for the Work will not be made until the above has been received.

.2 Hydrostatic Tests

.1 Conduct tests for a minimum period of two hours, or longer when requested by the Consultant or governing authority at the test pressure specified under the respective section of the Specifications.

.2 Test requirements:

.1 Pressure to remain constant over test period to a pressure of one and one-half times the operating pressure but not to exceed the material pressure class rating.

.2 Exterior surfaces of pipe or fittings free of cracks or other form of leak.

.3 Tests to be performed at a constant ambient temperature.

.3 Pneumatic Tests

.1 Initially pressurize the system with air to approximately one-half the specified operating pressure but not to exceed 345 kPa (50 psig).

.1 Examine joints for leaks with a soapsuds solution.

.2 Repair leaks as detected.

.3 Repeat test and repairs until soap test passes.

.2 Provide a final pressure test on the system with air to the test pressure specified under the respective section of the Specifications.

.4 Natural and Propane Gas Piping

.1 Conduct final tests in accordance with the requirements of the local utility or governing authority.

.2 If feasible, make tests when ambient air temperature is approximately constant.

.1 Corrections for pressure change due to temperature differential shall be allowed as approved by the Consultant.

.5 Drainage and Potable Water Testing

.1 Test drainage piping and potable water piping in accordance with requirements of the Ontario Building Code, latest edition, and any additional requirements of applicable local by-laws.

.6 Specific Test Requirements

.1 Test the following services with compressed air or inert gas at one and one-half times the working pressure, but in no event less than 345 kPa (50 psig).

.1 Natural gas piping

.2 Vacuum piping

3.8 PRE-OPERATIONAL CLEANING

.1 Temporary Connections

.1 Make temporary cross-overs, blank-off equipment connections, install drain and fill lines for circulating cleaning fluid through piping.

.2 Flushing of Piping Systems

.1 Flush water piping with water flowing at a velocity of not less than 1.8 m/sec, for a period of fifteen minutes or longer as required to remove all dirt, scale, and cuttings from the entire length of the piping.

.2 Thoroughly clean, prior to fabrication, sections of new piping which cannot be isolated for flushing purposes.

.3 Thoroughly clean, insofar as possible, welded joints by swabbing interior of pipe with swabs soaked with a caustic solution.

.4 Flush stainless steel piping with water as described above, then immediately flush with design Product fluid. Do not leave city water or chlorinated water in piping.

.3 Chilled Water, Condenser Water, Glycol and Heating Water Systems

.1 Clean systems with neutral pH, non-chromate chemical cleaner to remove sludge oil and debris. Use cleansing compound at rate of 10 kg per 5000 litres of water in system.

.2 Circulate cleaner for seventy-two hours at room temperature then drain and refill with water and inhibitor.

.3 Circulate inhibitor treated water for an additional six hours and drain.

.4 Refill each system with working fluid and add chemicals to provide protection against corrosion.

.5 Recirculate fluid for four hours and test samples from system for iron content. Drain, refill, and add chemicals so that total iron content in system is less than 1 ppm. (When iron content of glycol system is satisfactory, add glycol to achieve design concentration.)

3.9 PIPING SYSTEMS STANDARDS

.1 Abbreviations

.1 The Mechanical Pipe Standards (MPS) include the following abbreviations:

End Treatment		**Material**	
B&S	Bell and Spigot	ARCI	Acid Resisting Cast Iron
BDE	Beaded End	CB	Cast Bronze
BE	Beveled End	CBR	Cast Brass
BW	Butt Weld	CGI	Cast Grey Iron
CJ	Compression Joint	CI	Cast Iron
FE	Flange End	CK	Copper type "K" soft annealed
GE	Groove or Rolled End	CL	Copper Type "L" hard drawn
HFJ	Heat Fusion Joint	CS	Carbon Steel
LUG	Full Tapped Lug	CTSL	Cast Steel
MJ	Mechanical Joint	Cu	Copper
PE	Plain End	DWV	DWV Copper
SJ	Solder Joint	FS	Forged Steel
SO	Slip On	Galv	Galvanized
SW	Socket Weld	MI	Malleable Iron
SWJ	Solvent Weld Joint	PET	Polyethylene
TE	Threaded End	PPE	Polypropylene
WFR	Wafer	PVC	PVC
WN	Weld Neck	SMS	Semi-Steel
		SS	Stainless Steel
		TBS	Tempered Borosilicate Glass
		WC	Wrought Copper

.2 Mechanical Pipe Standards

.1 The following piping system standards are bound at the end of this section.

2000	
2060	Industrial Vacuum - Copper
3000	
3010	Fire Protection - Buried - 4” and Larger - Ductile Iron
3011	Fire Protection - Carbon Steel - Threaded, Cut Groove
3012	Fire Protection - Galvanized Steel (FM - Note 4) - Threaded, Cut Groove
3021	Fire Protection - Industrial - Carbon Steel - Welded, Roll Groove

3022	Fire Protection - Commercial - Carbon Steel - Welded, Roll Groove
3023	Fire Protection - Galvanized Steel (FM - Note 4) - Welded, Roll Groove
3031	Fire Protection - Buried - Ductile Iron
4000	
4011	Drainage and Vent - Buried - Cast Iron
4012	Drainage and Vent - Buried - PVC
4020	Pumped Sanitary - Pumped Storm - Above Ground
4031	Sanitary Drainage and Vent - Above Ground - DWV and Cast Iron
4032	Sanitary Drainage and Vent - Above Ground - PVC
4041	Storm Drainage - Above Ground - Steel - Drainage Fittings
4042	Storm Drainage - Above Ground - Steel - Grooved
4043	Storm Drainage - Above Ground - Cast Iron
4044	Storm Drainage - Above Ground - PVC
4052	Process Drain and Vent - Buried - PVC
4053	Process Drain and Vent - Above Ground - Cast Iron
4054	Process Drain and Vent - Above Ground - PVC
4055	Process Drain and Vent - Above Ground - Acid Resistant
4056	Process Wastewater Piping - Above & Below Ground - FRP
4100	
4111	City Water - Buried - Copper
4112	City Water - Buried - Polyethylene
4113	City Water - Buried - Ductile Iron
4114	City Water - Buried - PVC
4130	Domestic Water - Above Ground - Copper
5000	
5011	Service Water - Carbon Steel - Threaded and Welded
5012	Service Water - Carbon Steel - Threaded and Grooved End
5013	Service Water - Carbon Steel - Socket Weld and Welded
5014	Service Water - Carbon Steel - Socket Weld and Grooved End
5015	Service Water - Copper
5021	Service Water - Carbon Steel - Buried
5022	Service Water - Copper - Buried
5200	
5211	Natural Gas - Buried - Carbon Steel
5212	Natural Gas - Buried - Polyethylene
5221	Natural Gas - Above Grade - Steel
5222	Natural Gas - Above Grade - Steel - Socket Weld
5240	Fuel Oil - Above Grade - Socket Weld and Welded
6000	
6020	Refrigerant

End of Section

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Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3" & DN	PE	CL	B88				
Fittings	3" & DN	SJ	WC					Note 2
Flanges								
Unions	3" & DN	SJ	CB					Note 1
Couplings	3" & DN							Note 1

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	3" & DN	SJ	CB		GTV 10		125	
Globe	2" & DN	CJ	CB		GLV 6		125	
Needle	2" & DN	CJ	SBR		NV 1		3000	
Butterfly								
Ball	3" & DN	SJ	SBR		BV 8		3000	
Check	3" & DN	SJ	CBR		CV 9		125	
Strainers								

Line Reference	Service
V(I)	Industrial Vacuum

Notes
1. Dieletric unions or couplings at connections to ferrous pipe or equipment
2. Sil-Fos solder

IBI Group

PIPING SPECIFICATION

Industrial Vacuum
Copper

Maximum Temperature
180°F

Maximum Pressure
125

Revised	5/30/00	Checked	PS
Rev:	1	Appr'd	PS

MPS-2060

Item	Size	End Treatment	Mat'l	ASTM		AWWA (CSA)	Schedule , Class	Remarks
				Spec	Grade			
Pipe	4" & UP	MJ	DI			C150, C151, C111, C104	250	Note 2, 3
	4" & UP	B&S	DI				250	Note 2, 3
Fittings	4" & UP	MJ	CGI			C110	250	Note 2, 3
	4" & UP	MJ	DI			C110	250	Note 2, 3
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'L	Stem	Type	Approvals	Schedule Class	Remarks
Gate	4 & UP	FE	CI		GTV 4	AWWA C-500	175	
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
F	Fire Main

Notes
1. For buried piping within building and up to 5' (1.5m) from building
2. Cement mortar lined
3. Wrap pipe with polyethylene to AWWA C105
4. Provide adaptors for connection to buried PVC fire main

IBI Group

PIPING SPECIFICATION

Fire Protection
Buried - 4" and Larger
Ductile Iron

Revised	6/10/2002	Checked	RW
Rev:	1	Appr'd	CD

Maximum Temperature
100°F

Maximum Pressure
175 PSIG

MPS-3010

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE,BE	CS	A53	B		40	
	3"<>6"	GE	CS	A53	B		40	
	8" & UP	GE	CS	A53	B		30	
Fittings	2 1/2" & DN	SE	MI	A197	A	B16.3	150	
	1 1/4"<>8"	GE	DI	A536	654512		175	
Flanges	10" & DN	SO, WN	CI	A126	A	B16.1	125	
	12" & UP	SO, WN	CS	A181	II	B16.5	150	
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	14" & DN	MJ	CI	OS&Y	GTV 5	ULC/FM	175	
	14" & DN	FE	CB		GTV 6	ULC/FM	175	
Globe	3" & DN	SE	CB		GLV 1	ULC/FM	150	
Angle								
Butterfly	12" & DN	Lug	CI		BFV 2	ULC/FM	175	
Ball								
Check	12" & DN	FE	CI		CV 5	ULC/FM	125	
Strainers								

Line Reference	Service
F	Combined Fire Mains
SP	Standpipe
SPR	Sprinklers
FP	Fire Pump (discharge)
	Fire Pump (test line)
	Fire Pump (relief line)

Notes
1. Fire protection systems designed for 175 psig working pressure
2. Threaded joints usually used for smaller size piping (less than 2 1/2")

IBI Group

PIPING SPECIFICATION

Fire Protection
Carbon Steel
Threaded, Cut Groove

Revised	6/29/01	Checked	PS
Rev:	3	Appr'd	PS

Maximum Temperature
250°F

Maximum Pressure
175 PSIG

MPS-3011

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE,BE	CS	A795			40	Note 3
	3"<>6"	GE	CS	A795			40	Note 3
	8" & UP	GE	CS	A795			30	Note 3
Fittings	2 1/2" & DN	SE	MI	A197	A	B16.3	150	
	1 1/4"<>8"	GE	DI	A536	654512		175	
Flanges	10" & DN	SO, WN	CI	A126	A	B16.1	125	
	12" & UP	SO, WN	CS	A181	II	B16.5	150	
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	14" & DN	MJ	CI	OS&Y	GTV 5	ULC/FM	175	
	14" & DN	FE	CB		GTV 6	ULC/FM	175	
Globe	3" & DN	SE	CB		GLV 1	ULC/FM	150	
Angle								
Butterfly	12" & DN	Lug	CI		BFV 2	ULC/FM	175	
Ball								
Check	12" & DN	FE	CI		CV 5	ULC/FM	125	
Strainers								

Line Reference	Service
F	Combined Fire Mains
SP	Standpipe
SPR	Sprinklers
FP	Fire Pump (suction)

Notes

1. Fire protection systems designed for 175 psig working pressure
2. Threaded joints usually used for smaller size piping (less than 2 1/2")
3. Galvanized piping
4. For Factory Mutual approved Dry Valve and Pre-Action systems only, and Fire Pump suction lines

IBI Group

PIPING SPECIFICATION

Fire Protection
Galvanized Steel (FM - Note 4)
Threaded, Cut Groove

Revised	7/7/03	Checked	PS
Rev:	3	Appr'd	PS

Maximum Temperature
250°F

Maximum Pressure
175 PSIG

MPS-3012

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & UP	GE	CS	A53	B		NFPA-13	Note 2
	2 1/2" & UP	BE	CS	A53	B		NFPA-13	Note 2, 3
Fittings	2 1/2" & UP	GE	DI	A536	654512		175	
	2 1/2" & UP	BW	CS	A234	WPB	B16.9	150	Note 3
Flanges	2 1/2" & UP	GE	MI	A47	32510		125	
	4" & UP	WN,SO	FS	A181	1	B16.5	150	Note 3
Unions								
Couplings			MI					CSA B242-M

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Approvals	Schedule Class	Remarks
Gate	14" & DN	MJ	CI	OS&Y	GTV 5	ULC/FM	175	
	14" & DN	FE	CB		GTV 6	ULC/FM	175	
Globe	3" & DN	SE	CB		GLV 1	ULC/FM	150	
Angle								
Butterfly	12" & DN	Lug	CI		BFV 2	ULC/FM	175	
Ball								
Check	12" & DN	FE	CI		CV 5	ULC/FM	125	
Strainers								

Line Reference	Service
F	Combined Fire Mains
SP	Standpipe
SPR	Sprinklers

Notes

1. Fire protection systems designed for 175 psig working pressure
2. Risers to be Schedule 40 between floor level and first horizontal main
3. Shop welded assemblies only

IBI Group

PIPING SPECIFICATION

Fire Protection - Industrial
Carbon Steel
Welded, Roll Groove

Revised	7/7/03	Checked	PS
Rev:	2	Appr'd	PS

Maximum Temperature
250°F

Maximum Pressure
175 PSIG

MPS-3021

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & UP	GE	CS	A53	B		NFPA-13	
	2 1/2" & UP	BE	CS	A53	B		NFPA-13	Note 2
Fittings	2 1/2" & UP	GE	DI	A536	654512		175	
	2 1/2" & UP	BW	CS	A234	WPB	B16.9	150	Note 2
Flanges	2 1/2" & UP	GE	MI	A47	32510		125	
	4" & UP	WN,SO	FS	A181	1	B16.5	150	Note 2
Unions								
Couplings			MI					CSA B242-M

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Approvals	Schedule Class	Remarks
Gate	14" & DN	MJ	CI	OS&Y	GTV 5	ULC/FM	175	
	14" & DN	FE	CB		GTV 6	ULC/FM	175	
Globe	3" & DN	SE	CB		GLV 1	ULC/FM	150	
Angle								
Butterfly	12" & DN	Lug	CI		BFV 2	ULC/FM	175	
Ball								
Check	12" & DN	FE	CI		CV 5	ULC/FM	125	
Strainers								

Line Reference	Service
F	Combined Fire Mains
SP	Standpipe
SPR	Sprinklers

Notes
1. Fire protection systems designed for 175 psig working pressure
2. Shop welded assemblies only

IBI Group

PIPING SPECIFICATION

Fire Protection - Commercial
Carbon Steel
Welded, Roll Groove

Revised	7/7/03	Checked	PS
Rev:	2	Appr'd	PS

Maximum Temperature
250°F

Maximum Pressure
175 PSIG

MPS-3022

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE,BE	CS	A795			NFPA-13	Note 3
	3"<>6"	GE	CS	A795			NFPA-13	Note 3
	8" & UP	GE	CS	A795			NFPA-13	Note 3
Fittings	2 1/2" & DN	SE	MI	A197	A	B16.3	150	
	1 1/4"<>8"	GE	DI	A536	654512		175	
Flanges	10" & DN	SO, WN	CI	A126	A	B16.1	125	
	12" & UP	SO, WN	CS	A181	II	B16.5	150	
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	14" & DN	MJ	CI	OS&Y	GTV 5	ULC/FM	175	
	14" & DN	FE	CB		GTV 6	ULC/FM	175	
Globe	3" & DN	SE	CB		GLV 1	ULC/FM	150	
Angle								
Butterfly	12" & DN	Lug	CI		BFV 2	ULC/FM	175	
Ball								
Check	12" & DN	FE	CI		CV 5	ULC/FM	125	
Strainers								

Line Reference	Service
F	Combined Fire Mains
SP	Standpipe
SPR	Sprinklers

Notes
1. Fire protection systems designed for 175 psig working pressure
2. Threaded joints usually used for smaller size piping (less than 2 1/2")
3. Galvanized piping
4. For Factory Mutual approved Dry Valve and Pre-Action systems only

IBI Group

PIPING SPECIFICATION

Fire Protection
Galvanized Steel (FM - Note 4)
Welded, Roll Groove

Revised	7/7/03	Checked	PS
Rev:	2	Appr'd	PS

Maximum Temperature
250°F

Maximum Pressure
175 PSIG

MPS-3023

Item	Size	End Treatment	Mat'l	ASTM		AWWA (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	4" & UP	MJ	DI			C150, C151, C111, C104	250	Note 2, 3
	4" & UP	B&S	DI				250	Note 2, 3
Fittings	4" & UP	MJ	CGI			C110	250	Note 2, 3
	4" & UP	MJ	DI			C110	250	Note 2, 3
Flanges								Note 4
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	4 & UP	FE	CI		GTV 4	AWWA C-500	175	
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
F	Fire Mains (Buried)

Notes
1. For buried piping within building, and up to 5' (1.5m) from building
2. Cement mortar lined
3. Wrap pipe with polyethylene to AWWA C105
4. Provide mating flange/adaptor to suit site service piping

IBI Group

PIPING SPECIFICATION

Fire Protection
Buried
Ductile Iron

Revised	4/17/01	Checked	PS
Rev:	0	Appr'd	CD

Maximum Temperature
250°F

Maximum Pressure
175 PSIG

MPS-3031

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	8" & DN	PE	CI			B70-M		Note 1, 2
	10" & UP	PE	CI			B70-M		Note 3
Fittings	8" & DN	PE	CI			B70-M		Note 1, 2
	10" & UP	PE	CI			B70-M		Note 3
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
SAN	Sanitary
ST	Storm

Notes
1. Rubber ring gaskets integral with bell
2. Neoprene sleeve and stainless steel gear type clamp (MJ joint)
3. Lead and oakum joints
4. For buried piping within building, and up to 5' (1.5m) from building

IBI Group

PIPING SPECIFICATION

Drainage and Vent
Buried
Cast Iron

Revised	6/28/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4011

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	6" & DN	B&S	PVC			(B181.2-M)		Note 2, 3, 4
	8" & UP	B&S	PVC			(B181.2-M)		Note 2, 3, 4
Fittings	6" & DN	B&S	PVC			(B181.2-M)		Note 2, 3, 4
	8" & UP	B&S	PVC			(B181.2-M)		Note 2, 3, 4
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
SAN	Sanitary
ST	Storm

Notes
1. For buried piping within building, and up to 5' (1.5m) from building
2. Rubber ring gaskets integral with bell
3. Install in accordance with CSA B182.11 and manufacturers literature
4. Alternate for storm drainage: CSA B182.1-M in PVC

IBI Group

PIPING SPECIFICATION

Drainage and Vent
Buried
PVC

Revised	1/10/2003	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4012

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3" & DN	PE	Galv CS	A53	B		40	
Fittings	3" & DN	SE	Galv MI	A197		B16.3	150	
	3" & DN	FE	Galv CI	A126	A	B16.1	125	
Flanges	2" & DN	FE	Galv CI	A126	A	B16.1	125	
Unions	3" & DN	SE	Galv MI	A197		B2.1	150	Brass to Iron
								ground joint

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate	3" & DN	SE	CB	Rising	GTV 1		125	
Globe								
Angle								
Butterfly								
Ball								
Check	3" & DN	SE	CI		CV 3		125	Non-slam
Strainers								

Line Reference	Service
PSW	Pumped Sanitary
PST	Pumped Storm

Notes
1. Gaskets: 1/16" (1.6 mm) red rubber, full face type

IBI Group

PIPING SPECIFICATION

Pumped Sanitary
Pumped Storm
Above Ground

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4020

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3" & DN	PE	DWV	B306				
	4" & UP	PE	CI			B70-M		Note 1
Fittings	3" & DN	SJ	WC/CBR	B16.29		B16.29 (B158.1)		
	4" & UP	MJ	CI			B70-M		Note 1
Unions								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
SAN	Sanitary
	Sanitary Vent

Notes
1. Neoprene sleeves with stainless steel gear type clamps (MJ joints)

IBI Group

PIPING SPECIFICATION

Sanitary Drainage and Vent Above Ground DWV and Cast Iron

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature **140°F**

Maximum Pressure **-**

MPS-4031

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	6" & DN	PE	PVC			(B181.2-M)		
	8" & UP	PE	PVC			(B181.2-M)		
Fittings	6" & DN	SWJ	PVC			(B181.2-M)		Note 1
	8" & UP	SWJ	PVC			(B181.2-M)		
Unions								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
SAN	Sanitary Drainage Sanitary Vent

Notes
1. Solvent cement to CSA B181.11

IBI Group

PIPING SPECIFICATION

Sanitary Drainage and Vent
Above Ground
PVC

Revised	1/10/2003	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4032

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	12" & DN	PE	Galv CS	A53	B		40	
Fittings	12" & DN	PE	Galv CI			B16.12		Drainage Fittings

Line Reference	Service
ST	Storm

Notes

IBI Group

PIPING SPECIFICATION

Storm Drainage
Above Ground
Steel - Drainage Fittings

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4041

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	10" & DN	GE	Galv CS	A53	B		40	
Fittings	10" & DN	GE	Galv MI	A47	32510 35018			
Pipe	12" & UP	GE	Galv CS	A53	B		30	
Fittings	12" & UP	GE	Galv CS	A234		(B242-M)	30	
Couplings	12" & UP	GE	MI	A47	32510 35018	(B242-M)		

Line Reference	Service
ST	Storm

Notes

IBI Group

PIPING SPECIFICATION

Storm Drainage
Above Ground
Steel - Grooved

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4042

Item	Size	End Treatment	Mat'l	ASTM Spec	ASTM Grade	ANSI (CSA)	Schedule Class	Remarks
Pipe	15" & DN	PE	CI			(B70-M)		
Fittings	15" & DN	PE	CI			(B70-M)		Note 1
Pipe	15" & DN	PE	CI			(B70-M)		
Fittings	15" & DN	B&S	CI			(B70-M)		Note 2

Line Reference	Service
ST	Storm

Notes
1. Neoprene sleeves with stainless steel gear type clamps (MJ joints)
2. Lead and oakum joints

IBI Group

PIPING SPECIFICATION

Storm Drainage
Above Ground
Cast Iron

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4043

Item	Size	End Treatment	Mat'l	ASTM Spec	ASTM Grade	ANSI (CSA)	Schedule Class	Remarks
Pipe	18" & DN	PE	PVC			(B181.2)		Note 1,2,3
Fittings	18" & DN	SWJ	PVC			(B181.2)		Note 1,2,3

Line Reference	Service
ST	Storm

Notes
1. Solvent cement to CSA B181.11
2. Use of PVC for aboveground piping requires Underwriter's acceptance
3. Alternate for storm drainage: CSA B182.1-M and CSA B182.2-M in PVC

IBI Group

PIPING SPECIFICATION

Storm Drainage
Above Ground
PVC

Revised	1/10/2003	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-4044

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	18" & DN	B&S	PVC			(B181.2-M)		
Fittings	18" & DN	SWJ	PVC			(B181.2-M)		Note 2
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
PW	Process Waste Process Vent

Notes
1. For buried piping within building, and up to 5' (1.5m) from building
2. Solvent welding as per manufacturer's recommendations

IBI Group

PIPING SPECIFICATION

Process Drain and Vent
Buried
PVC

Revised	1/10/2003	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure

MPS-4052

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	8" & UP	PE	CI			(B70-M)		
Fittings	8" & UP	MJ	CI			(B70-M)		Note 2
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
PW	Process Waste Process Vent

Notes
2. Neoprene sleeve and stainless steel gear type clamp (MJ joint)

IBI Group

PIPING SPECIFICATION

Process Drain and Vent
Above Ground
Cast Iron

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure

MPS-4053

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	6" & DN	PE	PVC			(B181.2-M)		Note 1
Fittings	6" & DN	SWJ	PVC			(B181.2-M)		Note 1
Flanges	6" & DN	SWJ	PVC				125	Note 2
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
PW	Process Waste Process Vent

Notes
1. Solvent welding as per manufacturer's recommendations
2. Flanges finished and drilled to ANSI standard

IBI Group

PIPING SPECIFICATION

Process Drain and Vent
Above Ground
PVC

Revised	1/10/2003	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure

MPS-4054

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	All	BE	ARCI					
	All	BE	ARCI					
Fittings	All	FE	ARCI					
Flanges	All	WN	ARCI					Note 2, 3,
Unions								
Couplings	All	MJ	ARCI					Note 1

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
PW	Process Waste Process Vent

Notes
1. Inner Teflon sleeve, neoprene outer sleeve and two bolt stainless steel sleeve clamp
2. Flanges finished and drilled to ANSI standard
3. Split flange style

IBI Group

PIPING SPECIFICATION

Process Drain and Vent
Above Ground
Acid Resistant

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure

MPS-4055

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	18" & DN	B&S	FRP	D2996				
Fittings	18" & DN	B&S	FRP					
Flanges						B16.5		
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Plug								
Butterfly	4" & UP	FE	DI			BFV 5	150	
Ball	3" & DN	FE	SS			BV 12	150	
Check	18" & DN	WFR	SS			CV 18	150	
Strainers								

Line Reference	Service
IW	Industrial Waste
EDW	Industrial Waste

Notes

IBI Group

PIPING SPECIFICATION

Process Wastewater Piping
Above & Below Ground
FRP

Revised	5/13/2003	Checked	
Rev:	0	Appr'd	

Maximum Temperature
225ºF

Maximum Pressure
150ºF

MPS-4056

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2" & DN	PE	CK	B88				
Fittings	2" & DN	SJ	WC					
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
CW	City Water

Notes
1. For buried piping within building, and up to 5' (1.5m) from building

IBI Group

PIPING SPECIFICATION

City Water
Buried
Copper

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
74°F

Maximum Pressure
150 PSIG

MPS-4111

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2" & DN	PE	PET			(B137.1-M)		Note 2
Fittings	2" & DN	MJ-I	Nylon	D2609				
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
CW	City Water

Notes
1. For buried piping within building, and up to 5' (1.5m) from building
2. Inside smooth finish free of imperfections including grooves and ripples

IBI Group

PIPING SPECIFICATION

City Water
Buried
Polyethylene

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
74°F

Maximum Pressure
160

MPS-4112

Item	Size	End Treatment	Mat'l	ASTM		AWWA (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	4" & UP	MJ	DI			C150, C151, C111, C104	250	Note 2, 3
	4" & UP	B&S	DI				250	Note 2, 3
Fittings	4" & UP	MJ	CGI			C110	250	Note 2, 3
	4" & UP	MJ	DI			C110	250	Note 2, 3
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	4 & UP	FE	CI		GTV 4	AWWA C-500	175	
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
CW	City Water

Notes
1. For buried piping within building, and up to 5' (1.5m) from building
2. Cement mortar lined
3. Wrap pipe with polyethylene to AWWA C105

IBI Group

PIPING SPECIFICATION

City Water
Buried
Ductile Iron

Revised	11/1/2000	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
74°F

Maximum Pressure
150 PSIG

MPS-4113

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	4" & UP	B&S	PVC	D1784		(CAN3-B137.3-M)	150	AWWA C-900
Fittings	4" & UP	MJ	CGI DI				250	AWWA C110 Note 2, 3
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	4 & UP	FE	CI		GTV 4	AWWA C-500	175	
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
CW	City Water

Notes
1. For buried piping within building, and up to 5' (1.5m) from building
2. Tar coated outside, cement mortar lined to AWWA C104
3. Wrapped with a polyethylene encasement to AWWA C105

IBI Group

PIPING SPECIFICATION

City Water
Buried
PVC

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
74°F

Maximum Pressure
150 PSIG

MPS-4114

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3" & DN	PE	CL	B88				
	4" & UP	GE	Cu, CB	B42, B43				Seamless
Fittings	3" & DN	SJ	WC					
	4" to 8"	GE	Cu, CB					
Flanges								
	4" to 8"	GE	CB,CBR			16.24		
Unions	3" & DN	SJ, SE	CB					
Couplings	4" to 8"	GE	MI	A47	32510 35018			Note 1

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	3" & DN	SE	CB	Rising	GTV 1		125	
	3" & DN	SJ	CB		GTV 7		125	
	4" & UP	FE	CI	OS&Y	GTV 2		125	
Globe	2" & DN	SJ	SB	Rising	GLV 3		125	
	3" & UP	FE	CI		GLV 2		125	
Angle								
Butterfly								
	4" & UP	LUG	CI		BFV 1		150	
Ball	3" & DN	SJ	CB		BV 2		150	
Check	3" & DN	SE/SJ	CB		CV 1		125	
	4" & UP	FE	CI		CV 2		125	
Strainers								

Line Reference	Service
DCW	Domestic Cold Water
DHW	Domestic Hot Water
DHWR	Dom Hot Water Recirc

Notes
1. Copper plated malleable iron couplings

IBI Group

PIPING SPECIFICATION

Domestic Water
Above Ground
Copper

Revised	9/14/2000	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
180°F

Maximum Pressure
125

MPS-4130

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2"&DN	PE	CS	A53	B		40	
	3" to 10"	BW	CS	A53	B		40	
	12" & UP	BW	CS	A53	B		30	
Fittings	2 1/2"&DN	SE	MI	A197		B2.1	150	
	3" & UP	BW	CS	A234	WPB	B16.9		Seamless
Flanges								
	3" & UP	WN,SO	FS	A181	1	B16.5	150	Note 5, 6
Unions	2 1/2"&DN	SE	MI	A197		B2.1	150	Note 3
Plugs	2 1/2"&DN	SE	CS	A105	2		3000	Note 4

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	2 1/2"&DN	SE	CB	Rising	GTV 3		125	
	3" & UP	FE	CI	OS&Y	GTV 2		125	
Globe	2 1/2"&DN	SE	CB		GLV 1		150	
	3" & UP	FE	CI		GLV 2		125	
Plug	2 1/2"&DN	SE	SMS		PV 1		175	Lubricated
	3" & UP	FE	SMS		PV 2		175	Lubricated
Butterfly								
	3" & UP	LUG	CI		BFV 1		150	
Ball	2 1/2"&DN	SE	CB		BV 1		150	
Check	2 1/2"&DN	SE	CB		CV 4		125	
	2 1/2"&DN	WFR	CI		CV 3		125	Non Slam
	3" & UP	FE	CI		CV 2		125	
Strainers								

Line Reference	Service
WWS / R	Welding Water
CHWS / R	Chilled Water
CWS / R	Condenser Water
PCHWS / R	Process Cooling Water
HS / R	Constant Temp Heating
HST / R	Scheduled Heating
GHS / R	Glycol Heating
GCS / R	Glycol Cooling
HCS / R	Combined Heat/Cool

Notes
1. Piping to conform to ASME B31.9
2. Minimum operating temperature: -20°F
3. Brass to iron ground joint
4. Machined from solid steel or forged
5. Raised face, slip-on or weld neck for steel-to-steel flanges
6. Flat face for connection to cast iron valves

IBI Group

PIPING SPECIFICATION

Service Water
Carbon Steel
Threaded and Welded

Revised	4/9/2001	Checked	PS
Rev:	3	Appr'd	CD

Maximum Temperature
250°F

Maximum Pressure
150 PSIG

MPS-5011

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE	CS	A53	B		40	
	3" to 10"	GE	CS	A53	B	(B242-M)	40	Note 6
	12" & UP	GE	CS	A53	B	(B242-M)	30	
Fittings	2 1/2" & DN	SE	MI	A197		B2.1	150	
	3" to 10"	GE	MI	A47	32510	(B242-M)		
					35018			
	12" & UP	GE	CS	A234		(B242-M)	30	
Flanges	3" & UP	GE	MI	A47	32510			Hinged, two piece
Unions	2 1/2" & DN	SE	MI	A197		B2.1	150	Note 3
Plugs	2 1/2" & DN	SE	CS	A105	2		3000	Note 4
Couplings	3" & UP	GE	MI	A47	32510 35018	B242-M	150	Note 7,8

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	2 1/2" & DN	SE	CB	Rising	GTV 3		125	
	3" & UP	FE	CI	OS&Y	GTV 2		125	
Globe	2 1/2" & DN	SE	CB		GLV 1		150	
	3" & UP	FE	CI		GLV 2		125	
Plug	2 1/2" & DN	SE	SMS		PV 1		175	Lubricated
	3" & UP	FE	SMS		PV 2		175	Lubricated
Butterfly								
	3" & UP	LUG	CI		BFV 1		150	
Ball	2 1/2" & DN	SE	CB		BV 1		150	
Check	2 1/2" & DN	SE	CB		CV 4		125	
	2 1/2" & DN	WFR	CI		CV 3		125	Non Slam
	3" & UP	FE	CI		CV 2		125	

Line Reference	Service
WWS / R	Welding Water
CHWS / R	Chilled Water
CWS / R	Condenser Water
PCHWS / R	Process Cooling Water
HS / R	Constant Temp Heating
HST / R	Scheduled Heating
GHS / R	Glycol Heating
GCS / R	Glycol Cooling
HCS / R	Combined Heat/Cool

Notes
1. Piping to conform to ASME B31.9
2. Minimum operating temperature: -20°F
3. Brass to iron ground joint
4. Machined from solid steel or forged
5. Raised face, slip-on or weld neck for steel-to-steel flanges
6. Flat face for connection to cast iron valves

IBI Group

PIPING SPECIFICATION

Service Water
Carbon Steel
Threaded and Grooved End

Revised	4/9/2001	Checked	PS
Rev:	3	Appr'd	CD

Maximum Temperature
250°F

Maximum Pressure
150 PSIG

MPS-5012

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE	CS	A53	B		40	
	3" to 10"	BE	CS	A53	B		40	
	12" & UP	BE	CS	A53	B		30	
Fittings	2 1/2" & DN	SW	FS	A105	2	B16.11	2000	
	3" to 10"	BW	CS	A234	WPB	B16.9		Seamless
Flanges								
	3" & UP	WN,SO	FS	A181	1	B16.5	150	Note 5, 6
Unions	2 1/2" & DN	SE	MI	A197		B2.1	150	Note 3, 7
Plugs	2 1/2" & DN	SE	CS	A105	2		3000	Note 4, 7

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	2 1/2" & DN	SE	CB	Rising	GTV 3		125	
	3" & UP	FE	CI	OS&Y	GTV 2		125	
Globe	2 1/2" & DN	SE	CB		GLV 1		150	
	3" & UP	FE	CI		GLV 2		125	
Plug	2 1/2" & DN	SE	SMS		PV 1		175	Lubricated
	3" & UP	FE	SMS		PV 2		175	Lubricated
Butterfly								
	3" & UP	LUG	CI		BFV 1		150	
Ball	2 1/2" & DN	SE	CB		BV 1		150	
Check	2 1/2" & DN	SE	CB		CV 4		125	
	2 1/2" & DN	WFR	CI		CV 3		125	Non Slam
	3" & UP	FE	CI		CV 2		125	
Strainers								

Line Reference	Service
WWS / R	Welding Water
CHWS / R	Chilled Water
CWS / R	Condenser Water
PCHWS / R	Process Cooling Water
HS / R	Constant Temp Heating
HST / R	Scheduled Heating
GHS / R	Glycol Heating
GCS / R	Glycol Cooling
HCS / R	Combined Heat/Cool

Notes
1. Piping to conform to ASME B31.9
2. Minimum operating temperature: -20°F
3. Brass to iron ground joint
4. Machined from solid steel or forged
5. Raised face, slip-on or weld neck for steel-to-steel flanges
6. Flat face for connection to cast iron valves
7. Backseal weld threaded unions, plugs, etc

IBI Group

PIPING SPECIFICATION

Service Water
Carbon Steel
Socket Weld and Welded

Revised	4/9/2001	Checked	PS
Rev:	3	Appr'd	CD

Maximum Temperature
250°F

Maximum Pressure
150 PSIG

MPS-5013

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE	CS	A53	B		40	
	3" to 10"	GE	CS	A53	B	(B242-M)	40	Note 6
	12" & UP	GE	CS	A53	B	(B242-M)	30	
Fittings	2 1/2" & DN	SW	FS	A105	2	B16.11	2000	
	3" to 10"	GE	MI	A47	32510	(B242-M)		
					35018			
	12" & UP	GE	CS	A234		(B242-M)	30	
Flanges	3" & UP	GE	MI	A47	32510			Hinged, two piece
Unions	2 1/2" & DN	SE	MI	A197		B2.1	150	Note 3, 7
Plugs	2 1/2" & DN	SE	CS	A105	2		3000	Note 4, 7
Couplings	3" & UP	GE	MI	A47	32510 35018	B242-M	150	

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	2 1/2" & DN	SE	CB	Rising	GTV 4		125	
	3" & UP	FE	CI	OS&Y	GTV 2		125	
Globe	2 1/2" & DN	SE	CB		GLV 1		150	
	3" & UP	FE	CI		GLV 2		125	
Plug	2 1/2" & DN	SE	SMS		PV 1		175	Lubricated
	3" & UP	FE	SMS		PV 2		175	Lubricated
Butterfly								
	3" & UP	LUG	CI		BFV 1		150	
Ball	2 1/2" & DN	SE	CB		BV 1		150	
Check	2 1/2" & DN	SE	CB		CV 4		125	
	2 1/2" & DN	WFR	CI		CV 3		125	Non Slam
	3" & UP	FE	CI		CV 2		125	

Line Reference	Service
WWS / R	Welding Water
CHWS / R	Chilled Water
CWS / R	Condenser Water
PCHWS / R	Process Cooling Water
HS / R	Constant Temp Heating
HST / R	Scheduled Heating
GHS / R	Glycol Heating
GCS / R	Glycol Cooling
HCS / R	Combined Heat/Cool

Notes
1. Piping to conform to ASME B31.9
2. Minimum operating temperature: -20°F
3. Brass to iron ground joint
4. Machined from solid steel or forged
5. Raised face, slip-on or weld neck for steel-to-steel flanges
6. Flat face for connection to cast iron valves
7. Backseal weld threaded unions, plugs, etc

IBI Group

PIPING SPECIFICATION

Service Water
Carbon Steel
Socket Weld and Grooved End

Revised	4/9/2001	Checked	PS
Rev:	3	Appr'd	CD

Maximum Temperature
250°F

Maximum Pressure
150 PSIG

MPS-5014

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3" & DN	PE	CL	B88				
Fittings	3" & DN	SJ	WC					
Flanges								
Unions	3" & DN	SJ	CB					Note 2

Line Reference	Service
CHWS, CHWR	Chilled Water
HS, HR	Constant Temp Heating
HTS, HTR	Scheduled Heating
GHS, GHR	Glycol Heating
GCS, GCR	Glycol Cooling
HCS, HCR	Heating/Cooling

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate	3" & DN	SE	CB	Rising	GTV 1		125	
	2" & DN	SJ	CB		GTV 7		125	
	4" & UP	FE	CI	OS&Y	GTV 2		125	
Globe	3" & DN	SE	CB		GLV 1		150	
	2" & DN	SJ	CB	Rising	GLV 3		125	
	4" & UP	FE	CI		GLV 2		125	
Plug	3" & DN	SE	SMS		PV 1		175	Lubricated
	4" & UP	FE	SMS		PV 2		175	Lubricated
Butterfly								
	4" & UP	LUG	CI		BFV 1		150	
Ball	2" & DN	SJ	CBR		BV 2		150	
Check	3" & DN	SE	CB		CV 1		125	
	3" & DN	WFR	CI		CV 3		125	Non Slam
	4" & UP	FE	CI		CV 2		125	
Strainers								

Notes
1. Piping to conform to ASME B31.9
2. Ground joint, with either solder joint or screwed ends
3. Optional material spec for final connections to unitary equipment, unit heaters, etc

IBI Group

PIPING SPECIFICATION

Service Water
Copper

Maximum Temperature
250°F

Maximum Pressure
125 PSIG

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

MPS-5015

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 1/2" & DN	PE	CS	A53	B		40	Note 8
	3" to 10"	BE	CS	A53	B		40	Note 8
	12" & UP	BE	CS	A53	B		30	Note 8
Fittings	2 1/2" & DN	SW	FS	A105	2	B16.11	2000	
	3" & UP	BW	CS	A234	WPB	B16.9		Seamless
Flanges								
	3" & UP	WN,SO	FS	A181	1	B16.5	150	Note 5, 6
Unions	2 1/2" & DN	SE	MI	A197		B2.1	150	Note 3, 7
Plugs	2 1/2" & DN	SE	CS	A105	2		3000	Note 4, 7

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate	2 1/2" & DN	SE	CB	Rising	GTV 3		125	Located in Pit
	3" & UP	FE	CI	OS&Y	GTV 2		125	Located in Pit
Globe								
Angle								
Butterfly								
	4" & UP	LUG	CI		BFV 1		150	Located in Pit
Ball	3" & DN	SE	CB		BV 1		150	Located in Pit
Check								
Strainers								

Line Reference	Service
WWS / R	Welding Water
CHWS / R	Chilled Water
CWS / R	Condenser Water
PCHWS / R	Process Cooling Water
HS / R	Constant Temp Heating
HST / R	Scheduled Heating
GHS / R	Glycol Heating
GCS / R	Glycol Cooling
HCS / R	Combined Heat/Cool

Notes
1. Piping to conform to ASME B31.9
2. Minimum operating temperature: -20°F
3. Brass to iron ground joint
4. Machined from solid steel or forged
5. Raised face, slip-on or weld neck for steel-to-steel flanges
6. Flat face for connection to cast iron valves
7. Backseal weld threaded unions, plugs, etc
8. Complete with "Yellow Jacket" polyethylene jacket coating

IBI Group

PIPING SPECIFICATION

Service Water
Carbon Steel
Buried

Revised	4/9/2001	Checked	PS
Rev:	3	Appr'd	CD

Maximum Temperature
250°F

Maximum Pressure
150 PSIG

MPS-5021

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3" & DN	PE	CK	B88			40	Note 2,3
Fittings								
Flanges								
Unions								
Plugs								

Item	Size	End Treatment	Mat'l	ASTM	ANSI	Spec Type	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
HS, HR	Constant Temp Heating
HTS, HTR	Scheduled Heating
GHS, GHR	Glycol Heating
GCS, GCR	Glycol Cooling
HCS, HCR	Heating/Cooling

Notes
1. Piping to conform to ASME B31.9
2. No joints beneath floor
3. Tubing to be bent using approved tube bender
4. Optional material spec for final connections to unitary equipment, unit heaters, etc

IBI Group

PIPING SPECIFICATION

Service Water
Copper
Buried

Revised	6/29/2000	Checked	Name
Rev:	1	Appr'd	

Maximum Temperature
250°F

Maximum Pressure
125 PSIG

MPS-5022

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2 & DN	PE	CS	A53	B		40	Note 1
	2 1/2 & UP	BE	CS	A53	B		40	Note 1
Fittings	2 & DN	SW	FS	A105	2		2000	Note 2
	2 1/2 & UP	BW	CS	A234	B	B16.9	40	Note 2
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
G	Natural Gas
CNG	Compressed Natural Gas (125 psi max)

Notes
1. Shaw "Yellow Jacket", 22 mil thick covering
2. Protect joints and sleeves with Shaw "Shrink Sleeves", refer to Specification

IBI Group

PIPING SPECIFICATION

Natural Gas
Buried
Carbon Steel

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-5211

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	All	PE	PET			(CAN3-B137.4-M)	125	
Fittings	All	SW	PET			(CAN3-B137.4-M)	125	Note 1
Flanges								
Unions								
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Angle								
Butterfly								
Ball								
Check								
Strainers								

Line Reference	Service
G	Natural Gas

Notes
1. Heat fusion joints

IBI Group

PIPING SPECIFICATION

Natural Gas
Buried
Polyethylene

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-5212

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2" & DN	PE	CS	A53	B		40	Note 1
	2 1/2" & UP	BE	CS	A53	B		40	
Fittings	2" & DN	SE	MI	A197		B16.3		Note 1
	2 1/2" & UP	BW	CS	A234	B	B16.9		
Flanges								
	2 1/2" & UP	WN,SO	CS	A181	1	B16.5	150	
Unions	2" & DN	SE	MI				250	
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Plug	3" & DN	SE	SMS		PV 1	CGA, AGA	175	Lubricated, Note 2
	4" & UP	FE	SMS		PV 2	CGA, AGA	175	Lubricated, Note 2
Butterfly								
Ball	2" & DN	SE	CBR		BV 1	CGA, AGA	150	
Check								
Strainers								

Line Reference	Service
G	Natural Gas
P	Propane

Notes
1. Use socket weld fittings for piping in "concealed" spaces
2. Use plug valves on gas piping located outdoors

IBI Group

PIPING SPECIFICATION

Natural Gas
Above Grade
Steel

Revised	12/5/2002	Checked	PS
Rev:	2	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-5221

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2" & DN	PE	CS	A53	B		40	
	2 1/2" & UP	BE	CS	A53	B		40	
Fittings	2" & DN	SW	FS	A105	2	B16.11	2000	
	2 1/2" & UP	BW	CS	A234	B	B16.9		
Flanges								
	2 1/2" & UP	WN,SO	CS	A181	1	B16.5	150	
Unions	2" & DN	SE	MI				250	
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Plug	3" & DN	SE	SMS		PV 1	CGA, AGA	175	Lubricated
	4" & UP	FE	SMS		PV 2	CGA, AGA	175	Lubricated
Butterfly								
Ball	2" & DN	SE	CBR		BV 1	CGA, AGA	150	
Check								
Strainers								

Line Reference	Service
G	Natural Gas
P	Propane
CNG	Compressed Natural Gas (max 150 psig)

Notes

IBI Group

PIPING SPECIFICATION

Natural Gas
Above Grade
Steel - Socket Weld

Revised	10/16/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
150

MPS-5222

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	2" & DN	PE	CS	A53	B		40	
	2 1/2" & UP	BE	CS	A53	B		40	
Fittings	2" & DN	SW	FS	A105	2	B16.11	2000	Note 1
	2 1/2" & UP	BW	CS	A234	B	B16.9	40	
Flanges								
	2 1/2" & UP	WN,SO	FS	A181	1	B16.5	150	
Unions	2" & DN	SE	MI	A197		B2.1	250	
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe								
Plug	2" & DN	SE	CS		PV 3		150	Non-lubricated
	2 1/2" & UP	FE	CS		PV 3		150	Non-lubricated
Butterfly								
Ball	2" & DN	SE	CS		BV 4		150	
Check	2" & DN	SE	CI		CV 11		150	
	2 1/2" & UP	FE	CI		CV 12		150	
Strainers								

Line Reference	Service
FOS / R	Fuel Oil
FOF	Fuel Oil Fill
FOV	Fuel Oil Vent

Notes
1. Cast iron fittings will not be accepted

IBI Group

PIPING SPECIFICATION

Fuel Oil
Above Grade
Socket Weld and Welded

Revised	6/29/2000	Checked	PS
Rev:	1	Appr'd	CD

Maximum Temperature
140°F

Maximum Pressure
-

MPS-5240

Item	Size	End Treatment	Mat'l	ASTM		ANSI (CSA)	Schedule Class	Remarks
				Spec	Grade			
Pipe	3/4" & DN	CJ	ACR	B280		B31.5 (B52-M)		Note 1, 3
	1" & UP	SJ	ACR	B280		B31.5 (B52-M)		
Fittings	3/4" & DN	CJ	CL or CK	B280		B31.5 (B52-M)		
	1" & UP	SJ	CL or CK	B280		B31.5 (B52-M)		
Flanges	All	SJ	FS					
Unions	All	SJ	CBR				500	Note 2
Couplings								

Item	Size	End Treatment	Mat'l	Stem	Type	Approvals	Schedule Class	Remarks
Gate								
Globe	All	SJ	CBR	B31.5	GLV 10			
Angle								
Butterfly								
Ball								
Check	All	SJ	CBR	B31.5	CV 19			
Strainers								

Line Reference	Service
RL	Refrigerant Liquid
RS	Refrigerant Suction
HD	Halocarbon Discharge

Notes

1. De-oxidize and dehydrate tubing, with ends factory sealed and identified by the manufacturer as being suitable for refrigeration service
2. Brass tail piece adaptor for copper tubing, forged steel flanges, steel bolts, bronze nuts and asbestos-free fibre basket
3. Can be soft annealed or hard drawn to ASTM B280

IBI Group

PIPING SPECIFICATION

Refrigerant

Maximum Temperature **300°F**

Maximum Pressure **400 PSIG**

Issue	12/18/2002	Checked	PS
Rev:	1	Appr'd	CD

MPS-6020

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **THERMOMETERS AND PRESSURE GAUGES**

.1 General

.1 To match existing thermometers and pressure gauges

.2 Scale Reading Units

.1 Thermometers to read (both Fahrenheit and Celsius) (Fahrenheit) (Celsius) scale.

.2 Pressure gauges to read (both psi and kPa) (psi) (kPa) scale.

.3 Gauge stems and separable sockets of sufficient length to provide for proper insertion in piping or equipment in which they are installed.

.3 Products are identified by model designations from H.O. Trerice Co. and to be used as a guide to establish standard of construction. Comparable Products are acceptable from the following manufacturers:

.1 H.O. Trerice Company

.2 Dresser Canada Inc. - Ashcroft

.3 Weiss

.4 Weksler - Baker Instruments

.5 Winter's Thermogauges Limited

.2 Direct Reading Thermometers

.1 Industrial 230 mm scale length, variable angle type, liquid filled, aluminum case

.1 H.O. Trerice Company - A400 series

.2 Bi-metal dial type, 125 mm diameter, variable angle, stainless shell type 300 series case and stem with calibration screw.

.3 H.O. Trerice Company - B85600 series

.3 Remote Reading Thermometers

.1 115 mm diameter, liquid filled or gas activated type, braided bronze armour over copper capillary, stainless steel bulb and cast aluminum case for surface mounting.

.1 H.O. Trerice Company - Series No. L80300 (liquid filled)

.4 Thermometer Wells

.1 Provide wells in pipelines as follows:

.1 For copper pipe: Brass.

.2 For steel pipe: Brass or stainless steel.

.5 Conversion Kit

.1 Retrofit kit for converting wells of straight liquid filled thermometers to accept bi-metal dial thermometers.

.6 Direct Reading Pressure Measurement

.1 Dial type, 100 mm diameter, glycerine liquid filled

.1 Case: Stainless steel type 304

.2 Movement: Stainless steel

.3 Tube and socket: Stainless steel type 304

.4 Adjustable pointer

.5 Two-way gauge cock

.6 Operating temperature range, glycerine: -17°C to +115°C (0°F to 240°F)

.7 Operating temperature range, silicone: -34°C to +115°C (-30°F to 240°F)

.8 Accuracy: ASME B40.1 Grade 1A ±1% full scale

.9 H.O. Trerice Company - Series 700

.7 Differential pressure measurement at pumps, refrigeration machines and where shown

.1 Same as for direct reading pressure measurement, and:

.1 Maximum registering pointer

.2 Impulse snubber

.3 Three way switching valve

.8 Sanitary Direct Reading Pressure Measurement

.1 Dial type, 100 mm diameter, food grade glycerine liquid filled

.1 Case and ring: Polished stainless steel type 316

.2 Movement: Stainless steel type 316

.3 Capsule and socket: Stainless steel type 316

.4 Adjustable pointer

.5 Operating temperature range, glycerine: -20°C to +100°C (-4°F to +212°F)

.6 Accuracy: ASME B40.1 Grade 1A ±1% full scale

.7 Approvals: 3A and USDA

.8 H.O. Trerice Company - Series 700TALF

.9 Test wells. For use with partial immersion laboratory type thermometers.

.1 Manufactured from bar stock or forged brass with cap and chain, compatible with thermometers used.

.2 Registered with Technical Standards and Safety Association, Boiler and Pressure Vessel Safety Branch, and have C.R.N. Registration number.

.1 H.O. Trerice Company

2.2 STRAINERS AND FILTERS

.1 "Y" Pattern Strainers

.1 NPS 2 and under:

.1 "Y" pattern

.2 Class 125 (860 kPa) bronze body

.3 Screwed ends and screwed cleanout.

.2 NPS 3 and larger:

.1 "Y" pattern

.2 Class 125 (860 kPa) cast iron body

.3 Flanged ends and bolted cleanout cap

.4 Blow-off drain connection.

.3 Screen material: 20 mesh stainless steel unless otherwise noted

.4 Manufacturers:

.1 Erwel

.2 Spirax Sarco

.3 Streamflo

.4 Brooks – Hart

.5 Meuller

.2 Basket Strainers

.1 NPS 2 to 12, WOG service

.1 Single basket

.2 Class 150 (1033 kPa) cast iron body with quick release cover

.3 Bottom blow down valve

.2 NPS 2 to 12, steam service

.1 Single basket

.2 Class 125 (860 kPa) cast iron body with bolted cover

.3 Bottom blow down valve

.3 Basket Screens

.1 Stainless steel

.2 NPS 2 and 3: 1.15 mm perforation mesh

.3 NPS 4 and over: 3.2 mm perforation mesh

.4 Manufacturers

.1 Erwel

.2 Spirax Sarco

.3 Streamflo

.4 Brooks – Hart

.5 Meuller

2.3 FLEX CONNECTIONS AND EXPANSION COMPENSATION

.1 Flexible Metal Hose Connections

.1 Size Application

.1 Steel piping: NPS ½ to NPS 14

.2 Construction

.1 Corrugated inner hose of bronze or stainless steel.

.2 Outer jacket of bronze or stainless steel braided wire mesh.

.3 Screwed or female soldered end connections up to NPS 2.

.4 Forged steel raised face flanged NPS 2½ and above.

.5 Selected for 1034 kPa (150 psi) working pressure and 93°C (200°F) working temperature.

.6 Designed to absorb 150 mm transverse movement.

.7 Flexible length not less than six times nominal size.

.3 Manufacturer

.1 Senior Flexonics (Canada) Limited

.2 Piping Accessories Canada Ltd.

.3 SSI Equipment Inc.

.4 Anaconda Flexpipe

.5 United Flexible Metallic Tubing (Canada) Limited

.2 Flexible Rubber Expansion Joints

.1 Size Application

.1 Steel piping: NPS 1½ to NPS 12

.2 Construction

.1 Double arch, sphere design bellows

.2 Composite three layer EPDM or neoprene with nylon reinforcement construction

.3 Floating flanges complete with control units.

.4 Operating pressure: Minimum 860 kPa (125 psig)

.5 Operating temperature: -10°C to +100°C (14°F to 212°F)

.3 Manufacturer

.1 Senior Flexonics (Canada) Ltd - Style 102

.2 SSI - model ATM

.3 UniRoyal Rubber - Style 4140

.3 Expansion Compensators (bellows type)

.1 Size Application

.1 Steel piping: NPS ¾ to NPS 2

.2 Copper piping: NPS ¾ to NPS 3

.2 Construction

.1 Pressure external to bellows.

.2 Internal guides, limit stops and anti-torque device.

.3 Copper pipe installation: Bronze construction with female solder type ends.

.4 Steel pipe installation: Steel construction with stainless steel bellows and screwed ends.

.5 Selected for 1035 kPa (150 psi) (1380 kPa (200 psi)) working pressure.

.3 Manufacturers

.1 Senior Flexonics (Canada) Limited

.2 Badger

.3 Hyspan

.4 Uncontrolled Type Expansion Joints

.1 Size Application

.1 Steel piping: NPS 2 to NPS 24

.2 Construction

.1 Stainless steel bellows

.2 Flanged ends

.3 Suitable for axial extension and compression, lateral off-set, and angular rotation

.4 Temperature rating: -29°F to +426°C (-20°F to +800°F)

.5 Selected for 1035 kPa (150 psi) (1380 kPa (200 psi)) steam working pressure.

.3 Manufacturers

.1 Senior Flexonics (Canada) Limited

.2 Adsco Division - Yuba Industries Inc.

.3 Hyspan

.5 Ring Controlled Type Expansion Joints

.1 Size Application

.1 Steel piping: NPS 3 to NPS 24

.2 Construction

.1 Stainless steel bellows, limit stops and guides

.2 Reinforcing control rings

.3 Flanged ends

.4 Anchor type bases where required

.5 Temperature rating: -29°F to +426°C (-20°F to +800°F)

.6 Selected for 1035 kPa (150 psi) (1380 kPa (200 psi) 2070 (300 psig)) steam working pressure.

.3 Manufacturers

.1 Senior Flexonics (Canada) Limited

.2 Adsco Division - Yuba Industries Inc.

.3 Hyspan

.6 Slip Type Expansion Joints

.1 Size Application

.1 Steel piping: NPS 1½ to NPS 24

.2 Construction

.1 Packing chamber, limit stops, lubrication fittings, or lubricant impregnated packing rings

.2 Adjustable packing gland or fixed packing gland arrangement with a packing injection assembly

.3 Slip pipe of hard chrome plated carbon steel to ASTM A53-82

.4 Anchor base

.3 Manufacturers

.1 Senior Flexonics (Canada) Ltd.

.2 Rockwell

.3 Yarway

.4 United Flexible Metallic Tubing (Canada) Limited

.5 Adsco

.6 Hyspan

2.4 MISCELLANEOUS

.1 Pressure Relief Valves

.1 ASME rated, selected of relieving flow at 25% above the working pressure.

.2 Body construction and trim: To suit specific service.

.3 Manufacturers

.1 STM Specialty Sales

.2 Watts

.3 Fisher

.4 Consolidated

.2 Drain Valves

.1 NPS ½ brass sediment faucets with hose outlets

.2 Manufacturers

.1 Emco 10740

.2 Cambridge Brass 32W201

3 Execution

3.1 **INSTALLATION - THERMOMETERS AND PRESSURE GAUGES**

.1 General

.1 Installation height: Not greater than 3 m from floor or platform.

.2 Installation heights exceeding 3 m from floor or platform: Install remote reading thermometers and gauges, with dial mounted at 1500 mm above floor or platform, on steel or aluminum plate.

.2 Thermometers

.1 Install thermometers in wells.

.2 Install wells with extension necks in piping or equipment that is to be insulated.

.3 Provide thermometers at inlet and outlet of:

.1 Domestic hot water tanks

.2 Water heating and cooling coils

.3 Water boilers

.4 and as shown

.4 Thermometer Ranges

SYSTEM	SCALE RANGE
City water	(-5° to 40°C) (25° to 100°F)
Domestic cold water	(-5 °to 40°C) (25°to 100°F)
Domestic hot water	(5° to 120°C) (40° to 180°F)
Hot water heating (scheduled & constant temperature)	(5° to 115°C) (40° to 240°F)

.3 Pressure Gauges

.1 Selection

.1 Normal operating reading: Between one-half and two-thirds of full scale or range and expected maximum and minimum readings are within range.

.2 Provide pressure gauges at inlet and outlet of:

.1 Domestic water heaters

.2 Water heating and cooling coils

.3 Water boilers

.4 Water filters

.5 Pressure reducing valves

.6 Pumps (pressure differential)

.7 and as shown

.3 For direct pressure measurement, provide for each gauge:

.1 One-quarter turn bronze ball valve complete with lever handle

.2 Pressure snubber

.3 Syphons for gauges in steam service

.4 Isolation diaphragms where shown for gauges in corrosive service

.4 For differential pressure measurement, provide for each gauge:

.1 Three-way three position (left-off-right) switching valve with lever handle

.2 Pressure snubber

.3 Impulse dampener

.4 Syphons for gauges in steam service

.5 Isolation diaphragms where shown for gauges in corrosive service

.4 Test Plugs

.1 Provide test plugs for temporary insertion of thermometers and pressure gauges at locations shown on Drawings.

3.2 **INSTALLATION - STRAINERS AND FILTERS**

.1 “Y” Strainers

.1 Horizontal installation: Install with minimum 300 mm clearance between bottom of strainer and any obstruction.

.2 Vertical installation: Install with basket drain pointing down, and with minimum 300 mm clearance between bottom of strainer and any obstruction.

.3 Provide drain valve complete with chain and cap on NPS 3 and larger strainers.

.4 Remove baskets, clean and replace at time of building handover.

.2 Basket Strainers

.1 Install basket strainers with minimum of 450 mm clearance above strainer.

.2 Provide pipe supports on piping immediately adjacent to strainer; do not directly support strainer, or have adjacent piping supported through the strainer.

.3 Remove baskets, clean and replace at time of building handover.

.3 Automatic Back-Wash Filters

.1 Install automatic backwash filters in accordance with manufacturer's recommendations.

.2 Provide drain to back-wash drain connection and pipe to floor drain. (Pipe-up domestic cold water connection).

3.3 **INSTALLATION - FLEX CONNECTIONS AND EXPANSION COMPENSATION**

.1 Selection Criteria

.1 Provide manufactured expansion compensation units where shown on Drawings.

.2 Provide expansion loops where shown on Drawings.

.3 Select expansion joints to compensate for thermal expansion in pipe between anchors with not less than 25% safety factor calculating expansion from -18°C (0°F) ambient up to maximum possible operating fluid temperature, but not less than 93°C (200°F).

.2 Provision of expansion joints and flex connections:

.1 Flexible Metal Hoses

.1 On suction and discharge connections of domestic water booster pumps.

.2 On suction and discharge connections of base mounted double suction pumps.

.3 On discharge connections of sump and sewage pumps.

.4 In steam, hot water, chilled water, or glycol piping connections to coils and humidifiers in air supply units when units, or sections of units to which piping is connected, are supported or suspended by means of springs or isolation pads.

.5 On piping connections to domestic hot water tanks.

.6 Cooling tower supply and return connections at tower.

.2 Flexible Rubber Expansion Joint

.1 Cooling tower supply and return piping connections at pump.

.2 Above ground drainage piping where shown on Drawings.

.3 Expansion Compensators

.1 Domestic hot water supply and recirculation piping up to and including NPS 3.

.2 Heating system piping up to and including NPS 2 size.

.3 Compressed air, maximum 860 kPa (125 psig).

.4 Uncontrolled Type Expansion Joints

.1 Domestic hot water and recirculating water piping NPS 3½ size and larger.

.2 Heating system piping NPS 2½ size and larger.

.5 Ring Controlled Type Expansion Joints Slip Type

.1 High pressure steam piping over 100 kPa (15 psig).

.6 Slip Joints

.1 High temperature hot water over 100°C (212°F).

.7 Expansion joint installation:

.1 Provide pipe guides for each expansion joint using two guides on each side of and adjacent to joint.

.2 Refer to Section 15060 for pipe guides.

.3 Guide may be omitted between joint and anchor where an anchor is located within 900 mm of expansion joint.

.4 Provide anchors consisting of structural steel angles, channels, or plates secured to building structure.

.8 Flexible metal hose connection installation:

.1 Support or guide piping firmly adjacent to flexible connections and prevent pipes from swaying.

.2 At steam coils locate hoses between control valve and coil on steam supply side and on main condensate line leaving coil or bank of coils on return side.

.3 At chilled and/or hot water coils locate hoses on supply side between strainer and coil and on return side between coil and control valve.

3.4 INSTALLATION - MISCELLANEOUS

.1 Pressure Relief Valves

.1 Install relief valves downstream of pressure reducing valves, and on pressure vessels where shown.

.2 Provide discharge elbow drain, and pipe drain with NPS ¾ pipe to nearest floor drain.

.3 Terminate relief vent up through roof, at height as follows:

.1 900 mm for water systems below 92°C (200°F).

.2 1800 mm for water and steam systems above 92°C (200°F).

.2 Drain Valves

.1 Provide at:

.1 Low points of water piping systems in order to completely drain each system.

.2 Cooling and heating coils.

.3 Reheat coils where detailed on Drawings.

.4 Other locations as shown.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Submit Layout Drawings showing each type and placement of manufactured, pre-fabricated roof piping support system. Submit details for fixing roofing pad to roof.

2 Products

2.1 **MATERIALS**

.1 Acceptable Manufacturers

.1 Hangers:

.1 Anvil

.2 Myatt

.3 Carpenter & Paterson

.4 Hunt

.5 B-Line

.6 Taylor Pipe Supports

.2 Insulation shields:

.1 Anvil

.2 Myatt

.3 Pipe Shields Inc.

.4 Taylor Pipe Supports

.2 Lower Attachment

.1 Clevis hanger – steel pipe

.1 Standard weight black steel clevis hangers with level adjustment and locknut.

.2 Anvil figures 260 and 300.

.3 For figure 260, provide clevis bolt spacer on insulated piping.

.2 Clevis hanger – copper pipe

.1 Light weight black steel clevis hangers with copper colored finish and plastic insert to suit local authority requirements, with level adjustment and locknut (double bottom locknut).

.2 Anvil figure CT-65.

.3 Roller hanger

.1 Adjustable roller type hangers with locknuts.

.2 Rollers of sufficient width to clear the outside diameter of the insulation on the piping.

.3 Support rollers at both ends, either by a yoke, swivel type hanger or by two adjustable rods with locknuts (double locknuts).

.4 Anvil figure 177 or 171 as applicable.

.3 Insulation Protection

.1 Insulation saddles, for welding to pipe:

.1 Anvil figure 160-165 as applicable.

.2 Insulation shields

.1 Either shop fabricated, or manufactured plates of the size required to properly fit the outside diameter of the pipe insulation.

.2 Anvil figure167, modified with holes at each end to suit 12 mm wide. Stainless steel band clamps.

.3 Shop-fabricate bearing plates conforming to the following table for various pipe sizes:

Pipe Size (NPS)	Length of Plate mm	Thickness of Plate mm (gauge)
½ to 2	300	1.2 (18)
3 to 4	300	1.52 (16)
6	450	1.52 (16)
8 and over	600	1.9 (14)

.4 Form the bearing plates to the O.D. of the adjoining pipe insulation and extend the plate up to the horizontal centre line of the pipe.

.4 Middle Attachment

.1 Machine threaded rods

.1 Black steel finish in concealed areas.

.2 Galvanized finish in mechanical rooms and exposed areas.

.5 Upper Attachments

.1 Beam clamps:

.1 Malleable iron C-clamp with retaining clip, FM approved: Anvil figure 87, NPS ½ to NPS 2; maximum load: 180 kg.

.2 Malleable beam clamp FM approved: Anvil figure 218, NPS 2½ to NPS 8; maximum load: 540 kg.

.3 For pipes NPS 10 and larger, Provide supplementary steel members supported from structural steel.

.4 Do not use top beam clamps.

.2 Concrete inserts (new construction):

.1 Single hanger: Malleable iron body and nut, universal nut style: Anvil figure 282, to NPS 8.

.2 Continuous hanger: Cold formed hot dipped galvanized strip steel with end caps: Power-Strut PS 449.

.3 Concrete clevis plates (existing concrete):

.1 Carbon steel plate, with clevis attachment.

.2 Anvil figure 49.

.3 Do not use explosive driven anchors.

.6 Rooftop Pipe Supports

.1 Prefabricated pipe support system:

.1 Bases: (Injection moulded plastic or polycarbonate resin, with UV inhibiting additive) (Stainless steel) (Hot dipped galvanized steel).

.2 Framing: Channel strut system of size suitable for the load involved.

.3 Hangers: As specified above.

.4 Clamps, bolts, nuts and washers to suit installation, same material as framing members.

.5 Roof pads to suit roof construction.

.2 Acceptable Manufacturers:

.1 Portable Pipe Hangers

.2 Taylor Ecofoot

.3 Miro Industries Inc.

.7 Riser Clamps

.1 Black steel double clamp: Anvil figure 261, supported at floors; Anvil figure 240, supported by hanger rods.

.8 Pipe Guides

.1 Outer hinged housing with sliding spider clamp.

.1 Carbon steel, black steel finish.

.2 Anvil figure 256.

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Support or suspend piping with necessary hangers, structural supports and/or brackets, to prevent sagging, warping and vibration and to allow for movement due to expansion and contraction.

.2 Place hangers and supports close to fittings, elbows, valves and/or other heavy parts.

.3 Do not allow loads of any nature to be transmitted through the piping connections to equipment not specifically designed for such loads.

.1 Where flexible connections are not called for at connections to equipment, support the pipe by stands attached to both pipe and supporting structure so that force in any direction is not transmitted to the equipment.

.4 Place suitably dampened spring hangers at the first three supports from the equipment connection on piping subject to excessive movement or shock from any source, thermal expansion and contraction.

.1 Where it is evident that no undue loads will be transmitted to the equipment by the system concerned, i.e. small bore connections to comparatively large equipment, cold service piping not subject to shock, etc., then spring hangers may be omitted and standard hangers used.

.5 Use trapeze type hangers where pipes are grouped together, unless specifically indicated otherwise on the Drawings.

.1 Suspend horizontal member by adjustable rods with locking feature for maintaining level and slope.

.2 Space trapeze type hangers based on the closest interval required by any pipe supported thereon.

.3 Provide any auxiliary steel required to support trapeze between building steel.

.6 Do not hang pipe from another pipe unless specifically shown on the Drawings.

.2 Hanger Selection

.1 Select lower attachment and insulation protection based on the following, unless otherwise shown on drawings:

Pipe Size NPS	Operating Temperature		
	Less than 21°C (70°F)	Between 21°C (70°F) and 43°C (110°F)	Greater than 43°C (110°F)
	Insulated	Non-insulated	Insulated
2 and less, steel	Clevis and shield	Clevis only	Clevis
2½ to 6, steel	Clevis and shield	Clevis only	Roller and saddle
8 and over, steel	Roller and saddle	Roller only	Roller and saddle
½ to 4, copper	Clevis and shield	Clevis	Clevis and shield

.2 Install temporary spacers between the insulation shield and the pipe equal to the thickness of insulation specified. Refer to Section 23 07 19.

.3 Saddles and Roller Supports

.1 Place saddles at roller supports for piping carrying liquids at 43°C (110°F) or higher.

.2 Weld saddles to black or galvanized steel piping.

.3 Refinish galvanized surfaces destroyed by the welding with a zinc rich paint such as W.R. Meadows "Galvafroid", Kerry Industries "ZRC" or Niagara Paint Inc. "PL052898".

.4 Insulation Shields

.1 Place insulation shields at pipe supports for pipes carrying liquids at 21°C (70°F) or less.

.2 Field or factory punch a hole at each end of the shield to allow a 12 mm stainless steel band clamp to pass through opening.

.3 Secure shields with two @ 12 mm stainless steel band clamps per shield.

.5 Hanger Spacing - General

.1 Horizontal runs of plumbing and drainage piping: To hanger spacing requirements of the Ontario Building Code.

.2 Place additional hangers in locations where there are concentrated loads such as valves, specialties, etc.

.6 Hanger Spacing - Black Steel and Galvanized Pipe

.1 For horizontal runs of black or galvanized steel pipe, other than for plumbing service.

.2 Maximum distances between supports and with minimum diameter rods as follows:

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
Thru 1	10	2.0	2.7
1¼	10	2.0	2.7
1½	10	2.7	3.6
2	10	3.0	3.9
2½	12	3.3	4.2
3	12	3.6	4.5
4	16	4.2	5.0
6	19	5.0	6.4
8	19	5.7	7.3
10	22	5.7	7.3
12	22	7.0	7.9
14	25	7.6	9.7
16	25	8.2	10.6
18	25	8.5	11.2
20	32	9.0	11.8
24	38	9.7	12.8
30	51	10.0	13.4
36	51	13.7	18.0

.7 Hanger Spacing - Copper Tubing

.1 For horizontal runs of copper tubing for services other than plumbing:

.2 Maximum distances between supports and with minimum diameter rods as follows:

Pipe Size NPS	Rod Size mm	Spacing	
		Water Service m	Gas, Steam or Air m
Thru ¾	10	1.5	1.8
1	10	1.8	2.4
1¼	10	2.0	2.7
1½	10	2.4	3.0
2	10	2.4	3.3
2½	12	2.7	3.9
3	12	3.0	4.2
4	16	3.6	4.8

.8 Hanger Spacing - PVC or CPVC

.1 For horizontal runs of PVC or CPVC for services other than plumbing.

.2 Maximum distances between supports and with minimum rods sizes for un-insulated pipe as follows.

Pipe Size NPS	Rod Size mm	Pipe Schedule			
		PVC 40	CPVC 40	PVC 80	CPVC 80
½	10	1.2	1.2	1.2	1.2
¾	10	1.2	1.2	1.2	1.5
1	10	1.2	1.5	1.5	1.8
1¼	10	1.2	1.5	1.5	1.8
1½	10	1.5	1.8	1.8	1.8
2	10	1.5	1.8	1.8	2.0
2½	12	1.8	2.0	1.8	2.4
3	12	1.8	2.0	2.0	2.4
4	16	1.8	2.0	2.0	2.7
6	19	2.0	2.4	2.7	3.0
8	19	2.4	2.4	2.7	3.0
10	22	2.7	-	3.3	-
12	22	3.0	-	3.6	-

.3 For insulated pipe, reduce spacing by 30%.

.4 Do not restrain axial movement.

.5 Spacing based on fluids with specific gravity of 1.0 and 26°C (80°F). For other conditions, use other published data approved by Consultant.

.9 Vertical Piping Supports

.1 Vertical plumbing and drainage piping:

.1 To the Ontario Building Code, unless more stringent requirements are specified herein.

.2 Vertical support spacing:

.1 Cast iron soil pipes: At every floor with riser clamps.

.2 Other piping: At every other floor with riser clamps, unless otherwise required by expansion conditions or otherwise specified.

.3 Support bottom of riser with base fitting set on concrete pier or by hanger located at top of riser pipe as close to riser as possible.

.4 Riser clamps:

.1 Bolted securely to pipes.

.2 Rest ends of clamp on the pipe sleeve or on the floor.

.3 Weld shear lugs to pipe to transfer load to riser clamp.

.5 Stabilize vertical piping laterally by fabricated brackets or malleable iron, extension type split hangers.

.6 Run vertical piping at columns in the column webs, on either or both sides of the column, unless otherwise directed by the Consultant.

.10 Anchors and Guides

.1 Use anchors where shown on the Drawings and/or as required to maintain permanent location of pipe lines.

.1 Construct anchors for steel or galvanized pipe of approved steel straps and/or rods.

.2 For anchoring copper lines, use copper plated anchors, or use insulation bands between tubing and clamps if steel straps or rods are used.

.2 Provide minimum two pipe guides on each side of an expansion joint and expansion compensator.

.1 1.2 m between each guide.

.2 Not more than 900 mm between last guide and start of expansion joint or expansion compensator.

.3 For special expansion joint/compensator or for special applications, where more than two guides on each side are required, follow manufacturer recommendations for location of guides.

.11 Inserts

.1 In new construction, set inserts onto formwork prior to pouring of concrete.

.1 Provide a 200 mm length of rebar and wire through insert.

.2 Mechanical rooms and other areas of multiple pipe runs.

.1 Provide continuous type insert channels at 1.8 m intervals along route of piping.

.2 Provide a 200 mm length of rebar and wire through insert.

.12 Upper Attachments - Structural Steel

.1 For pipe size NPS 10 and larger supported from structural steel:

.1 Provide supplementary structural steel and weld or bolt to structural steel.

.2 Submit Plan Drawings and details to the Structural Engineer for review.

.13 Roof Mounted Piping

.1 Manufacturer site responsibilities:

.1 Provide on site assistance and inspection as required for installation.

.2 Provide Layout Drawing, located positions of each hanger.

.2 Hanger system installation:

.1 Remove roofing ballast and debris from areas of base.

.2 Adhere roofing pad to roof membrane with adhesion system as recommended by manufacturer.

.3 Adhere base to roofing pad with adhesion system as recommended by manufacturer.

.4 Set frame legs in to bases and assemble hangers.

.5 Remove excess adhesive from frame, bases and pads.

.6 Replace roof ballast up to edge of base.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **DESIGN CRITERIA – NOISE AND VIBRATION**

.1 General

.1 Limit noise and vibration levels of equipment and systems within design intent.

.2 If noise or vibration levels created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical Work, or are over the limits, make all necessary changes without additional cost.

.3 Install equipment, piping and ductwork in accordance with good noise and vibration control engineering practice in order to meet the requirements specified below.

.4 Maximum sound levels, combined internal background and mechanical equipment generated noise:

Room	N.C. Levels
Open Plan Offices	35-38
Cellular Offices	33-35
Service/Plant Areas	50

.1 Exclude environmental transient noise (traffic, etc).

.5 Meet the seismic requirements for the region as listed in the latest edition of the Ontario Building Code.

.2 Vibration Limits of Mechanical Equipment

.1 Equipment classification:

.1 One of three categories defined in ISO standard 2372.

.2 Vibration severity limits corrected for hard and soft support as defined by ISO standard 3945.

.3 Maximum vibration severity, as measured: Not to exceed category A (Good).

.2 Summary of the standards:

.1 Hard support: The fundamental frequency of the machine on its support is higher than its main excitation frequency (in general, rigidly mounted machine).

.2 Soft support: The fundamental frequency of the machine on its support is lower than its main excitation frequency (in general, machines on vibration isolators).

.3 Vibration severity: The largest of all the rms values of vibration velocity of a machine measured at three perpendicular axes at main support bearings of the rotor.

.3 Vibration severity limits:

.1 For equipment on hard support.

Type of Machine	Class	Vibration Severity Limit mm/s
Small Equipment (up to 20 HP)	I	0.71
Medium Equipment (21-100 HP)	II	1.11
Large Equipment (over 100 HP)	III	1.80

.2 For soft support the limits are 1.6 times higher:

.4 These limits apply for all normal running conditions of the equipment.

.5 Measurement equipment: To ISO standard 2954.

.1 Carry out measurements by a technically competent person.

.3 Minimum Requirements

.1 Refer to Mechanical Drawings and schedules for the minimum requirements of vibration isolation and sound attenuation.

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit in accordance with Section 01 33 00.

2 Products

2.1 **MANUFACTURERS**

.1 Acceptable manufacturers of noise and vibration control hardware are:

.1 Vibron

.2 Vibro-Acoustics

.3 Korfund-Sampson

.2 Noise and vibration control hardware: Supplied by a single Supplier.

.1 Exception: Where vibration isolation is supplied as an internal component as part of a manufactured Product.

2.2 **MATERIALS**

.1 Pad Isolators

.1 Rubber in shear, minimum 13 mm thick, bonded to 6 mm steel plates.

.2 Neoprene Isolators

.1 Captured mount design with threaded insert and hold down bolts.

.2 Double deflection isolator refers to mounts with design static deflection of 13 mm.

.3 Selection: Not loaded beyond its design limit, but not less than 60% of its design value.

.3 Spring Isolators

.1 Colour coded stable springs, levelling devices and neoprene insert or pad for acoustical isolation.

.2 Lateral spring stiffness: Minimum 0.8 times vertical stiffness.

.3 Mounting hardware: Zinc chromate plated.

.4 Bolt holes for hold down bolts and suitably stepped rubber washers.

.5 Stable spring types for open spring mounts.

.6 Steel spring operating load rating: Load to between 50% and 70% of the SOLID spring deflection.

.7 Rubber spring operating load rating: Between 60% to 100% of rated maximum.

.8 Neoprene pads: Size pads at the base of the steel spring mounts to deflect between 1.5 to 2.5 mm at the operating load (for acoustical isolation above the first spring resonance).

.4 Resilient Hangers

.1 Captured mount design with threaded insert and hold down bolts.

.2 Capable of tolerating vertical misalignment for a total of plus or minus ten degrees with the specified hanger rod and at the rated deflection.

.3 Double deflection isolator refers to mounts with design static deflection of 13 mm.

.4 Selection: Not loaded beyond its design limit, but not less than 60% of its design value.

.5 Structural Steel Fan Bases

.1 Continuous integral box section structural steel base, reinforced as necessary to withstand the belt tension without drive misalignment or distortion.

.2 Drill holes in the structural base to correspond with anchor bolt holes of fan base.

.3 Provide built-in motor slide rails in each base.

.4 Beams and brackets, flange and web thickness: Minimum of 5 mm.

.5 Use height saving brackets in all mounting locations to provide a base clearance of 25 mm.

.6 Minimum depth: 1/10th of the longer dimension, but not less than 125 mm.

.7 Maximum depth: 300 mm unless specifically advised by the Consultant.

.8 Beam stiffness: Maximum deflections in between the support points (at the isolators) do not exceed 1/8th of the deflection of the isolators.

.9 Overall stiffness: Withstand the reaction torque of the drive without relative deflection at the corners of more than 1/8th the isolator deflection.

.6 Thrust Restraints

.1 Design: Similar to open spring restricted mount for intake, and precompressed hanger for discharge.

.2 Specified precompression complete with attachment rods and angle brackets.

.3 Stiffness: Less than one-fifth of the horizontal stiffness of the main isolation system.

.7 Concrete Inertia Bases

.1 Continuous integral box section structural steel base, reinforced as necessary to withstand the belt tension without drive misalignment or distortion.

.1 T-shaped base to support piping elbows for base mounted pumps.

.2 Drill holes in the structural base to correspond with anchor bolt holes of fan base.

.3 Provide built-in motor slide rails in each base.

.4 Beams and brackets, flange and web thickness: minimum of 5 mm.

.5 Form with full depth perimeter frames with flanges pointed to the centre of base.

.6 Base reinforcement: Reinforcing rods at maximum 250 mm centres in both directions and minimum 38 mm up from the bottom of the steel channels, or place additional steel as required by structural condition or by code.

.7 Metal pans: Minimum 1.6 mm (16 gauge) welded sheet metal.

.8 Use height saving gusseted brackets in all mounting locations to provide a base clearance of 25 mm from housekeeping pad.

.9 Minimum base depth: 1/12th of the longer dimension, but not less than 125 mm.

.10 Maximum base depth: 300 mm unless specifically advised by the Consultant.

.11 Stiffness: Deflection in between the support points (at the isolators) does not exceed 1/40th deflection of the isolators.

.12 Overall base stiffness: Sufficient to withstand the reaction torque of the drive without relative deflection of the corners of base of more than 1/40th isolator deflection.

.13 Concrete fill: 30 MPa concrete.

.8 Isolated Rooftop Equipment Rail Support

.1 Continuous support roof rails.

.1 Upper aluminum channel frame construction: Minimum height 120 mm.

.2 Distributed open springs, designed to suit equipment load distribution.

.3 Lower aluminum channel plate, continuous contact to roof curb.

.4 Elastomeric air and weather seal on outside edge of frame (concealing springs).

.5 Aluminum weather seal flashing.

.6 Internal levelling system.

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Carry out the Work of this section in accordance with manufacturer's instructions (and supervision where required) and only by workers experienced in the installation of such systems.

.2 Noise Control

.1 Select and install isolation equipment to ensure that the mechanical equipment does not produce undue amounts of noise and vibration induced noise.

.2 Oversized pipe sleeves:

.1 Location: At wall or floor within the first one hundred times diameter length from a noise/vibration source.

.2 Sleeve size: At least 50 mm larger than the pipe diameter.

.3 Sleeve sealing: Pack the periphery with firestopping, or high density mineral wool (greater than 5 lb/cu.ft.) at not more than 50% compression.

.4 Caulk the ends of the packing and seal with non-hardening caulk such as Tremco Dymeric (with colourpak if weatherproof quality is required).

.3 Duct sealing:

.1 Pack and seal all spaces and cracks around ducts passing through mechanical room walls or floor, as described above for pipes.

.3 Vibration Control

.1 Types of vibration isolation hardware:

.1 Isolation mount types (xx specifies static deflection)

CSxx	Closed spring mount
OSxx	Open spring mount
OSRxx	Open spring restricted mount
OSRIxx	Open spring restricted mount with internal levelling devices
ERxx	Elastomer rubber mount

.2 Rubber isolation pads types

R	Single layer rubber waffle pad
N	Single layer neoprene waffle pad
RSR	Multiple layers of rubber and steel as indicated
NSN	
RSRSR, etc	

.3 Isolation hangers types

SH	Spring hanger
SHR	Spring hanger with rubber isolator
SHP	Either of above spring hangers with precompressed spring rubber isolator hanger
SHRP	
RH	Rubber isolator hanger

.4 Base types

IS	Integral steel base
CI	Concrete inertia base
IR	Isolated rooftop equipment curb

.2 Minimum vibration isolation requirements for all motor driven equipment: type R

.1 Refer to equipment schedules for isolation requirements.

.2 Use neoprene in potentially oily areas or outdoors.

.3 IS bases

.1 Use IS base type structural steel frame as required for the support rigidity of the installation of the isolators.

.2 Maximum isolation frequency: Not to exceed one-third of the lowest speed of the rotating equipment unless specified otherwise.

.4 Floor mounted equipment

.1 Install on a housekeeping concrete pad.

.2 Adjust and level the isolators for a 50 mm clearance unless otherwise noted.

.4 Isolator Requirements

.1 Vibration isolation supplier to examine and conform to the overall requirements for the Project in accordance with the requirements specified herein.

.2 Include:

.1 Consider RPM of equipment in determining the disturbing frequency on all fans, pumps, compressors, etc.

.2 Establish vibration isolation requirements from equipment manufacturer’s certified Shop Drawings and performance data.

.3 Select spring isolators from the manufacturer's catalogue inventory wherever possible.

.4 Should deflection requirements warrant the use of special springs, provide complete design data to the Consultant with the Review Drawings.

.5 Equip base type spring isolators with 9 mm thick neoprene or neoprene composition anti-vibration pads bonded to the base and with combination levelling bolts.

.6 Equip hanger type spring isolators with neoprene or composition pads at both ends of the spring.

.5 Equipment Isolation

.1 Mount equipment as follows, unless otherwise shown on Equipment Schedules.

Equipment	Remarks	Base Type	Isolation Type	Minimum Deflection mm
Centrifugal fans floor mounted suspended slab	up to 30 HP	IS	OS	25
	over 30 HP	CI	OS	45
Centrifugal fans - suspended	-	None	S4	45
Base mounted pumps	Basement or slab-on-grade	None	R	6
	Suspended slab	CI	OS	25
Refrigeration machines	Basement or slab-on-grade	None	RSR	6
	Suspended slab	None	OSRI	25
Cooling towers		Supplemental Steel	OSR	64
Air compressors	Up to 10 HP	None	CS	25
	Over 10 HP	CI	CS	25
Boilers	Basement or slab-on-grade	None	R	-
	Suspended slab	None	R	-
Propeller fans and roof exhausters		None	R	-
Air handling units	Fans internally isolated as above	None	R	-
Packaged rooftop equipment	Fans internally isolated as above	None	R	-

.6 Thrust Restraints

.1 Required locations:

.1 Fan intakes in excess of 1 kPa (4" W.G.) static vacuum.

.2 Fan discharge other than vertical, in excess of 1 kPa (4" W.G.) static gauge pressure.

.3 On hanger supported, horizontally mounted axial fans with more than 34 kg thrust due to static pressure.

.2 Unless specified otherwise, attach horizontal restraints at the centreline of thrust and symmetrically on either side of the unit.

.3 If horizontal thrust restraints are used, adjust same after installation for a maximum of 6 mm movement at start and stop.

3.2 INSPECTION AND REPORTING

.1 Supervision of Installation

.1 Manufacturer/Supplier of hardware to provide on-site technical supervision of installation during construction.

.2 Hardware Supplier to inspect and report in writing that the installation has been carried out to their satisfaction.

.2 On-Site Testing

.1 If, after the start-up of mechanical equipment, the Consultant is not satisfied that noise and vibration goals have been met, the Consultant retains the option of asking for a sound and vibration test report of all areas under question.

.2 Carry out measurements by a competent person using equipment meeting general requirements of international standards following measurement methods that follow similar standards.

.3 Remedial Work

.1 If Consultant finds any installation of equipment and piping, and fabrication and installation of ductwork to be unsound or poor with regard to sound and vibration requirements, refabricate and reinstall such works as required at no increase in Contract Price.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the work of this section.

.2 This section includes, but is not limited to, the following:

.1 Design, selection and provision of materials, installation instructions, installation and inspection of seismic restraint of mechanical piping, ductwork, fire protection and equipment.

.2 Design, selection and provision of materials, installation instructions, installation and inspection of seismic restraints of electrical conduits, cable trays, equipment and lighting fixtures under electrical Divisions 26, 27 and 28.

.3 The requirements under this section are in addition to the requirements for equipment, piping and duct supports and vibration isolation specified in other sections.

.4 Where Specifications of materials of this section differ from those in other sections of the mechanical divisions, this section governs, including but not limited to vibration isolation devices.

1.2 **REFERENCE STANDARDS**

.1 Comply with the latest edition of the following:

.1 SMACNA - “Seismic Restraint Manual Guidelines for Mechanical Systems”

.2 ASHRAE - “HVAC Applications, Seismic and Wind Restraint Design”

1.3 **DESIGN CRITERIA**

.1 Design seismic restraint systems to conform to the Ontario Building Code

.2 Building Data

.1 Calculate SMACNA SHL Class for location, site factor and importance factor indicated above.

.2 The vertical uplift force is restrained by the systems as identified in SMACNA standard.

1.4 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Submit test certificates for each seismic restraint device, identifying maximum tested load capacities.

.2 Calculations

.1 Submit calculations for each piece of restrained equipment, piping, ductwork and conduit, including seismic forces and restraint selection.

.2 Include worst case combination of tension and shear loads at each snubber and restraint location.

.3 Include anchor bolt diameters, embedment depth, full welding details including type and length for field welds, and required housekeeping base dimensions.

.4 Calculations to be sealed by a Professional Engineer licensed in the province of Ontario.

1.5 **QUALITY ASSURANCE**

.1 Pre-Construction Meeting

.1 Request and arrange a meeting with the Consultant to review seismic restraint approach, prior to any restraint insulation. Obtain approval from the Consultant before commencing Work.

.2 Testing and Review

.1 Install the first three lateral and three longitudinal braces, for each of the fire protection, one building service piping system and one ductwork system, and request and arrange for a review of the installation by the Consultant. Obtain approval of the installation before commencing remainder of the Work.

.2 Provide services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the Work. Provide a copy of the final inspection report to the Consultant for review.

.3 Request and arrange for a construction review by the Consultant of the completed seismic restraint installation, before any ceilings are installed.

2 Products

2.1 **GENERAL**

.1 Manufacturer to be a member of VISCMA (Vibration Isolation and Seismic Control Manufacturers Association).

.2 Acceptable Manufacturers

.1 Vibro Acoustics

.2 Kinetics Noise Control Inc.

.3 Cooper B-Line

2.2 **SEISMIC RESTRAINTS**

.1 Seismic Snubber Restraints

.1 Impact surfaces: High quality elastomeric facing to prevent metal-to-metal contact.

.2 Easily accessible resilient material, for inspection and replacement.

.3 Resilient material, snubber assemblies: Minimum 6 mm thick.

.4 Resilient material, snubber grommets: Minimum 3 mm thick.

.5 Restraint axis: All three principle directions unless otherwise specified or shown.

.6 Maximum clearance between resilient material and restrained equipment surface: 6 mm.

.7 Verify seismic restraint capacities by independent test laboratory, or certified by a Professional Engineer licensed in the province of Ontario.

.2 Type “S-OSA” – Restrained Spring Isolator – Constant Load

.1 Colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm neoprene pad.

.1 Removable coil spring element without having to disturb supported equipment.

.2 Lateral stiffness greater than 1.2 times rated vertical stiffness.

.3 Minimum 50% overload capacity

.4 Non-welded spring elements: Epoxy coated, with a minimum one thousand hour rating when tested in accordance with ASTM B-117.

.2 Steel housing design to limit lateral and vertical movement of the supported equipment.

.3 Neoprene snubber to limit maximum equipment movement in any direction to 6 mm.

.4 Adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

.5 Kinetics Noise Control model FHS.

.3 Type “S-OSB” – Restrained Spring Isolator – Variable Load

.1 Colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm neoprene pad.

.1 Removable coil spring element without having to disturb supported equipment.

.2 Lateral stiffness greater than 1.2 times rated vertical stiffness.

.3 Minimum 50% overload capacity.

.4 Non-welded spring elements: Epoxy coated, with a minimum one thousand hour rating when tested in accordance with ASTM B-117.

.2 Steel housing design to limit lateral and vertical movement of the supported equipment.

.1 Top load plate with adjustable and leveling bolts.

.2 Adjustable vertical restraints.

.3 Isolation washers.

.4 Bottom load plate with internal non-skid isolation pads and anchor holes.

.5 Hot dipped galvanized for outdoor installations.

.3 Neoprene snubber to limit maximum equipment movement in any direction to 6 mm.

.4 Adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

.5 Kinetics Noise Control model FLSS.

.4 Type “S-OSC” – Modular Spring Isolator with Integral Seismic Restraint

.1 Colour coded seismic-controlled spring isolator, single or multiple spring coils, with minimum 6 mm neoprene pad.

.1 Integral lateral and vertical seismic restraints.

.2 Removable coil spring element without having to disturb supported equipment.

.3 Lateral stiffness greater than 1.2 times rated vertical stiffness.

.4 Minimum 50% overload capacity.

.5 Non-welded spring elements: Epoxy coated, with a minimum one thousand hour rating when tested in accordance with ASTM B-117.

.2 Steel housing design to limit lateral and vertical movement of the supported equipment.

.1 Designed to accept coil springs of different sizes and capacities.

.2 All spring forces isolated from seismic housing under non-seismic events.

.3 Replaceable elastomeric elements at all dynamic contact points.

.3 Neoprene snubber to limit maximum equipment movement in any direction to 6 mm.

.4 Adaptor base suitable sized for larger anchors, when required to suit anchorage capacity.

.5 Kinetics Noise Control model FMS

.5 Type “S-SA” – All Direction Neoprene Isolator

.1 Molded, oil resistant neoprene compound, with encapsulated cast-in-place top steel load plate, and steel base plate with anchor holes.

.2 Designed for seismic loads in all directions with no metal-to-metal contact.

.3 Kinetics Noise Control model RQ.

.6 Type “S-SB” – Multi-Axis Limit Stop Snubber Assemblies

.1 Interlocking steel construction, attached to equipment structure and equipment, maximum of 6 mm seismic movement.

.2 Designed to restrict movement in two or three axis.

.3 Minimum 6 mm thick resilient neoprene pads to prevent metal-to-metal impact.

.4 Minimum two snubbers for each piece of equipment.

.5 Kinetics Noise Control model HS series.

.7 Type “S-SC” – Single-Axis Limit Stop Snubber Assemblies

.1 Steel construction, attached to equipment structure and equipment, maximum of 6 mm seismic movement.

.2 Designed to restrict movement in one axis.

.3 Minimum 6 mm thick resilient neoprene pads to prevent metal-to-metal impact.

.4 Minimum four snubbers for each piece of equipment.

.5 Kinetics Noise Control model HS-1.

.8 Type “S-CR” – Cable Restraints for Suspended Piping and Ductwork

.1 Steel wire strand cables.

.1 Rope connections: Overlap wire “U” clips or tool-less wedge insert lock connectors.

.2 Connector strength rating equal to 90% of cable breaking strength rating.

.3 Kinetics Noise Control model KSBC / KWRC / KWGC

.2 Building and equipment attachment brackets: Designed to permit free cable movement in all directions up to a forty-five degree misalignment.

.1 Protective thimbles at sharp corners to protect against cable wear.

.2 Selected to exceed the cable working design load by 50%.

.3 Single sided “C” beam clamps are not acceptable.

.4 Kinetics Noise Control model KSCA / KCAB Wedge / KUAB Undercut.

.3 Vertical Suspension Rods

.1 Braced to avoid potential for buckling due to vertical up-lift forces.

.2 Structural steel angle or formed channel brace selected to prevent support rod buckling.

.3 Brace attached to support rod with a series of adjustable clips, without the use of hand-tools.

.4 Kinetics Noise Control model KHRC.

3 Execution

3.1 **INSTALLATION**

.1 Install seismic restraint devices in accordance with manufacturer's instructions.

.2 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact.

.3 Seismic restraint manufacturer to provide training to the Installation Contractor on installation methods.

.4 Anchors on piping systems used for thermal expansion may be used as both a lateral and longitudinal restraint where they are designed for concurrent thermal and seismic loadings.

.5 Pipe and duct penetrations through floors are acceptable as a lateral restraint, provided sleeves and firestopping materials are installed correctly.

.6 Racked piping systems may have the rack braced (laterally, longitudinally, or combination thereof), provided each pipe supported by the rack is restrained to the rack.

.7 Each lateral or longitudinal brace must be secured to the building structure, and not any other building service.

.8 Pipe and duct penetrations through masonry and poured concrete wall partitions are acceptable as a lateral restraint, provided sleeves and firestopping materials are installed correctly.

.1 Drywall partitions, including demountable partitions, are not to be used for lateral restraint.

3.2 **SYSTEMS**

.1 Seismically restrain the following systems:

.1 Ductwork

.1 Rectangular and oval ductwork with cross sectional area 0.55 m^2 and greater.

.2 Round ducts with diameters 710 mm and larger.

.2 Electrical conduit

.1 Conduit 64 mm I.D. and larger.

.2 Cable trays supporting conduit which is sized 64 mm I.D. and larger.

.3 Static equipment (both mechanical and electrical)

.1 Anchor equipment to equipment supports. Anchor equipment supports to structure.

.2 Suspended equipment, including lighting fixtures:

.1 Use one or more of following methods depending upon Site conditions:

.1 Install tight to structure.

.2 Cross brace in every direction.

.3 Brace back to structure.

.4 Cable restraint system.

.2 Seismic restraints:

.1 Cushioning action gentle and steady.

.2 Never reach metal-like stiffness.

.4 Vibration isolated equipment (both mechanical and electrical)

.1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.

.2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.

3.3 **EXEMPTIONS**

.1 The following systems do not require additional seismic restraint other than as specified for regular piping and duct supports:

.1 Piping

.1 Natural gas, vacuum, petroleum based liquid, and compressed air piping less than NPS 1 size.

.2 Piping inside of mechanical service rooms less than NPS 1¼ size.

.3 All other piping less than NPS 2½ size.

.4 Piping suspended from hangers at a distance of 305 mm or less, measured from the top surface of the pipe, to the underside of the supporting structure above.

.2 Ductwork

.1 Rectangular and oval ductwork with cross sectional area less than 0.55 m^2.

.2 Round ducts with diameters less than 710 mm.

.3 Ductwork suspended by hangers at a distance of 305 mm or less, measured from the top surface of the duct to the underside of the supporting structure above.

.3 Electrical conduit

.1 Conduit less than 64 mm I.D.

.2 Cable trays supporting conduit which is sized less than 64 mm I.D.

.3 Electrical conduit or cable trays suspended by hangers at a distance of 305 mm or less, measured from the top surface of the conduit / tray to the underside of the supporting structure above.

.4 Lighting fixtures suspended by hanger at a distance of 305 mm or less, measured from the top surface of the fixture to the underside of the supporting structure above.

3.4 **INSPECTION**

.1 Provide services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the Work. Provide a copy of the final inspection report to the Consultant for review.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Submit schedule of equipment identification nameplates for review.

.2 Samples

.1 Submit samples of piping, valve and ductwork identification markers.

2 Products

2.1 **MATERIALS**

.1 Equipment Nameplates

.1 Laminated phenolic plastic with white finish and minimum 10 mm high black letters.

.2 Three rows of text, based as shown in equipment schedules.

.1 Line 1: Equipment ID (e.g. P-1)

.2 Line 2: Equipment name (e.g. northwest zone heating pump)

.3 Line 3: Optional, up to fifteen characters (e.g. standby pump)

.3 This identification is in addition to manufacturer's nameplate data.

.2 Ductwork Identification

.1 Painted stencil lettering: 50 mm high.

.2 Paint colour:

.1 Black paint on canvas covered insulated ductwork

.2 Black paint on metal covered insulated ductwork

.3 Black paint on uninsulated ductwork

.3 Two levels of text in accordance with designations shown on schedules:

.1 Level 1: Abbreviated name of air handling system for supply systems (e.g. AHU-1), or fan number for exhaust or ventilation only systems (e.g. F-1)

.2 Level 2: System name (e.g. general supply)

.4 Direction arrows: 65 mm high

.3 Pipe Identification – Type 1: Adhesive Labels

.1 Pre-printed 6 mil thick vinyl cloth, plastic coated with pressure sensitive self-adhesive backing surface. On insulated pipe, use adhesive suitable for this application.

.1 Pipe diameter (including insulation) 75 mm or less: 29 mm width, 25 mm high lettering. Length of labels as dictated by legend.

.2 Pipe diameter (including insulation) greater than 75 mm: Minimum width of 64 mm and with 50 mm high letters.

.3 Primary label colour: To CAN/CGSB-24.3.

.4 Pipe label to include service pressure for steam, compressed air, natural gas (if more than one gas service pressure inside of building), and vacuum.

.5 Legend: Black with the legend printed in full wherever feasible.

.2 Direction arrow banding tape: Colour coded vinyl tape with pressure sensitive adhesive backing, 50 mm wide, with directional arrows.

.3 Acceptable Manufacturers:

.1 Brady

.2 Safety Supply Co.

.3 S.M.S

.4 Revere-Seton

.4 Pipe Identification – Type 2: Coil Wrap Labels

.1 Reversible direction, semi-rigid plastic vinyl, with subsurface printing, and integral direction arrows.

.1 Up to 150 mm diameter: Coil wrap six rows of printing

.2 Over 150 mm diameter: Saddle type with two rows of printing, fastened with stainless steel springs

.3 Lettering Size:

Outside Diameter	Letter Height
Less than 5/8”	¼”
¾” – 1¼”	½”
1 1/8” – 2 3/8”	¾”
2½” – 4½”	1¼”

.4 Primary label colour: To CAN/CGSB-24.3.

.5 Pipe label to include service pressure for, natural gas and vacuum.

.6 Legend: Black with the legend printed in full wherever feasible.

.2 Acceptable Manufacturers:

.1 Brady

.2 Safety Supply Co.

.3 S.M.S

.4 Revere-Seton

.5 Valve Identification

.1 Laminated phenolic plastic with minimum 10 mm high lettering, with brass keychain.

.2 Minimum two lines of text:

.1 Line 1: Valve designation

.2 Line 2: Valve position instruction

.3 Acceptable manufacturers

.1 S.M.S.

.2 Brady

.3 Safety Supply Co.

.4 Revere-Seton

3 Execution

3.1 **INSTALLATION**

.1 Equipment Nameplates

.1 Identify mechanical and electrical equipment installed under this division with nameplates describing the function or use of the particular equipment involved.

.2 Do not commence fabrication of nameplates until after receipt of Consultant's review.

.3 Equipment includes, but not limited to:

.1 Equipment as shown on schedules and specified

.2 Motor starters

.3 Motor control centres

.4 Pushbutton stations

.5 Control panels

.6 Time switches

.7 Disconnect switches

.8 Contactors or relays in separate enclosures

.4 Equipment nameplates for building automation system components are specified under Section 25 05 00.

.5 Securely fasten nameplates to the equipment with round-head cadmium plated steel self-tapping screws.

.2 Ductwork Identification

.1 Label ductwork installed under this division to indicate the content and direction of flow.

.2 Locate labels as follows:

.1 Within 1.5 m of air handling units and free standing fans.

.2 Within 3 m of divisions in exposed ductwork.

.3 On each exposed duct passing through a wall, partition or floor (one on each side of such wall, partition or floor).

.4 At intervals not to exceed 15 m along every exposed duct run exceeding 15 m in length.

.5 On every concealed duct where it enters a floor area that it serves.

.3 Labels to be visible from 1.5 m above the adjacent floor or platform.

.4 Clean surfaces with a trisodium phosphate solution before application of paint.

.3 Piping Identification

.1 Label all piping installed under this division to indicate the content and direction of flow with Type 1 or Type 2 labeling system.

.2 For piping carrying steam, compressed air and vacuum, show on label the pressure or vacuum, and working units as applicable.

.3 Locate labels as follows:

.1 At every end of pipe run, adjacent to the valve or item of equipment serviced.

.2 At valves, tees and changes of direction.

.3 On each exposed pipe passing through a wall, partition or floor (one on each side of such wall, partition or floor).

.4 At intervals not to exceed 15 m along every exposed pipe run exceeding 15 m in length.

.5 At every access point on concealed piping.

.4 Labels to be visible from 1.5 m above the adjacent floor or platform.

.5 Type 1 Labels;

.1 Clean surfaces before application of labels.

.2 Secure label with direction arrow banding tape for full circumference of pipe, at each end of label.

.6 Natural gas piping: In addition to pipe labels specified above, paint all piping and tubing with one coat oil alkyd primer and one top coat of alkyd enamel, bright yellow.

.7 Natural gas piping: As specified above except provide labels every 6 m.

.4 Valve Tags

.1 Provide valve tags on all valves, except as follows:

.1 At plumbing fixtures.

.2 On balancing valves at equipment being served.

.3 On isolation valves around control valves

.2 Provide a valve identification directory for each system.

.1 Quantity: Two copies of valve identification directories for each system

.2 Documented as follows (example given):

Valve No.	Service	Valve Location	Nearest Column
HV-1	Northwest Zone Heating	Penthouse, North Side	A-8

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

.2 Section Excludes

.1 The following items are not to be insulated, or are factory insulated.

.1 Ductwork:

.1 Variable volume terminal boxes

.2 Internal acoustically insulated ductwork, except overlap thermal insulation 300 mm over acoustic insulation section

.3 Supply ductwork which is exposed to the occupied space, unless otherwise noted

1.2 **REFERENCE STANDARDS**

.1 General

.1 Provide insulation materials and adhesives of fire retardant type with flame spread and smoke developed ratings not exceeding ULC, government, or municipal standards.

.2 Fire retardant materials with flame spread/smoke developed ratings not exceeding 25/50 when tested in accordance with CAN/ULC-S102, and complying with the requirements stated in the building code having jurisdiction.

.3 Identify insulation, coverings and adhesives where required by federal and/or provincial health and safety WHMIS legislation.

.4 Asbestos-free materials.

.2 Reference Standards

.1 Comply with the latest edition of:

.1 NFPA 90-A, Standard for the Installation of Air-Conditioning and Ventilating Systems

.2 NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials

.3 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

.4 ASTM C-411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

1.3 **SUBMITTALS**

.1 Samples

.1 Submit in accordance with Section 01 33 00.

.2 Before ordering insulation materials prepare sample board on which mount cross-section sample of types of insulation, including exterior jacket, properly identified for various services and equipment on Project. State types of adhesives.

.3 Submit sample board to Consultant for review. After review and acceptance keep sample board in Consultant's Site office for duration of Project, for reference. No deviation from accepted samples will be allowed.

1.4 **PRODUCT DELIVERY, STORAGE AND HANDLING**

.1 General

.1 Retain insulation materials in original cartons or containers until immediately prior to application and store in dry location.

.2 Keep adhesives in their original containers with manufacturer's name and catalogue number clearly stated. Protect contents against freezing.

1.5 **DEFINITIONS**

.1 For the purposes of this section, the following definitions apply:

.1 “Conditioned supply ducts": Ductwork conveying air which has either been heated or cooled.

.2 “Concealed": Mechanical services and equipment located in ceiling spaces above solid drywall and T-bar ceilings; space beneath raised floors; vertical service shafts; trenches; and non-accessible chases and furred spaces.

.3 “Exposed": Mechanical services and equipment in all other spaces not considered to be “concealed" as defined above. Services in tunnels are to be treated as "Exposed".

2 Products

2.1 **DUCTWORK INSULATION**

.1 Type D1

.1 Fiberglass: To ASTM C553

.2 Flexible blanket

.3 Laminated kraft-aluminum foil facing jacket

.4 Operating temperatures: 4°C to 121°C (40°F to 250°F)

.5 Density: 12 kg/m³

.6 k value: 0.051 W/m°C @ 24°C (0.35 BTUH•in/ft²°F @ 75°F)

.7 Acceptable Manufacturers

.1 Johns Manville - Microlite

.2 Knauf Fibreglass

.2 Type D2

.1 Fiberglass: To ASTM C553

.2 Semi-rigid board

.3 Laminated kraft-aluminum foil facing jacket

.4 Operating temperatures: 4°C to 121°C (°F

.5 Density: 48 kg/m³

.6 k value: 0.044 W/m°C @ 24°C (

.7 Acceptable Manufacturers

.1 Owens Corning - 703/AF530

.2 Johns Manville - Spin-Glas Series 814

.3 Knauf Fibreglass

.3 Type D3

.1 Inorganic mineral fibre: To ASTM C518

.2 Flexible blanket or rigid board

.3 ULC approved ductwork fire rating: To two hours

.4 Laminated kraft-aluminum foil facing jacket

.5 Maximum operating temperature: -173°C to +1260°C (°F

.6 Acceptable manufacturers

.1 3M Ceramics Materials - Firemaster Duct Wrap
Firemaster Grease Duct
Firemaster Board

2.2 **INSULATION FINISH**

.1 Canvas Jacket

.1 ULC listed plain weave cotton fabric

.2 Weight: 220 gm/m²

.3 Acceptable manufacturers

.1 Fattal's Thermocanvas

.2 PVC (Polyvinyl Chloride) Jacket

.1 Minimum thickness: 20 mil

.2 Maximum permeability: 0.09 perms

.3 Premoulded one-piece fitting covers

.4 Tape: Vinyl, pressure sensitive, colour matched

.5 Acceptable manufacturers

.1 Johns Manville - Manville Zeston 2000

.2 ACWIL Insulations

.3 Sure Fit Systems

.3 Metal Jacket

.1 Aluminum: Stucco embossed, minimum 0.45 mm thick

.2 Stainless steel: Corrugated, minimum 0.25 mm thick

.3 Fittings: Custom made, swaged ring or lobster back style on bends, die shaped over fittings, valves, strainers and flanges

.4 Bands: 13 mm wide stainless steel with mechanical fasteners

.5 Acceptable manufacturers

.1 Alcan Canada Products - Thermaclad Type 1

.2 Childers Products Inc - Fab straps

2.3 **ADHESIVES**

.1 Contact Bond Cement

.1 Quick setting for metal surfaces

.2 Acceptable manufacturers:

.1 Henry - 200-37

.2 Foster - 85-75

.2 Lap Seal Adhesive

.1 For joints and lap sealing of vapour barriers

.2 Acceptable manufacturers:

.1 Henry - 230-39

.2 Foster - 85-75

.3 Contact Adhesive

.1 Acceptable manufacturers:

.1 Foster - 85-20

.4 Lagging Adhesive

.1 Acceptable manufacturers:

.1 Henry - 120-18

.2 Foster - 30-36

2.4 **MASTIC**

.1 Interior

.1 Acceptable manufacturers:

.1 Henry - 120-19

.2 Foster - 30-35

.2 Exterior, With Vapour Barrier

.1 Acceptable manufacturers:

.1 Henry - 130-11

.2 Foster - 65-07

.3 Exterior, Breather Type

.1 Acceptable manufacturers:

.1 Childers - CP-10

.4 Exterior - Aluminum Colour Finish

.1 Acceptable manufacturers:

.1 VentureClad 1579CW

.2 Alumaguard All-weather

.5 Cutback Asphalt

.1 Acceptable manufacturers:

.1 Henry - 700-01

.2 Foster - 60-25

2.5 **MISCELLANEOUS PRODUCTS**

.1 Sealants

.1 Acceptable manufacturers:

.1 Henry - 230-39

.2 Foster - 30-80

.2 Vapour Barrier Tape

.1 Colour matched, foil faced vapour barrier tape

.2 75 mm wide

.3 Vinyl backed or foil backed to suit insulation

.4 Acceptable manufacturers:

.1 Johns Manville - Zeston Z-tape

.2 MacTac Canada Ltd - Vinyl Scrim or Foil Scrim Kraft

.3 Compac Corp

.4 Fattal Canvas Inc

.3 Bands

.1 Stainless steel or galvanized metal, 12 mm wide with mechanical cinch locks.

.4 Insulation Cement

.1 Acceptable manufacturers:

.1 Partek - Hilcote

.5 Vapour Barrier Insulation Coating

.1 Acceptable manufacturers:

.1 Henry - 130-11

.2 Foster - 60-38

.6 Weld Pins, Studs and Clips

.1 Acceptable manufacturers:

.1 Midwest Fasteners Inc

.2 Continental Studwelding

.3 AGM

.7 Caulking

.1 Fast-drying colour matched flexible butyl elastomer based vapour barrier sealant.

3 Execution

3.1 **APPLICATION**

.1 General

.1 Perform insulation work using qualified insulating applicators, in accordance with latest trade application methods and to the Consultant’s approval.

.2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean and dry surfaces.

.3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.

.4 Do not apply insulation until such time as installation and testing of piping, ductwork and equipment has been inspected, verified, and accepted by General Contractor.

.5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted together. Lap canvas (or other specified wrapping) well over joints and cement down well with adhesive.

.6 At wall sleeves: Extend insulation through to make insulation continuous.

.7 At fire walls: Terminate insulation at wall, and pack space between wall sleeve and duct or pipe as specified in Section 23 05 01.

.2 Treatment of Existing Insulation

.1 Where new piping or ductwork systems connect to existing and where existing insulation is damaged through installation of new work, remove damaged sections of insulation for a minimum of 1 m and replace and finish to match existing.

.3 Ductwork

.1 General

.1 Insulate access doors or removable panels in ductwork as separate units to permit opening or removal without damage to adjoining insulation.

.2 Type D1

.1 Fasten insulation with adhesive, applied in 150 mm wide strips at 300 mm centres.

.2 Tightly butt all edges and joints and seal with interior mastic and scrim foil tape.

.3 Tying cord may be used to temporarily hold insulation until adhesive has set.

.3 Type D2

.1 Secure insulation with welded pins and speed washer type fasteners at 300 mm centres. Provide a minimum of two rows of fasteners on each side of duct.

.2 In addition to mechanical fasteners, adhere insulation with adhesive applied in 150 mm strips on 450 mm centres.

.3 Tightly butt all edges and joints and seal with interior mastic and scrim foil tape.

.4 Cut off protruding ends of welded pins and cover speed washers with same tape.

.4 Type D3

.1 Install fire rated insulation in strict accordance with manufacturer’s recommendations and ULC listing requirements.

.2 Provide the services of the manufacturer’s technical representative to inspect the installation prior to inspection by the Consultant. Submit inspection certificate from the manufacturer.

3.2 **INSULATION SELECTION**

.1 HVAC Ductwork

.1 Insulate the following systems:

System	Size	Max. Op. Temp °C (°F)	Insulation Type	Insulation Thickness mm
Conditioned air supply ducts	Exposed Concealed	65 (150)	D2 D1	25 38
Fresh air intake plenums and ducts	Exposed Concealed	38 (100)	D2 D1	25 38
Return air ducts (as noted)	Exposed Concealed	38 (100)	D2 D1	25 38
Exterior supply and return ductwork	All	65 (150)	D2	50
Exhaust duct behind registers in high humidity areas, minimum 3 m long	Concealed	38 (100)	D1	38
Exhaust air plenums and ducts, between outside wall and motorized damper	Exposed Concealed	38 (100)	D1 D1	38 38
Fabricated steam boiler breeching and hot water boiler stacks	Round Rectangular	454 (850)	E3 E4	50 Note 1
Fire rated ducts, two hour	All	-	D3	Note 2

Note 1: Two layers of 25 mm thickness, overlapped butt joints.
Note 2: Thickness and installation in strict accordance with ULC listing requirements.

3.3 **FINISH**

.1 Ductwork

.1 Finish exposed ductwork in accordance with the following:

System	Equipment
D1 (round)	Canvas
D2	(Canvas) (Metal)
D3	None

.2 General

.1 Canvas installation:

.1 Do not apply canvas to elastomeric closed cell foam insulation.

.2 Securely paste canvas on with a two coat application of fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tightly and smoothly with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.

.3 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.

.2 Outdoor ductwork:

.1 Non-winter application: Finish with one layer of glass fabric applied between two full mop coats of outdoor mastic with all laps completely sealed.

.2 Winter application: Finish insulated ductwork with one layer of glass fibre fabric applied between two full mop coats of exterior mastic, aluminum colour. Topcoat with aluminum coating in accordance with manufacturer's direction. Store materials in a heated space prior to application.

.3 Do not allow mastic materials to come in contact with single ply membrane roofs.

.1 Clean up accidental spills immediately.

.2 Provide temporary drop sheets to protect the roof.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section including, but not limited to, the following:

.1 Thermal insulation to piping, ductwork and equipment.

.2 Section Excludes

.1 The following items are not to be insulated, or are factory insulated:

.1 Piping:

.1 Compressed air piping

.2 Natural gas piping

.3 Fire protection piping (except where heat traced)

.4 Vertical sections of rainwater leaders (except where running exposed or concealed within high humidity areas including shower rooms, locker rooms, kitchens, etc.)

.5 Vertical sections of exposed sanitary drainage piping

.6 Condenser water supply and return piping inside of building

1.2 **REFERENCE STANDARDS**

.1 General

.1 Provide insulation materials and adhesives of fire retardant type with flame spread and smoke developed ratings not exceeding ULC, government, or municipal standards.

.2 Fire retardant materials with flame spread/smoke developed ratings not exceeding 25/50 when tested in accordance with CAN/ULC-S102, and complying with the requirements stated in the building code having jurisdiction.

.3 Identify insulation, coverings and adhesives where required by federal and/or provincial health and safety WHMIS legislation.

.4 Asbestos-free materials.

.2 Reference Standards

.1 Comply with the latest edition of:

.1 NFPA 90-A, Standard for the Installation of Air-Conditioning and Ventilating Systems

.2 NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials

.3 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies

.4 ASTM C-411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

1.3 **SUBMITTALS**

.1 Samples

.1 Submit in accordance with Section 01 33 00.

.2 Before ordering insulation materials prepare sample board on which mount cross-section sample of types of insulation, including exterior jacket, properly identified for various services and equipment on project. State types of adhesives.

.3 Submit sample board to Consultant for review. After review and acceptance keep sample board in Consultant's Site office for duration of Project for reference. No deviation from accepted samples will be allowed.

1.4 **PRODUCT DELIVERY, STORAGE AND HANDLING**

.1 General

.1 Retain insulation materials in original cartons or containers until immediately prior to application and store in dry location.

.2 Keep adhesives in their original containers with manufacturer's name and catalogue number clearly stated. Protect contents against freezing.

1.5 **DEFINITIONS**

.1 For the purposes of this section, the following definitions apply:

.1 “Conditioned supply ducts": Ductwork conveying air which has either been heated or cooled.

.2 “Concealed": Mechanical services and equipment located in ceiling spaces above solid drywall and T-bar ceilings; space beneath raised floors; vertical service shafts; trenches; and non-accessible chases and furred spaces.

.3 “Exposed": Mechanical services and equipment in all other spaces not considered to be “concealed" as defined above. Services in tunnels are to be treated as "Exposed".

.4 “Cold piping”: Piping carrying fluids at temperatures below 16°C (60°F).

2 Products

2.1 **PIPE INSULATION**

.1 Type P1

.1 Fiberglass: To ASTM C547

.2 Rigid, split formed with pressure sensitive longitudinal adhesion strip

.3 Reinforced all service vapour retarder jacket:

.4 Operating temperatures: -40°C to +454°C (-40°F to +850°F)

.5 k value: 0.042 W/m°C @ 93°C

.6 Acceptable Manufacturers

.1 Owens Corning - SSL-II

.2 Johns Manville - Micro-Lok with AP-T plus jacket

.3 Manson Alley - K with all purposed APT jacket

.4 Knauf Pipe Insulation with ASJ-SSI jacket

.2 Type P2

.1 Inorganic mineral fibre: To ASTM C547

.2 Rigid, split formed, moulded insulation

.3 Maximum operating temperature: 648°C (1200°F)

.4 k value: 0.058 W/m°C @ 176°C

.5 Tie wire: 0.045 mm (16 gauge) stainless steel with twisted ends, on maximum 300 mm centres

.6 Acceptable manufacturers

.1 Johns Manville - Thermo 12 Gold

.2 Calsilite

.3 Type P3

.1 Closed cell elastomeric: To ASTM C534

.2 Preformed, with self closing adhesion strips

.3 k value: 0.04 W/m°C @ 82°C

.4 Maximum operating temperature: 82°C (180°F)

.5 Acceptable manufacturers:

.1 Armstrong - AP/Armaflex Self Seal Pipe Insulation

.2 Rubatex - 25-50

.3 Nomaco - IMC04 Polyolefin Foam

.4 Type P4

.1 CFC-free rigid phenolic insulation: To ASTM C1126

.2 Rigid, split formed and sidewall segmented, depending on size

.3 Reinforced all service low permeance vapour retarder jacket

.4 Operating temperatures: -180°C to +120°C (-290°F to +250°F)

.5 K value: 0.019 W/mK @ 24°C

.6 Density: 35 kg/m³

.7 Acceptable manufacturers:

.1 Kingspan - Koolphen K

.5 Type P5 - Cold Piping Support Inserts

.1 CFC-free rigid phenolic insulation: To ASTM C1126

.2 Rigid, split formed and sidewall segmented, depending on size

.3 Reinforced all service low permeance vapour retarder jacket

.4 Operating temperatures: -180°C to +120°C (-290°F to +250°F)

.5 K value: 0.019 W/mK @ 24°C

.6 Density, up to NPS 10: 60 kg/m³

.7 Density, NPS 12 and over: 80 kg/m³

.8 Acceptable manufacturers:

.1 Kingspan - Koolphen K Pipe Support Inserts

2.2 **INSULATION FINISH**

.1 Canvas Jacket

.1 ULC listed plain weave cotton fabric

.2 Weight: 220 gm/m²

.3 Acceptable manufacturers

.1 Fattal’s Thermocanvas

.2 PVC (Polyvinyl Chloride) Jacket

.1 Minimum thickness: 20 mil

.2 Maximum permeability: 0.09 perms

.3 Premoulded one-piece fitting covers

.4 Tape: Vinyl, pressure sensitive, colour matched

.5 Acceptable manufacturers:

.1 Johns Manville - Manville Zeston 2000

.2 ACWIL Insulations

.3 Sure Fit Systems

.3 Metal Jacket

.1 Aluminum: Stucco embossed, minimum 0.45 mm thick

.2 Stainless steel: Corrugated, minimum 0.25 mm thick

.3 Fittings: Custom made, swaged ring or lobster back style on bends, die shaped over fittings, valves, strainers and flanges

.4 Bands: 13 mm wide stainless steel with mechanical fasteners

.5 Acceptable manufacturers:

.1 Alcan Canada Products - Thermaclad Type 1

.2 Childers Products Inc - Fab straps

2.3 ADHESIVES

.1 Contact Bond Cement

.1 Quick setting for metal surfaces

.2 Acceptable manufacturers:

.1 Henry - 200-37

.2 Foster - 85-75

.2 Lap Seal Adhesive

.1 For joints and lap sealing of vapour barriers

.2 Acceptable manufacturers:

.1 Henry - 230-39

.2 Foster - 85-75

.3 Contact Adhesive

.1 Acceptable manufacturers:

.1 Foster - 85-20

.4 Lagging Adhesive

.1 Acceptable manufacturers:

.1 Henry - 120-18

.2 Foster - 30-36

.5 Mastic Interior

.1 Acceptable Manufacturers

.1 Henry - 120-19

.2 Foster - 30-35

.6 Exterior, With Vapour Barrier

.1 Acceptable manufacturers:

.1 Henry - 130-11

.2 Foster - 65-07

.7 Exterior, Breather Type

.1 Acceptable manufacturers:

.1 Childers - CP-10

.8 Exterior - Aluminum Colour Finish

.1 Acceptable manufacturers:

.1 USE Hickson Hydroshield Mastic 451 with "Stormking" aluminum coating

.9 Cutback Asphalt

.1 Acceptable manufacturers:

.1 Henry - 700-01

.2 Foster - 60-25

2.4 MISCELLANEOUS PRODUCTS

.1 Sealants

.1 Acceptable manufacturers:

.1 Henry - 230-39

.2 Foster - 30-80

.2 Vapour Barrier Tape

.1 Colour matched, foil faced vapour barrier tape

.2 75 mm wide

.3 Vinyl backed or foil backed to suit insulation

.4 Acceptable manufacturers:

.1 Johns Manville - Zeston Z-tape

.2 MacTac Canada Ltd - Vinyl Scrim or Foil Scrim Kraft

.3 Compac Corp

.4 Fattal Canvas Inc

.3 Bands

.1 Stainless steel or galvanized metal, 12 mm wide with mechanical cinch locks.

.4 Insulation Cement

.1 Acceptable manufacturers:

.1 Partek - Hilcote

.5 Vapour Barrier Insulation Coating

.1 Acceptable manufacturers:

.1 Henry - 130-11

.2 Foster - 60-38

.6 Weld Pins, Studs and Clips

.1 Acceptable manufacturers:

.1 Midwest Fasteners Inc

.2 Continental Studwelding

.3 AGM

.7 Caulking

.1 Fast-drying colour matched flexible butyl elastomer based vapour barrier sealant.

3 Execution

3.1 **APPLICATION**

.1 General

.1 Perform insulation Work using qualified insulating applicators, in accordance with latest trade application methods and to the Consultant’s approval.

.2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean and dry surfaces.

.3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.

.4 Do not apply insulation until such time as installation and testing of piping, ductwork and equipment has been inspected, verified, and accepted by General Contractor.

.5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted together. Lap canvas (or other specified wrapping) well over joints and cement down well with adhesive.

.6 At wall sleeves: Extend insulation through to make insulation continuous.

.7 At fire walls: Terminate insulation at wall, and pack space between wall sleeve and duct or pipe as specified in Section 23 05 01.

.2 Treatment of Existing Insulation

.1 Where new piping or ductwork systems connect to existing and where existing insulation is damaged through installation of new Work, remove damaged sections of insulation for a minimum of 1 m and replace and finish to match existing.

.3 Piping

.1 General

.1 Neatly finish insulation at pipe hangers, supports, sensors and interruptions.

.2 At expansion joints in piping: Apply insulation over sleeve of 1.6 mm metal, fabricated to fit around expansion joint without restricting movement of joint.

.3 Provide sleeves which can be removed without damage to adjoining insulation to allow repacking and lubrication of expansion joint.

.4 Provide sleeves minimum of 75 mm longer than expansion joint and fitted with insulation retaining flanges and with means for maintaining position of sleeve over expansion joint.

.5 At heat traced piping: Make allowance in sizing inside diameter of insulation for tracing cable which will be provided under Electrical Contract.

.2 Type P1

.1 Lap and seal all joints (longitudinal and transverse). Use vapour barrier tape on transverse joints. Locate longitudinal joints on top of pipe.

.2 Insulate fittings, unions, flanges and valves with preformed block insulation or with segments cut from insulation of same type and thickness as pipe insulation.

.3 Form insulation on fittings and valves without voids. Secure in place with galvanized metal bands.

.3 Type P2

.1 Seal all joints (longitudinal and transverse).Secure in place with metal bands at 230 mm centres. Use vapour barrier tape on transverse joints.

.2 Insulate fittings, and flanges with preformed block insulation or with segments cut from insulation of same type and thickness as pipe insulation.

.1 Exception: Steam valves NPS 2 and smaller in low pressure steam piping.

.2 Form insulation on fittings and valves without voids. Secure in place with metal bands.

.3 Finish with insulating and finishing cement.

.3 Insulate valves with removable “box” insulation blocks. Ensure top spindle and wheel/lever are free running and clear of insulation and covering.

.4 Stop insulation on each side of unions and at connections to equipment.

.4 Type P3

.1 Lap and seal all joints (longitudinal and transverse). Use vapour barrier tape on transverse joints. Locate longitudinal joints on top of pipe.

.5 Type P4 and P5

.1 Lap and seal all joints (longitudinal and transverse). Use vapour barrier tape on transverse joints. Locate longitudinal joints on top of pipe.

.2 Seal ends of insulation with mastic matching finish colour of insulation.

.6 Drainage systems

.1 Apply insulation on roof drain bodies with 100% coverage of adhesive.

.2 Insulate above ground sanitary drainage systems (above finished ceiling areas).

.3 Insulate above ground storm horizontal rainwater leaders, located beneath roofs.

.7 Insulation termination points

.1 Terminate 75 mm from fittings.

.2 Bevel insulation at forty-five degree angle away from fitting.

.3 Finish exposed face with insulating and finishing cement.

.8 Insulation protection inserts - cold piping systems under 15°C (60°F)

.1 Place an insert between support with insulation shield and pipe on cold piping NPS 1½ and larger

.2 Fabricate insert from Type P5 insulation

.3 Insert length: Extending a minimum 150 mm beyond each end of insulation shield

.4 Insert circumference: 360 degrees

.5 Insulation shield: To Section 23 05 29

.6 Where insert material actual thickness is different from the actual thickness of the adjacent insulation, shave the insert to an equal thickness of the adjacent insulation

.7 Bond the insulation shield to the insulation insert with adhesive and finish and seal complete assembly with vapour barrier insulation coating to form an unbroken vapour barrier, or,

.8 Finish insulation insert as part of the main pipe insulation, and provide two metal band clamps for each insulation shield and strap the shield to the finished pipe insulation.

3.2 **INSULATION SELECTION**

.1 HVAC piping:

.1 Insulate the following systems:

System	Maximum Op. Temp °C (°F)	Pipe Size NPS	Insulation Type	Insulation Thickness mm
Equipment drain lines, safety valve vents, relief valve vents, etc.	110 (230)	All	P1	25
Dual temperature cooling/heating piping	93 (200)	All	P1, P4	38
Hot water heating piping	93 (200)	All	P1	38
Low temperature heating piping	60 (140)	Up to 4 5 and over	P1 P1	25 38
Refrigerant piping	60 (140)	All	P3, P4	19
Condensate water piping (exterior)	40 (105)	All	P1, P4	38

Note 1: Two layers of 25 mm thickness, overlapped butt joints.

.2 Plumbing Piping

.1 Insulate the following systems:

System	Maximum Op. Temp °C (°F)	Pipe Size	Insulation Type	Insulation Thickness mm
City water piping	27 (80)	All	P1, P4	25
Domestic cold water piping, including piping downstream of backflow preventers	27 (80)	All	P1, P4	25
Domestic hot and recirculating water piping, including piping downstream of backflow preventers	82 (180)	Up to 2 2½ and over	P1 P1	25 38
Storm and sanitary drainage piping	38 (100)	All	P1	25
Hot water supplies to barrier free use lavatories	82 (180)	All	P1	12

3.3 **FINISH**

.1 Piping

.1 Finish exposed piping in accordance with the following:

System	Pipe	Fittings, Valves, etc
P1	ASJ (Canvas) (PVC) (Metal)	(Canvas) (PVC) (Metal)
P2	(Canvas) (PVC) (Metal)	(Canvas) (PVC) (Metal)
P3	None	None
P1 Barrier Free Use	Canvas	Canvas

.2 General

.1 Canvas installation

.1 Do not apply canvas to elastomeric closed cell foam insulation.

.2 Securely paste canvas on with a two coat application of fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tightly and smoothly with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.

.3 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.

.2 Piping insulated with elastomeric foam insulation (P3):

.1 Indoors and outdoors: Finish with one coat of white acrylic latex as recommended by insulation manufacturer.

.3 Outdoor piping:

.1 Finish insulated piping with a field or factory applied aluminum jacket. Fasten and caulk butt joints and secure with sheet metal screws. Locate longitudinal joints on bottom of pipe.

.2 Alternatively, finish with two coats of outdoor type mastic (outdoor mastic - aluminum colour finish).

.4 Do not allow mastic materials to come in contact with single ply membrane roofs.

.1 Clean up accidentally spills immediately.

.2 Provide temporary drop sheets to protect the roof.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section including but not limited to the following:

.1 Performance testing and balancing of heating, ventilating, air conditioning and liquid systems

.2 Measuring and reporting all specified space noise levels

.3 Measuring and reporting all specified vibration isolation levels

.4 Rechecking of testing and balancing during the alternate (heating/cooling) season

.2 Section Excludes

.1 The following systems do not require air and water balancing:

.1 Domestic cold water

.2 Domestic hot water (except balancing valve on connections to hot water recirculation piping)

.3 Steam and condensate systems (except steam flow meters at steam plant as part of heating equipment performance test)

.4 Natural gas (except natural gas metering as part of heating equipment performance test)

.2 The following equipment does not require air and water balancing:

.1 Hydronic and electric convection heaters (baseboards)

.2 Hydronic and electric unit heaters

.3 Hydronic radiant panel heating units

1.2 **RELATED WORK IN OTHER SECTIONS**

.1 Factory testing, and calibrating of equipment or control systems.

.2 Testing and checking of equipment supplied by other divisions, except where such equipment forms an integral part of the mechanical systems.

1.3 **QUALIFICATIONS**

.1 Perform testing and balancing of air and water systems by an accredited testing and balancing firm who is a member of the Associated Air Balance Council (AABC).

.1 Acoustic and vibration measurements may be performed by a specialist Sub-contractor to the testing and balancing firm.

1.4 **PERFORMANCE STANDARDS**

.1 Perform testing and balancing in accordance with the current issue of:

.1 Associated Air Balance Council Standards for Total System Balance.

.2 SMACNA “Testing, Adjusting and Balancing” guidelines.

.2 Instruments: Recently calibrated; state date of calibration in the report.

1.5 **COORDINATION**

.1 General

.1 Review with affected trades before fabrication, the location of balancing devices, test connections and access openings and report conditions which could affect optimum system performance.

.2 By inspection, assure that all testing, balancing and metering devices are installed properly and in pre-selected locations.

.3 The Mechanical Contractor will obtain the approval of the testing and balancing firm before relocating these devices due to field conditions.

.4 Coordinate efforts so that items requiring replacement and/or delivery time (sheaves, motors, etc.) are tested as early as possible.

.2 The Mechanical Contractor and/or associated Subcontractors will provide the following assistance and/or services to the testing and balancing firm.

.1 Schedule sufficient time so that initial testing and balancing can be completed before occupancy begins and coordinate with trades involved.

.2 Keep testing and balancing firm informed of any major changes made during construction and furnish same with a set of Project Drawings and reviewed Shop Drawings.

.3 Furnish balancing devices, test connections access openings, balancing probe inlets and plugs.

.4 Clean and pre-run all equipment, filters, etc. and place all heating, ventilating and air conditioning systems into full operation and continue same during each Working Day of testing and balancing.

.5 Provide immediate labour from pertinent mechanical trades and tools, equipment and materials to make equipment and system alterations and adjustments as required, including control adjustments.

.6 Building Management System technical representative to operate the BMS during air and water balancing testing.

.7 Make available all equipment data (Shop Drawing performance data and operating instructions) to the testing and balancing firm.

.8 Refrigeration machine manufacturer service representative for performance testing of the refrigeration equipment. Testing and balancing firm witnesses and records all test results.

.9 Fuel fired heating equipment manufacturer service representative, or other qualified service company technical representative, for performance testing of heating equipment. Testing and balancing firm witnesses and records all test results.

.3 As part of the coordination effort, the Mechanical Contractor will be fully responsible for systems constructed, installed and adjusted to provide optimum performance as required by design intent. Any re-adjusting required as the result of spot checks by the Consultant shall be done at no increase in Contract Price.

1.6 **DEFINITIONS**

.1 “Balancing”

.1 To proportion and regulate flows within the distribution system (subsystems, branches, mains, terminals, etc.) at appropriate pressures in accordance with the design intent. This includes setting discharge volume and patterns of terminal devices, and individual return and exhaust air volumes.

.2 “Testing"

.1 To measure, interpret and report in writing, such parameters as may be required to verify design compliance and as specified herein.

1.7 **SUBMITTALS**

.1 Submit in accordance with Section 01 33 00.

.2 Submit layout drawings and report format a minimum fourteen days prior to start of air and water balancing on-site.

.1 Layout Drawings

.1 Identify specific locations of all adjusting, balancing and permanent measuring devices, neatly marked on a set of plans for approval by the Consultant. A set of reproducible drawings will be furnished by the Consultant for this purpose.

.2 Propose, for review by the Consultant, additional devices deemed advisable for satisfactory operation and completion of the Work of mechanical division.

.2 Report Format

.1 Submit proposed format of initial report.

.2 Include a complete list of instruments and tests for which they are to be used as they relate to this Project, including date of last calibration

2 Products

2.1 **NOT APPLICABLE**

3 Execution

3.1 **REQUIRED REPORTS**

.1 Provide the following start-up and performance testing reports:

.1 Air and water balancing report

.2 Acoustic survey report

.3 Alternate season test report

.2 Report Format

.1 Prepare test forms in MS Excel or Word format.

.2 Include the following header information for each test report:

.1 Owner name

.2 Project name

.3 Contractor name

.4 Consultant name

.5 Name of test report

.3 Submit the above tests in a hardcopy form, separately bound from the Operations and Maintenance Manuals, and in Adobe Acrobat PDF format, in accordance with Section 01 33 00.

3.2 AIR AND WATER BALANCING

.1 Site Visits

.1 Visit the Site as required prior to testing and balancing systems and advise respective trades of this section's requirements for probe inlets, etc. Submit a report to the Consultant after each site visit.

.2 Balancing Tolerances

.1 Balance all systems to the performance parameters indicated on Drawings and in the Specifications.

.2 If interpretation, clarification or additions to performance parameters are required, request such information from the Consultant.

.3 Balancing Tolerances

.1 Air Flow Rates

Under 70 L/S	10% of flow
Over/at 70 L/S	5% of flow

.2 Water Flow Rates

Hydronic Heating	5% of flow

.3 Heat Flow Rates

Air Coils	5% of design capacity
Heat Exchangers	5% of design capacity
Water Heaters	5% of design capacity

.4 Drawing Review

.1 Review all pertinent plans, specifications, Shop Drawings, interference drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

.5 Air Systems

.1 Test relative barometric pressures in various building areas, as deemed necessary by the Consultant and at least in all areas served by different systems.

.2 Operate, test and balance all air systems over their entire design range of operation including minimum and maximum fresh air, return air and supply air.

.3 Simulate full heating and cooling conditions. Record sufficient data to verify compliance with design requirements.

.4 Balance air systems within acceptable tolerances before water systems are balanced.

.6 Hydronic Systems

.1 Operate, test and balance all water systems over their entire design range of operation.

.2 Simulate full heating and cooling conditions. Record sufficient data to verify compliance with design requirements.

.3 Balance water systems within acceptable tolerances before air systems are balanced.

.7 Continuous Recording

.1 Set-up trend logs on the Building Management System to record on a temperature and humidity levels on a twenty-four hour basis, in areas as directed by the Consultant.

.8 Data Required

.1 Submit the following data as a minimum. If Contractor's standard forms provide for additional data, also submit such additional data. Indicate if tests were not specifically made. Do not repeat design data or other values not specifically tested.

.2 Hydronic heating equipment (boilers, heaters, etc.)

.1 Manufacturer and model

.2 Gas and fuel oil input flow rating

.3 Gas and fuel oil input pressure rating

.4 Gas pressure regulator inlet and outlet pressure

.5 Entering and leaving water temperature - design and actual

.6 Entering and leaving water pressure - design and actual

.7 Water flow rate - design and actual

.8 Steam flow rate and pressure - design and actual

.9 Combustion efficiency test at maximum rated capacity; including flue gas analysis

.10 Combustion efficiency test - as per Ministry of Environment Guideline A-9, corrected to 3% O2, for fuel input ratings exceeding 10 MMBtu/h (2932 kW)

.11 Thermal efficiency, based on ASME short form power test code, for fuel input ratings exceeding 10 MMBtu/h (2932 kW)

.3 Motors:

.1 Manufacturer

.2 Model or serial number

.3 Rated amperage and voltage

.4 Rated horsepower

.5 Rated RPM

.6 Corrected full load amperage

.7 Measured amperage and voltage

.8 Calculated BHP (kW)

.9 Measured RPM

.10 Sheave size, type and manufacturer

.4 Fans:

.1 Manufacturer

.2 Model or serial number

.3 Rated CFM (L/S)

.4 Rated RPM

.5 Rated pressures (suction and discharge)

.6 Measured CFM (L/S)

.7 Measured RPM

.8 Measured pressures (suction and discharge)

.9 Pulley size, type and manufacturer

.10 Belt size and quantity

.5 Pumps:

.1 Manufacturer

.2 Model or serial number

.3 Rated GPM (L/S)

.4 Rated Head

.5 Rated pressures

.6 Measured discharge pressure (full flow and no flow)

.7 Measured suction pressure (full flow and no flow)

.8 Measured gpm (L/s) at operating conditions

.9 Operating head

.10 Operating RPM

.6 Air systems (Including inlets and outlets):

.1 Grille, register or diffuser reference number and manufacturer

.2 Grille, register or diffuser location

.3 Design velocity

.4 Design cfm (L/s)

.5 Effective (or free) area factor and size

.6 Measured velocity

.7 Measured cfm (L/s)

.7 Heat transfer equipment:

.1 Manufacturer and type

.2 Design inlet and outlet temperatures

.3 Design pressure drop

.4 Design flow rate

.5 Measured inlet and outlet temperatures

.6 Measured pressure drop

.7 Measured flow rate

3.3 ACOUSTIC SURVEY

.1 Test Locations

.1 Provide acoustic noise measurements in locations agreed with the Consultant. As a minimum, the following areas are to be tested:

.1 Service rooms: Electrical and mechanical - one location per room

.2 Open office areas: Minimum one test per 500 m^2

.3 Enclosed office areas: Minimum 20% of all offices

.4 Boardrooms and meeting rooms: One location per room

.5 Kitchens, cafeterias and seating areas: One location per space

.2 Test Methods

.1 Test noise levels on the dBA weighting scale over eight bandwidths.

.2 Report results in tabular and graphical plots, including NR curves for each space tested.

.3 Conduct two tests per test location:

.1 Background ambient: Building ventilation and air conditioning systems turned OFF.

.2 Operating: Building ventilation and air conditioning systems turned ON, but building otherwise not occupied, and process equipment turned off.

.4 Report any objectionable noise or vibration and be prepared to locate cause by instrumentation and analysis (including octave band and analysis)

3.4 VIBRATION SURVEY

.1 Measure and record test results to Section 23 08 19.

3.5 ALTERNATE SEASON TESTING

.1 Requirements

.1 Re-check testing and balancing of the heating, ventilating and air conditioning systems and water flow conditions at flow meter locations at approximately six months after initial testing and balancing has been performed and accepted, as advised by the Consultant.

.2 Include items which, because of their seasonal character could not be adequately completed during the initial balancing.

.3 Include the reading and recording of temperatures and pressures at all gauges, as well as outdoor and indoor conditions.

.4 Measure and record the motor amperages and drive RPM of all fans and pumps during re-checking.

.2 Report

.1 Provide an addendum report to the original balancing report, in accordance with the reporting requirements described herein.

3.6 DEFICIENCIES

.1 Immediately report to Consultant, any deficiencies in the systems or equipment performance resulting in design requirements being unobtainable.

3.7 DRAFT REPORT

.1 On completion of the start-up, testing, adjusting and balancing of all systems, submit to the Consultant, two typewritten copies of a full report on all tests, adjustments, and balancing performed, including the following:

.1 Summary of all systems

.2 Testing methods and instrumentation

.3 Air systems testing and balancing data

.4 Liquid systems testing and balancing data

.5 Acoustic survey report

.6 Attachments including systems schematics with numbered terminals for referring to data above.

.2 After review by the Consultant and at the Consultants direction, retest up to 10% of all measurements in locations as directed by the Consultant, at no cost extra to the Contract.

3.8 **INTERIM REPORT**

.1 After completion of any retesting described above, submit three typewritten copies of the interim report, in a three-hole “D” style binder, and two CD-R electronic copies in Adobe Acrobat ver.6 PDF format.

.2 This report is required to obtain Substantial Performance of the Contract.

3.9 **FINAL REPORT**

.1 Submit to Consultant following completion of alternate season testing and balancing. Submit three typewritten copies and two CD-R Adobe PDF in the same formats as the initial report specified above.

3.10 **SPOT CHECKS**

.1 Before acceptance of the air and water balancing report, the Consultant may request to witness spot-checks of the report results.

.2 If results indicate unusual testing inaccuracy, omissions, or incomplete balancing/ adjustment, in the opinion of the Consultant, re-balance entire affected system(s) at no increase in Contract Price.

3.11 **ACCEPTANCE**

.1 The Substantial Performance of the mechanical Work will be considered reached when the initial start-up and performance testing report is accepted by the Consultant and in the opinion of the Consultant all systems have been satisfactorily installed, operated, tested, balanced, and adjusted to meet the specified and intended performance.

.2 The Substantial Performance will not depend upon alternate season testing, however, make such relevant repairs or modifications deemed necessary during this re-checking as part of the guarantee of the Work.

.3 The total performance of the Mechanical Subcontract (Contract) will not be considered reached until the alternate season testing and balancing is completed and the final report submitted and accepted by the Consultant.

3.12 **ADDITIONAL TESTING**

.1 The Consultant may request such additional testing in connection with this Project as he deems necessary.

.2 Additional testing and balancing shall be performed at the rates quoted and costs shall be withdrawn from the Mechanical Subcontractor's (Contractor's) allowance for the testing and balancing Work as approved by the Consultant.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **GENERAL**

.1 Provide Work of this section in accordance with the Contract Documents, and in accordance with Section 01 18 10 Commissioning General Requirements.

.2 This Specification covers commissioning of mechanical systems which are part of the Work.

.3 Commissioning Work shall be a team effort to ensure that all equipment and systems have been completely and properly installed and function correctly to meet the design intent, and to document system performance parameters for fine tuning of control sequences and operational procedures.

.1 Refer to Section 01 18 10 regarding roles and responsibilities of all parties involved in the commissioning process.

.4 The commissioning process develops, coordinates, and documents the following:

.1 Equipment start-up

.2 Control system calibration

.3 Testing and balancing

.4 Verification and performance testing

.5 Operation documentation

.6 Operator training

.5 Mechanical system installation, start-up, testing, balancing, preparation of O&M Manuals, and operator training are the responsibility of the Mechanical Contractors, with the coordination of the commissioning process the responsibility of the Commissioning Authority in conjunction with the Construction Manager.

.6 The commissioning program is divided into four parts:

.1 Part 1: Verification testing

.2 Part 2: Performance testing

.3 Part 4: Operator training

1.3 **SUBSTANTIAL COMPLETION**

.1 Substantial completion of the Division 23 Work requires the following parts of the commissioning program to be completed and accepted by the Owner:

.1 Part 1: Verification testing

.2 Part 4: Operator training

.2 Part 2 - Performance Testing may begin before Substantial Completion and extend upwards of nine months after Substantial Completion, based on seasonal conditions required to obtain test load conditions.

1.4 **WORK INCLUDED**

.1 Commissioning Work of Division 23 includes, but is not limited to:

.1 Testing and start-up of equipment.

.2 Testing, adjusting and balancing of hydronic and air systems.

.3 Cooperation with the commissioning authority in developing and implementation of the commissioning plan.

.4 Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.

.5 Providing equipment, materials, and labour as necessary to correct construction and/or equipment deficiencies found during the commissioning process.

.6 Providing Operation and Maintenance Manuals and As-Built Drawings to the Commissioning Authority for verification.

.7 Providing training and demonstrations for the systems specified in this division.

.2 Conduct complete and thorough evaluation and documentation of the operation and performance of all components, systems, and sub-systems, including the following equipment and systems:

.1 Automatic temperature control

.2 Air handling systems

.3 Cooling generation systems

.4 Heating generation systems

.5 Hydronic distribution systems

.6 Process cooling systems

.7 Compressed air systems

.8 Electric heating systems

.9 Air distribution and exhaust systems

.10 Domestic hot water systems

.11 Domestic cold water systems

.12 Fire protection systems/suppression systems

.13 Variable frequency drives

.14 Building Management Systems

.15 Indoor air quality (IAQ) systems

.16 Smoke venting/control systems

.17 IT/data AC and process cooling systems

.18 Kitchen HVAC systems, including fire suppression systems

.19 Fuel systems

.3 Commissioning documentation includes but is not limited to:

.1 Progress and status reports, including deficiency lists

.2 Verification of pre-start and start-up procedures and results

.3 Performance testing procedures and results

.4 Training agenda and materials

.5 As-built records

.6 Final commissioning report

.7 Systems operating manuals

.8 Operation and Maintenance Manuals

1.5 **RELATED WORK**

.1 Section 23 08 13 – Start-Up and Performance Testing

1.6 **REFERENCE STANDARDS**

.1 Comply with the latest edition of the following:

.1 ASHRAE Guideline 1, The HVAC Commissioning Process, as amended herein.

1.7 **REPORTING SOFTWARE**

.1 Commissioning documentation to be developed and recorded using the following software:

.1 MS Word

.2 MS Excel

.3 MS Access

.4 Adobe Acrobat version 6 – for scanned documents

.5 Photos – scanned or digital - *.jpg format

1.8 **DOCUMENTATION DELIVERABLES**

.1 Identify documents including test documents, binder covers, etc. using equipment ID numbers provided on equipment schedules.

.2 Scan original signed test reports, including verification and performance test reports, manufacturers service reports, etc. in Adobe Acrobat *.pdf version 6 format. For original document chapters, provide Adobe chapter referencing.

.3 Digital File Naming Convention

.1 Store documents with filenames which include the equipment type, ID number, and type of document.

.2 Equipment type:

.1 PS – Process Systems, piping, compressed air

.2 FP – Fire Protection

.3 PD – Plumbing and Drainage

.4 HG – Heating Generation

.5 CG - Cooling Generation

.6 HV – HVAC

.7 BMS – Building Management System

.3 Equipment ID:

.1 As per equipment schedules / drawings

.4 Document type:

.1 VT – Verification Test

.2 PT – Performance Test

.3 SOM – Systems Operating Manual

.4 TM – Training Manual/Material

.5 Example: A verification test report for air conditioning unit No. 1

.1 HV-AC1-VT.*

.4 Submit three copies of each verification and functional performance test report, both preliminary and final issues.

.1 Collate final, accepted and signed test results in separate binders as follows:

.1 Fire protection

.2 Plumbing and drainage

.3 HVAC systems

.4 Building Management Systems

.5 Provide three CD-R or DVD-R copies of all commissioning documentation. File the documents in directories as follows:

.1 Primary directories: Verification / Performance / SOMS / Training

.2 Sub-directories: Fire / Plumbing / HVAC / BMS

1.9 **SUBMITTALS**

.1 Report Samples

.1 Provide sample test documentation for each type of equipment and system for review by the commissioning authority prior to the start of the verification process

.1 Pre-start and start-up procedure check list form

.2 Verification test method and results form

.3 Functional performance test method and results form

.4 Operating and Maintenance Manual

2 Products

2.1 **TEST EQUIPMENT - GENERAL**

.1 Furnish all special tools and equipment required during the commissioning process.

.2 Submit a list of tools and equipment to be used during the commissioning process to the commissioning authority for approval.

.3 Utilities (water, gas, fuel oil, electrical power) will be provided by the Owner.

2.2 **TEST EQUIPMENT - PROPRIETARY**

.1 Provide any proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not.

.2 The manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed.

.3 Proprietary test equipment and software shall become the property of the Owner upon completion of the commissioning process.

3 Execution

3.1 **GENERAL**

.1 Complete all phases of Work so that the systems can be started, tested, balanced, and Owner's acceptance procedures be undertaken.

.2 Participate and assist in the development of the commissioning plan by the commissioning authority, by providing all necessary information pertaining to the equipment and installation. Provide commissioning schedule information to be incorporated into the overall commissioning plan schedule.

.3 Acceptance procedures may begin prior to completion of a system and/or sub-system. Start of acceptance procedures before system completion does not relieve the Contractor from completing those systems in accordance with the commissioning and construction schedule.

3.2 **COMMISSIONING MEETINGS**

.1 Pre-Construction

.1 Participate in a pre-construction meeting of all commissioning team members, to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

.2 Construction and Post-Construction

.1 Participate in commissioning meetings as scheduled by the commissioning authority and Construction Manager. Identify to the commissioning group problems relating to the commissioning schedule, identification of start-up issues, etc., and participate in the resolution of these problems.

3.3 **PARTICIPATION IN ACCEPTANCE PROCEDURES**

.1 Provide skilled technicians to start-up and debug all systems within the mechanical scope of Work. Include for labour, materials, and subsistence costs for these same technicians to assist the commissioning authority in completing the commissioning program.

.2 Provide details regarding work schedules, time commitments, work sequence programming, etc., to the commissioning authority, to permit the development and monitoring of a coordinated commissioning schedule.

.3 Ensure the qualified technician(s) are available and present during commissioning testing to complete the tests, make adjustments and to assist in problem resolutions.

.4 Should any equipment or system experience performance problems and/or reconstruction or replacement of comments is required, include for additional technician time for subsequent retesting of systems until required system performance is achieved.

.5 The commissioning authority reserves the right to approve proposed technicians with regard to the technical skill level required for each type of equipment and/or system, and a willingness by the individual(s) to work within the commissioning group.

3.4 **PROBLEM RESOLUTION**

.1 In the event that additional work is required to correct systems, misapplied equipment, and/or deficient performance under varying load conditions, this work will be carried out under the direction of the Owner. Assist the Owner and commissioning authority in developing an acceptable resolution to the problem, including the resources of equipment suppliers.

.2 The Owner and/or the Consultant has final jurisdiction over any additional work required to achieve the required level of performance.

.3 Complete corrective Work in a timely fashion to permit the completion of the commissioning process.

3.5 **ADDITIONAL COMMISSIONING**

.1 Additional commissioning activities may be required after completion of system performance testing. Include in the tender cost a reasonable reserve to complete this work, including assistance from manufacturers' service technicians.

3.6 **SEASONAL COMMISSIONING**

.1 Commence initial performance testing commissioning at the completion of the installation Work and verification testing phase. Conduct performance testing, which is weather dependent, as applicable to current seasonal conditions. Complete performance testing

on non-weather dependant systems in accordance with the agreed commissioning plan schedule.

.2 For out-of-season system performance testing, conduct initial performance tests to demonstrate off-peak load performance. Schedule peak load performance testing over the succeeding nine months to ensure all equipment is tested at peak load prior to the expiry of the construction contract warranty.

.1 Test heating equipment/systems during winter design extremes.

.2 Test cooling systems during summer design extremes with a fully occupied building.

.3 Alternatively, provide temporary equipment (load banks, etc) to simulate full load conditions. Submit proposed methodology for review by the commissioning authority and Consultant.

3.7 REPORT FORMAT

.1 Provide separate checklists for each piece of equipment and system tested, including interfaces, interlocks, etc.

.1 For checklists generated in MS Excel format, provide a separate file for each piece of equipment; do not store multiple pieces of equipment on separate worksheets in the same file.

.2 Each item to be checked will be recorded on a separate entry line and include the following information, reading from left to right across the entry:

.1 Checklist item number

.2 Test description

.3 Test status – “Pass”, “Fail”, “Not Applicable”

.4 Deficiency status – “Major”, “Minor”

.5 Comments

.3 Deficiency definitions:

.1 “Major”: An item which if not corrected renders the equipment or system unsuitable or unsafe for use by the Owner. Major deficiencies must be corrected as a condition for achieving Substantial Completion.

.2 “Minor”: An item which does not impact on the operation of the equipment or system and will allow the Owner to use the system safely. Minor deficiencies may be corrected before or after Substantial Completion, but will not prevent certification of Substantial Completion of the Work.

3.8 VERIFICATION TESTS (PART 1)

.1 Scope of Work

.1 Conduct operating tests and checks to verify that all components, equipment, systems, and interfaces between systems, operate in accordance with Contract Documents.

.2 Tests to demonstrate and verify all operating modes, interlocks, specified control sequences, specific responses to abnormal or emergency conditions, and verification of the proper response of the Building Automation System.

.3 Validate the results of the TAB report.

.1 Roles and responsibilities:

Verification Testing	
Organized by:	Commissioning Authority
Test sheets provided by:	Mechanical Contractors
Testing conducted by:	Mechanical Contractors
Testing recorded by:	Mechanical Contractors
Tests witnessed by:	Commissioning Authority Design Consultant (optional) Owner (optional)
Reports reviewed by:	General Contractor/Construction Manager Commissioning Authority Design Consultant
Reports accepted by:	Owner

.2 Submittals

.1 Submit a copy of each type of equipment and system verification report for approval by the Owner prior to commencement of the verification tests.

.2 Include any specific test requirements provided by the Owner and/or Consultant in the test reports. These requirements will be provided in MS Word or Excel format.

.3 Participants in Verification Tests

.1 Commissioning authority: Schedules tests and assembles commissioning team members who are responsible for the implementation, witnessing and documentation of the tests.

.2 Mechanical Contractor: Provide the services of qualified technician(s) who are familiar with the construction and operation of the system. Provide access to the Contract plans, Shop Drawings, and equipment cut sheets of all installed equipment.

.3 Controls Contractor: Provide the services of qualified technician(s) who are familiar with the Work. Provide details of the control system, schematics, and a narrative description of control sequences of operation.

.4 Electrical Contractor: Provide a foreman electrician familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans, and all as-built schematics of sub-systems, interfaces and interlocks.

.5 Equipment Suppliers: Provide the services of manufacturers' service personnel to provide assistance with pre-start and initial start-up of the equipment, as required.

.4 Documentation and Reporting Requirements

.1 Provide separate test records for each piece of equipment and system.

.2 Information used to develop the check lists are to include material from the following sources:

.1 Manufacturers installation requirements

.2 Contractor's own checklists

.3 Design consultants checklists

.4 Owners checklists

.3 Checklists to include the following information:

.4 Front cover sheet: Project name, Owner name, equipment ID and name, test date(s), and space for sign-off signatures and dates as follows:

.1 Mechanical Contractor: "Submitted by"

.2 General Contractor/Construction Manager: "Reviewed by"

.3 Design Consultant" "Reviewed by"

.4 Commissioning Authority: "Reviewed by"

.5 Owner: "Accepted by"

.5 Second and subsequent pages to include tests as defined below.

.6 Equipment Checklists:

.1 Motor, power and drives

.2 Equipment piping, between equipment isolation valves

.3 Installation pre-start tests specific to the class of equipment

.4 Equipment start-up tests specific to the class of equipment

.5 Electrical audit for CSA label or ESA field approval label

.6 Gas and fuel fired equipment audit for CSA/CGA approvals, or TSSA field approvals

.7 Expansion tank installation and settings

.8 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations

.9 Status of as-built documentation, and Operating and Maintenance Manuals reviews

.7 Piping System Checklists:

.1 Hydrostatic and/or pneumatic pressure tests, including date of test, duration, starting and ending pressures, and TSSA inspection reports where required

.2 Municipal plumbing inspector reports attached

.3 NFPA certificates attached (sprinklers and standpipe systems)

.4 Flushing and cleaning records, including date of cleaning, chemical treatment contractors test reports, volume of fluid in the system and amount of cleaner used

.5 Chemical treatment added; type and quantity, chemical treatment contractor's test reports included

.6 Piping installation, including supports, insulation, vibration isolation, piping identification, valve tagging, valve chains, etc.

.7 TAB balancing report, by system

.8 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations

.9 Status of as-built documentation, and Operating and Maintenance Manuals reviews

.8 Ductwork System Checklists:

.1 Ductwork pressure test results

.2 Inspection of fire damper linkages by area/floor

.3 TAB balancing report, by system

.4 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations

.5 Status of as-built documentation, and Operating and Maintenance Manuals reviews

.9 Building Management System:

.1 Operating check of each I/O and control loop

.2 Operating check of each control sequence

.3 Operating check of motorized control dampers for full open and full close stroke/spring return positions

.4 Operating check of motorized fire dampers for full open and full close stroke/spring return positions

.5 Temperature and humidity survey report, identifying date and time for each reading at each transmitter/sensor device

.6 Graphics display and report generation - provide display screen "snap-shots"

.7 Operator training, including attendee names and dates, and details of manufacturers equipment demonstrations

.8 Status of as-built documentation, and Operating and Maintenance Manuals reviews

.10 Specialty Systems

.1 Refrigeration system compliance check to CSA B52-99, Mechanical Refrigeration Code

.5 Instrumentation

.1 Provide all measurement instrumentation for conducting the verification tests. Include hand-held “HART” instrument testing units or similar test equipment.

.2 All instruments will have been calibrated within the six month period prior to the start of the tests.

.6 Verification Procedures

.1 The commissioning authority shall direct and witness, as required, the verification operating tests and checks for selected or all equipment and systems.

.2 Set the system equipment into operating mode to be tested including but not limited to:

.1 Normal shut-down

.2 Normal auto position

.3 Normal manual position

.4 Unoccupied cycle

.5 Emergency power operation, including transition states

.6 Alarm conditions

.3 Inspect and verify the position of each device and interlock identified on the checklist.

.4 Repeat the above tests for each operating cycle that applies to the system being tested.

.5 Check the operating condition of the following elements during all modes of operation of the system:

.1 Safety interlocks

.2 Alarms

.3 Smoke control and smoke venting interlocks

.4 Life safety systems

.6 For failed test items, provide appropriate comments to the checklist data sheet and identify whether it is a “Major” or “Minor” deficiency.

.1 The Consultant retains the right to make the final decision regarding classifications of deficiencies

.7 Verify the operational control of the systems through the Building Management System as follows:

.1 TAB airflow rates and calibrate terminal boxes in all modes of operation

.2 Equipment operation in both heating and cooling modes

.3 Minimum outdoor air intake positions, air-side economizer cycles, and multi-set outdoor air damper positions as required for each operating sequence and mode

.4 Building pressurization and other specialty programs

.8 Verify the proper responses of instrumentation and control devices (actuators) as follows:

.1 For each controller or sensor, record the indicated monitoring and control system reading, and the test instrument reading

.2 If the initial test indicates that the test reading is outside of the control range of the installed device, check the calibration of the installed device and adjust as required. Re-test the deficient device and record the results on the checklist data sheets

.9 The commissioning authority shall direct and witness the field verification of the final TAB report as follows:

.1 Select, at random, 10% of the report data for verification

.2 The TAB Contractor will be provided advance notice of the date of retesting, but not the equipment to be tested

.3 The TAB to provide and use the same equipment and instruments used for collecting the original data

.4 Test failure is defined as:

.1 For all readings other than sound, a deviation of more than 10% from the TAB report results

.2 For sound pressure readings, a deviation of 3 dB at any bandwidth, not including differences in background noise readings

.5 A failure rate greater than 10% of the selected items (1% of all TAB test results) will result in rejection of the final TAB report

.7 Acceptance

.1 The final reports will be reviewed by the Commissioning Authority and the Consultant, to determine if verification is complete and the operating systems are functioning in accordance with the Contract Documents.

.2 The Commissioning Authority, in conjunction with the Consultant, shall review and make final classification of all noted deficiencies. Deficiencies classified as “Major” shall be corrected before acceptance of the verification stage.

3.9 **PERFORMANCE TESTING (PART 2)**

.1 Scope of Work

.1 Conduct performance tests and checks to verify that all equipment and system components are providing the required heating and cooling performance (capacity) in accordance with the Contract Documents, including but not limited to:

.1 Capability of the chilled water system to deliver the required flow rate, and water temperature at design conditions.

.2 Capability of the hydronic and domestic water heating systems to deliver the required flow rate, and temperature.

.3 Capacity of electric heating systems at design temperatures.

.4 Confirm the ability of the HVAC systems to deliver the required cooling/heating services, at the design supply air temperature, required static pressure, and proper outside air ventilation rate.

.2 Roles and Responsibilities:

Functional Performance Testing	
Organized by:	Commissioning Authority
Test sheets provided by:	Mechanical Contractors
Testing conducted by:	Mechanical Contractors
Testing recorded by:	Mechanical Contractors
Tests witnessed by:	Commissioning Authority Design Consultant (optional) Owner (optional)
Reports reviewed by:	General Contractor/Construction Manager Commissioning Authority Design Consultant
Reports accepted by:	Owner

.2 Submittals

.1 Submit detailed test procedures and methodology to the commissioning authority for review and acceptance. Include samples of data record sheets.

.3 Participants

.1 Participants are the same as that described for the verification stage.

.4 Documentation and Reporting Requirements

.1 Provide separate test records for each piece of equipment and system.

.2 Checklists to include the following information:

.1 Front cover sheet: Project name, Owner name, equipment ID and name, test date(s), and space for sign-off signatures and dates as follows:

.1 Mechanical Contractor: “Submitted by”

.2 General Contractor/Construction Manager: “Reviewed by”

.3 Design Consultant: “Reviewed by”

.4 Commissioning Authority: “Reviewed by”

.5 Owner: “Accepted by”

.2 Second and subsequent pages to include tests as defined below:

.1 Description of test methodology, including reference standards (SMACNA, ARI, ASME, etc).

.2 Permanent and temporary resource requirements to implement the test (power, temporary drains, etc).

.3 Summary of results.

.4 Test data sheets and measured data.

.5 Ambient temperature conditions at time of test.

.6 Load simulation method used, if required.

.3 Provide a preliminary test report for review by the commissioning authority and the Consultant prior to conducting the performance test.

.5 Instrumentation

.1 Refer to the instrumentation requirements for the verification stage.

.6 Functional Performance Test Procedures

.1 The Commissioning Authority shall direct and witness, as required, the performance tests for selected or all equipment and systems.

.2 For each test, provide instrumentation required to calculate the total capacity of the system for each mode of operation under test.

.3 Special testing requirements:

.1 Test heating boiler and steam boiler performance in accordance with ASME Power Test Code 4.1 (short form), for thermal efficiency, and combustion efficiency.

.2 Test water chillers in accordance with ARI 590 and 591, at design conditions for full load ratings, and IPLV ratings.

.7 Acceptance

.1 Any identified deficiencies will be reviewed by the Consultant in conjunction with the General Contractor/Construction Manager to determine if correction of the deficiency is part of the Contractor’s or Subcontractor’s contractual obligations.

.2 If it is determined the performance deficiency is part of the Contract Documents, the Contractor will rectify the deficiency and repeat the performance test until the required performance levels are achieved.

.3 If it is determined the mechanical system is constructed in accordance with the Contract Documents, and the performance deficiency is not part of the Contract Documents, the Owner will decide whether to accept the performance as is, or,

direct the Installation Contractor to make changes to the system as required to obtain performance levels which meet the design intent.

.4 Should remedial Work to correct the not-in-contract deficiency be implemented, the Owner will decide whether all or part of the performance testing is to be repeated. If repeated, complete the retesting and submit a revised report.

3.10 OPERATING AND MAINTENANCE TRAINING (PART 4)

.1 Scope of Work

.1 Provide systems training in addition to the requirements of Sections 21 05 00, 22 05 00 and 23 05 01.

.2 Roles and responsibilities:

Systems Operating Manuals	
Organized by:	Mechanical Contractor
Lecture material provided by:	Mechanical Contractor
Systems training provided by:	Mechanical Contractor
Resource material by:	Sub-Contractors Manufacturers Design Consultant
Training manuals reviewed by:	Commissioning Authority Design Consultant
Manuals accepted by:	Owner

.2 Equipment Training

.1 Provide equipment training in accordance with Sections 21 05 00, 22 05 00 and 23 05 01.

.2 The manufacturer’s representative training will emphasize operating instructions and preventative maintenance.

.3 Systems Training

.1 In addition to the equipment training described above, provide additional training to describe the operational requirements and design intent of each system.

.2 Include classroom instruction, delivered by competent instructors, based upon the contents of the SOM manuals. Place emphasis on overall systems diagrams and descriptions, and design criteria and conditions.

.3 If required, obtain and pay for the services of the Design Consultant to provide the instructor services and to provide lecture material for inclusion in the training manual.

.4 Training topics to include:

.1 Types of installed systems

.2 Design intent and design criteria

.3 Design constraints

.4 Different operating modes - occupied, unoccupied, emergency conditions, etc.

.5 Seasonal operating modes

.6 IAQ

.7 Energy efficiency

.8 System operation

.9 Automatic controls

.10 Service, maintenance, diagnostics and repairs

.11 Use of reports and logs

.12 Troubleshooting

.5 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each equipment, with the services of the manufacturers' representative as required. Demonstrate the start-up and shut-down of each system.

.6 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Allow for three training sessions for each topic, separated by approximately one week each, to allow for shift coverage.

.7 Structure each training session based on type of maintenance personnel attending the training session, i.e. plumbers, fitters, general maintenance, controls technicians, etc. Develop the proposed training plan and obtain approval from the Owner before commencing the training.

.8 Complete the training as close to Substantial Completion as possible, so that the Owner's operations staff are prepared to operate the system after Substantial Completion is certified.

.4 Training Manuals

.1 Provide training material hand-outs for each session. This information will be abstracted from the SOM's and shall be presented in abbreviated form (i.e. bullet points).

.2 Collect training material and bind into separate binders in accordance with the requirements for the SOM manuals.

.5 Recording of Training Sessions

.1 Record training sessions typical for each training topic. Provide one DVD for each training topic.

.2 Provide three DVD copies of each training topic, appropriately labeled.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBSTANTIAL PERFORMANCE**

.1 Complete the Substantial Performance checklist and submit with required documentation when applying for Substantial Performance of the Work.

.1 Where the Work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.

.2 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or designated portion of the Work.

.1 Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.

.3 Within five Working Days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.3 **TOTAL PERFORMANCE**

.1 Complete the Total Performance checklist and submit required documentation when applying for Substantial Performance of the Work.

.2 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of alternate season testing.

.3 The following documentation is included with this application for Total Performance, or, has already been submitted to the Owner and a copy of the transmittal is included with this application.

2 SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST

Project Information	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

Required Documentation		
No.	Item	Included
1.	Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.	
2.	Equipment start-up reports (interim)	
3.	Authorities report (interim)	
4.	Air and water balancing reports (interim)	
5.	Acoustic survey report (interim)	
6.	Vibration survey report (interim) - *if specified*	
7.	Controls / BMS operation report (interim)	
8.	Operating and Maintenance Manuals, draft, submitted	
9.	Training, completed	
10.	Commissioning report – verification and training (if part of Contract)	

Reviewed by Consultant	
Status	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

3 TOTAL PERFORMANCE APPLICATION CHECKLIST

Project Information	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

Required Documentation		
No.	Item	Included
1.	Contractor submits a statutory declaration that all known deficiencies have been corrected, including latent deficiencies reported by the Owner.	
2.	Equipment start-up reports – updated and final	
3.	Authorities report – updated and final	
4.	Air and water balancing reports – updated and final	
5.	Acoustic survey report – updated and final	
6.	Vibration survey report – updated and final - *if specified*	
7.	Controls / BMS operation report – updated and final	
8.	Operating and Maintenance Manuals – updated and final	
9.	As-Built Drawings – final	
10.	Commissioning report – performance testing (if part of Contract)	

Reviewed by Consultant	
Status	☐ Reviewed ☐ Incomplete or deficient - resubmit
Signed:	
Date:	

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section

.2 Section includes, but is not necessarily limited to, the following:

.1 Hot water heating systems, all types

1.2 **REFERENCE STANDARDS**

.1 Comply with the following:

.1 Technical Standards and Safety Act

.2 Boiler and Pressure Vessels O.Reg. 220/01

.3 CSA B51-97: Boiler, Pressure Vessel, and Pressure Piping Code, as amended

	B31.1	B31.9
Liquids	> 350 psig, or > 250°F	⩽ 350 psig, and ⩽ 250°F
Vacuum	< -1 atm, or > 200°F	≥ -1 atm, and ⩽ 200°F
Gas	> 150 psig, or > 200°F	⩽ 150 psig, and ⩽ 200°F

.4 ANSI/ASME B31.9 - Building Services Piping Code, as specified

.5 ANSI/ASME B31.1 - Power Piping Code, as specified

.6 Technical Standards and Safety Authority (TSSA), Pressure Vessels Safety Division, inspection requirements for registered systems.

.2 Materials

.1 To CSA B51 - M1991 with:

.1 Cast iron to ASTM A-278-84, Class 30 or ASTM A-126-84 Class B.

.2 Bronze to ASTM B62-82a.

.3 Stainless steel to ASTM A351-84b, ASTM A-167-84, ASTM A-276-84 or ASTM A-564-79.

.2 Bolting requirements:

.1 To ASTM A307-84.

1.3 **PERMITS, EQUIPMENT REGISTRATION AND FEES**

.1 Contractor Certification

.1 Contractors providing Work regulated under the Boilers and Pressure Vessels O.Reg. 220/01 are to be holders of a TSSA Certificate of Authorization to conduct this Work, including:

.1 Pressure piping fabrication and installation

.2 Boiler and pressure vessel repairs and alterations

.2 Equipment Certification

.1 Equipment and fittings designated as pressure vessels or Class “H” fittings as per CSA B51-97, Part 1, require:

.1 ASME stamp

.2 CRN registration

.3 Registration

.1 Register the following pressure vessel and pressure piping systems:

.1 Building heating and cooling water systems operating at: pressures exceeding 1100 kPag (160 psig); or temperatures exceeding 121°C (250°F).

1.4 **DESIGN CRITERIA**

.1 Hot Water Heating Systems (Constant Temperature)

.1 Operating Temperatures:

.1 Supply: 93°C (200°F)

.2 Return: 77°C (170°F)

.2 Design pressures: 860 kPa (125 psig)

.2 Hot Water Heating Systems (Scheduled Temperature)

.1 Operating Temperatures:

.1 Supply: 88°C (190°F)

.2 Return: 71°C (160°F)

.2 Design pressures: 860 kPa (125 psig)

1.5 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

1.6 **TESTING**

.1 General

.1 Test piping in Consultant's presence, in accordance with testing requirements specified in Section 23 05 23 and with tests and test pressures hereinafter specified for various services.

.2 Lines may be tested in sections as authorized by the Consultant to accommodate construction schedule. However, test complete systems on completion.

.2 Hydronic Systems

.1 Hydrostatically test hydronic (water) piping at 862 kPa (125 psig) pressure.

2 Products

2.1 **PIPELINE SPECIALTIES**

.1 Automatic Air Vents

.1 Construction:

.1 Float operated with brass or cast iron body

.2 Rated working pressure: (10 kPa (45 psi)) (690 kPa (100 psi)1035 kPa (150 psi)) (2070 kPa (300 psi))

.2 Acceptable Manufacturers:

.1 Maid-O-Mist No. 7 (75 to 150 psi)

.2 Taco Hy-Vent (35 to 150 psi, 240 F)

.3 Braukmann EA 122 (90 psi, 230 F)

.4 Spirax Sarco 13 WS (150 psi, 200 F)

.5 Spirax Sarco 13 W (150 psi, 450 F)

.6 Armstrong Machine Works No. 2-AV (250 psi, 450 F)

.2 Circuit Balancing Valves

.1 Construction:

.1 Positive shut-off calibrated balancing valves with handwheel and division ring scale

.2 Flow measuring disconnects

.3 Metal tag with chain listing design flow rate, metered fluid, and meter reading for design flow rate

.4 Minimum working pressure: 1035 kPa (150 psig)

.5 Combined accuracy of valve and meter: Manufacturer certified to be within ±2% of actual flow

.6 NPS 2 and smaller: Brass body with screwed ends

.7 NPS 2½ and larger: Cast iron body with flanged ends

.2 Meters:

.1 Digital direct reading type calibrated in (both) (L/s) (USgpm) of flow

.2 Carrying case, hoses, installation and operating instructions

.3 Minimum working pressure: 1035 kPa (150 psig)

.3 Acceptable Manufacturers:

.1 Taco - MPV

.2 Armstrong - CBV

.3 Tour & Anderson

.3 Radiation Temperature Control Valves

.1 Construction:

.1 Angle or straightway valves with type RA-6 control units

.2 Acceptable Manufacturers:

.1 Danfoss

.2 Braukmann equivalent

.4 Radiator Valves

.1 Construction:

.1 Packless type radiator valves for installation on supply and return lines at each convector-radiator and finned tube element

.2 Angle or straightway, with union nipple and wheel handle

.2 Supply side installation:

.1 Spirax Sarco RP-6 or RP-7

.2 Dahl 11041 or 11042F

.3 Return side installation:

.1 Spirax Sarco RP-6 or RP-7

.2 Dahl 13012 or 13013

2.2 **HYDRONIC SPECIALTIES**

.1 Closed Expansion Tanks

.1 Construction:

.1 Black welded steel fabricated in accordance with ASME Code Section VIII requirements.

.2 Material: ASTM A516/A516M-82 pressure vessel carbon steel plate with dished ends.

.3 Working pressure: (690) (862) (1034) kPa ((100) (125) (150) psi) and bearing ASME stamp.

.4 Manhole 275 mm x 375 mm on end or as shown on Drawings.

.5 Water expansion tanks: Hot dip galvanized after fabrication.

.6 (Glycol expansion tanks: Black steel primed on outside only).

.7 Sizes as scheduled.

.2 Tank accessories:

.1 Gauge glasses with isolating valves to indicate water level in tank from 75 mm above bottom to 75 mm below the top of (straight side of) tank.

.2 ASME code rated relief valve.

.3 Saddles with horizontally mounted tanks.

.4 Structural steel legs for vertical tanks, with bottom of tank 300 mm above floor level.

.5 Armstrong or Taco combination drain valve and air charger.

.3 Tank connections:

.1 Expansion pipe connection at bottom.

.2 Make-up connection at bottom.

.3 NPS 1 drain connection at bottom.

.4 Vent connection at top.

.5 Relief valve connection near bottom.

.6 Schraeder valve connection for compressed air at top.

.4 Manufacturers:

.1 John Wood

.2 Bell & Gossett

.3 Drummond Welding & Steel Works Limited

.4 O'Connor Tanks Limited

.5 Clemmer Industries Limited

.2 Diaphragm Type Expansion Tanks

.1 Construction:

.1 Cylindrical galvanized steel pressurized type with diaphragm sealed in elastomer suitable for 115°C (240°F) operating temperature.

.2 Working pressure: 860 kPa (125 psi) with ASME stamp and certification.

.3 Air precharged to 84 kPa (12 psi).

.4 Schraeder tank valve for compressed air located above diaphragm.

.5 Saddles for horizontal installation or base mount for vertical installation.

.2 Manufacturers:

.1 Amtrol Extrol

.2 Taco Tacotrol

.3 Bell & Gossett

.3 Air Separators

.1 Construction:

.1 Size as indicated on Drawings.

.2 Working pressure: (690) (862) (1034) kPa ((100) (125) (150) psi) bearing ASME stamp.

.3 Furnish mounting legs or brackets as required.

.4 Up to NPS 2: Cast iron body and threaded connections.

.5 NPS 2½ and over: With shell heads and flanged connections.

.2 Acceptable Manufacturers:

.1 Armstrong

.2 Taco

.3 Bell & Gossett

.4 Thrush

.5 Amtrol

.4 Centrifugal Separation Type

.1 Construction:

.1 Designed as unfired pressure vessel

.2 ASME stamped

.3 Working pressure: 860 kPa (125 psi)

.2 Manufacturers:

.1 Taco Air Separator

.2 Bell & Gossett Rolairtrol

.3 Amtrol Tangential Air Separator

.4 Armstrong VA

.5 Amtrol

.5 Hydronic System Pressure Safety Relief Valves

.1 Construction:

.1 Brass or iron body

.2 ASME stamped

.3 Adjustable pressure setting from 55 to 172 kPa (8 to 25 psi) above system operating pressure at point of connection

.4 Operating differential pressure from open to close not more than 20 kPa (3 psi)

.6 Suction Diffuser

.1 Construction:

.1 NPS 2 and under: Cast iron body with screwed connections

.2 NPS 2½ and over: Cast iron body with flanged connections

.3 Disposable fine mesh screen

.4 Screen blow down connection

.5 Permanent magnet particle trap

.6 Full length straightening vanes

.7 Pressure gauge tappings

.2 Acceptable Manufacturers:

.1 Bell & Gossett FTP screwed, FLG-flanged

.2 Taco Series "SD"

.3 Armstrong Suction Guide

.4 Victaulic Suction Fitting

.7 Water Pressure Reducing Valves

.1 Construction:

.1 Self-contained hydraulic pilot controlled type

.2 Single seated with resilient disc in iron body

.3 Bronze seat for pressure drops below 480 kPa (70 psi)

.4 Stainless steel seat for pressure drops 480 kPa (70 psi) and over

.5 Diaphragm suitable for 120°C (250°F) service

3 Execution

3.1 **CONNECTIONS TO EXISTING SERVICES**

.1 Tie-Ins

.1 Make arrangements with the Owner and obtain permission to tie into existing services at a time acceptable to all parties.

.2 Insulation Repair

.1 Repair or replace any insulation or covering removed from existing lines to permit tie-ins. Use only new materials as specified for new work.

3.2 **PIPELINE SPECIALTIES**

.1 Air Vents

.1 Install automatic air vents at high points of water piping systems and also in any other location noted on Drawings.

.2 Install automatic air vent with 150 mm high, line size or NPS 4 size air pocket, whichever is smaller, and NPS ¾ isolating gate valve and piping to inlet connection of air vent.

.3 Connect discharge to nearest funnel or hub drain or as shown on Drawings.

.4 Provide manual air vents in locations noted on Drawings.

.2 Drain Valves

.1 Install drain valves at low points of water and compressed air piping systems in order to completely drain each system, and also in any other location noted on Drawings.

.3 Circuit Balancing Valves

.1 Provide balancing valves at all locations shown on the Drawings and as required to result in accurate flow balancing.

.2 Install valves in accordance with Supplier's instructions.

.3 Make meters available to the Testing and Balancing Contractor during the balancing of the systems.

.4 Turn over meters to Owner at Substantial Completion.

.4 Radiation Temperature Control Valves

.1 Provide radiation temperature control valves to control hot water convector-radiators and finned tube linear convectors, sized and located as noted on Drawings.

.5 Radiator Valves

.1 Provide packless type radiator valves on supply and return lines at each convector-radiator and finned tube element.

3.3 **HYDRONIC SPECIALTIES**

.1 Expansion Tanks

.1 Tank type:

.1 Diaphragm type for closed water systems not including glycol systems.

.2 Closed type for glycol systems.

.2 System piping and auxiliaries:

.1 Provide an equalizer line from piping system to bottom of each expansion tank.

.2 Provide domestic cold water line with globe valve, strainer, and line size backflow preventer with isolating valves.

.3 Provide water make-up assembly on water line to each tank past backflow preventer.

.4 Provide manual air relief valve at each tank.

.5 Provide pressure gauge to show pressure in tank.

.6 Provide compressed air line from control air system to each tank or group of tanks with globe valve and check valve and terminate 1.2 m above finished floor near tanks with 6 m length of hose and hose end fitting compatible with Schraeder connection on tank.

.3 Safety valves:

.1 Provide code rated water relief valve, located in piping near bottom of each tank. Set relief pressures to maintain 70 kPa (10 psi) at highest point in system with pumps off.

.2 Relief valve for steam generated hot water system to be same model and size as relief valve used on heating convertor in system.

.3 Relief valve of chilled water system expansion tank: minimum 20 mm size.

.4 Drains:

.1 Pipe relief valve, relief connection on backflow preventer, and relief connection on make-up assembly to nearest open drain.

.2 Pressure Safety Relief Valves

.1 Install on hot water boilers, heating convertors, expansion tanks and other pressure vessels in accordance with relevant codes.

.2 Pipe outlets to drain.

.3 Pressure Reducing Valves

.1 Install pressure reducing valve stations with shut-off valve on either side of assembly and 115 mm pressure gauges on upstream and downstream sides of station

3.4 FLUSHING OF PIPING SYSTEMS

.1 Applicable Systems

.1 Flush hydronic piping systems in accordance with Section 23 05 23.

.1 Flush water piping with water flowing at a velocity of not less than 1.8 m/sec, for a period of fifteen minutes or longer as required to remove all dirt, scale, and cuttings from the entire length of the piping.

.2 Thoroughly clean, prior to fabrication, sections of new piping which cannot be isolated for flushing purposes

.3 Thoroughly clean, insofar as possible, welded joints by swabbing interior of pipe with swabs soaked with a caustic solution.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data:

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **MATERIALS**

.1 Minimum General Requirements

.1 The following are minimum construction requirements, unless specified elsewhere.

.2 Pump casings:

.1 Close grained cast iron or cast bronze as specified.

.2 Fitted with casing or impeller wear rings, or both.

.3 Impellers:

.1 Enclosed bronze or duralloy.

.2 Dynamically balanced.

.3 Mounted on carbon steel shaft fitted with stainless steel or bronze sleeves.

.4 Seals:

.1 Suction pressures less than 700 kPa (100 psi): Fitted with mechanical seals.

.2 Stuffing box pressure in excess of 690 kPa (100 psig): Balanced type seals.

.3 Pumps with packing glands: Fitted with stainless steel shaft sleeves for full length of stuffing box.

.5 Performance:

.1 Characteristic curve to be continuously rising to from run-out to shut-off.

.2 Select pump to operate within flow range from 30% below point of maximum efficiency to 10% above that point for impeller diameter chosen.

.3 Installed impeller diameter not to exceed 90% of maximum impeller diameter catalogued for pump casing.

.4 Motors to be sized for continuous operation without motor overload at runout condition for impeller size and rotational speed selected.

2.2 IN-LINE STANDARD DUTY CIRCULATING PUMPS (IN-LINE CIRCULATORS)

.1 Construction

.1 Volute: Cast iron or bronze, with screwed or flanged suction and discharge connections.

.2 Impeller: (cast bronze,) (stamped brass,) (alloy steel) (or cast iron).

.3 Shaft: Alloy steel or stainless steel with bronze sleeve bearing and integral thrust collar.

.4 Seal assembly: Mechanical.

.5 Flexible self-aligning coupling.

.6 Resilient mounted, drip proof, sleeve bearing motor.

.2 Manufacturer

.1 S.A. Armstrong Models "S" and "H"

.2 ITT Fluid Products - Bell & Gossett Series 100

.3 Taco 110

2.3 IN-LINE COMMERCIAL DUTY CIRCULATING PUMPS (HIGH FLOW IN-LINE CIRCULATORS)

.1 Construction

.1 Volute: Cast iron or bronze, with tapped openings for venting, draining, pressure gauges, and with screwed or flanged suction and discharge connections.

.2 Impeller: (Cast bronze,) (Stamped brass,) (Alloy steel) (Cast iron).

.3 Shaft: Alloy steel or stainless steel with bronze sleeve bearing and integral thrust collar.

.4 Seal assembly: Mechanical.

.5 Flexible self-aligning coupling.

.6 Resilient mounted, drip proof, sleeve bearing motor.

.2 Manufacturer

.1 S.A. Armstrong Series 1020, 1050

.2 ITT Fluid Products - Bell & Gossett Series 60

.3 Taco Series 1600

2.4 **SINGLE SUCTION CENTRIFUGAL PUMP**

.1 Construction

.1 (Bronze fitted) (All iron) (All bronze) (All stainless steel) type.

.2 Common cast iron or fabricated steel base with drip rim and tapping for drain connection.

.3 Impeller: Bronze, cast iron, or stainless steel enclosed dynamically balanced, keyed to shaft and secured with locking nut or screw.

.4 Alloy steel or stainless steel shaft with two point support and sleeve bearings.

.5 Bronze, cast iron, or stainless steel enclosed dynamically balanced impeller keyed to shaft and secured with locking nut or screw.

.6 Cast iron, bronze or stainless steel radially split end suction volute with flanged suction and discharge, drain plug, vent cock and suction and discharge pressure gauge tappings.

.7 Mechanical seal or packing gland with hardened wear rings and drip pocket piped to base gutter.

.8 Positive seal flushing system with valved copper piping from pump discharge to stuffing box and cyclone separators for pump heads up to 2400 kPa (800 ft) or 50 micron filters on pumps subject to dynamic heads of less than 160 kPa (55 ft) and ball type flow indicators.

.9 Flexible self-aligning coupling.

.2 Manufacturers:

.1 S.A. Armstrong

.2 ITT Bell & Gossett

.3 Aurora

.4 Taco-Leitch

2.5 **SINGLE SUCTION CLOSE COUPLED VERTICAL-IN-LINE CENTRIFUGAL PUMP**

.1 Construction

.1 (Bronze fitted) (All iron) type.

.2 Cast iron casing with motor mounting flange and drip rim and tapping for drain connection.

.3 Alloy steel or stainless steel shaft.

.4 Bronze, cast iron, or stainless steel enclosed dynamically balanced impeller keyed to motor shaft and secured with locking nut or screw.

.5 Cast iron radially split end suction volute with flanged suction and discharge, drain plug, vent cock and suction and discharge pressure gauge tappings.

.6 Mechanical seal with positive seal flushing system consisting of valved copper piping from pump discharge to stuffing box and cyclone separators for pump heads up to 2400 kPa (800 ft) or 50 micron filters on pumps subject to dynamic heads of less than 160 kPa (55 ft) and ball type flow indicators.

.2 Manufacturer

.1 S.A. Armstrong

.2 ITT Bell & Gossett

.3 Aurora

.4 Taco-Leitch

2.6 **SPECIAL APPLICATIONS:**

.1 Hot Water Heating

.1 End suction, close coupled type.

.2 May use packing gland provided gland, nuts are of bronze construction, gland bolts are stainless steel.

.3 Packing suitable for application temperature.

.4 Rotary type mechanical seals must be rated for 104°C (220°F) operating temperature.

.2 Condensate Pump

.1 Centrifugal type.

.2 Seal ratings: 100°C (212°F).

.3 Pump impeller hydraulically balanced.

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Make piping and electrical connections to pumps.

.2 Check pump rotation.

.3 Set up and adjust controls.

.4 Pipe drain tapping to drain.

.5 Install gauges.

.2 Base Mounted Pumps

.1 Supply templates for anchor bolt placement, dimension layouts for pump bases and furnish anchor bolts with sleeves.

.2 Place pumps level on concrete base; dowel, shim and grout with minimum 13 mm grout.

.3 Fill hollow portion of bases with concrete.

.4 Align couplings before and after piping connections have been made.

.5 Check oil level and lubricate.

.6 Tighten glands after run-in.

.3 In-Line Circulators

.1 Install with fluid flow direction as indicated by flow arrows on pump body.

.2 Support piping and pump at flanges or near unions on connections to unit.

.3 Install with bearing lubrication points accessible.

.4 Check pump rotation.

.4 Vertical In-Line Pumps

.1 Support pump from stanchions or hangers on suction and discharge piping.

.2 Install volute venting pet cock in accessible location.

.3 Check pump rotation.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

1.3 **COORDINATION**

.1 Prepare coordination and fabrication drawings at a minimum scale of 1:50 ¼”=1’-0” and coordinate with other trades affected by this Work to ensure access to other portions of the Work is not impeded by the duct work systems.

.2 Maintain these Drawings on site and make them available for review by the Owner’s Representative when requested.

1.4 **PROJECT CONDITIONS**

.1 Environmental Requirements

.1 Maintain a space work temperature not less than the minimum ambient working temperature as required by the duct sealant manufacturer requirements. Any duct work sealant installed where the space temperature is less than these recommendations will be removed and replaced.

.2 Field Measurements

.1 In existing buildings, make detailed field measurements for routing of new duct work, and provide all offsets and transitions which may be required to accommodate the new work with existing and new services.

.3 Protection

.1 Temporarily cap-off duct work openings to protect against dirt accumulation inside the duct work.

2 Products

2.1 **DUCT WORK**

.1 Materials

.1 Galvanized steel sheet

.1 Z275 (G90) for unpainted duct work, indoor

.2 Z275 (G90) for outdoor duct work

.3 ZF075 (A25) designation zinc coating to ASTM A653/A653M for painted duct work

.2 Stainless steel sheet

.1 Type 304L / Type 316L to ASTM A167

.3 Flexible duct work

.1 ULC approved, insulated double wall polymeric liner bonded to mechanical lock spiral joints

.1 Thermoflex M-KE

.2 Flexmaster

.4 Metal duct sealant – high velocity duct sealer

.1 3M EC800

.2 Foster #30-02

.3 Hardcast Iron Grip #601

.4 Duro-Dyne S-2

.5 Transcontinental Equipment "MP".

3 Execution

3.1 **DUCT WORK**

.1 General

.1 Install duct work in arrangement shown on Drawings in accordance with standards and recommended practices of ASHRAE and SMACNA. Provide required offsets and transitions, whether specifically indicated or not, to facilitate duct installation and to avoid interference with building structure, piping, equipment and services.

.2 Duct sizes as shown on Drawings. Where ducts are to have internal acoustical liner, adjust duct size to accommodate acoustic liner thickness; clear inside dimensions as shown on Drawings.

.3 Fabricate duct work free from vibration, rattle or drumming under operating conditions; reinforce, brace, frame, place gaskets, etc. to comply with performance criteria.

.4 Place galvanized screens of 13 mm x 13 mm mesh x 2.7 mm diameter wire for air intakes, exhausts and open ends of duct work.

.5 Install duct work in locations and at elevations appropriate to ceiling heights shown on Drawings. Where required to be concealed, install duct work in furred spaces provided in walls and ceilings. Where there is no provision for concealment install duct as close as possible to walls, partitions and overhead structures to attain maximum headroom and clearance.

.6 Where shape of duct changes, install transition piece so that angle of side of transition piece does not exceed fifteen degrees from straight run of duct being connected, unless shown otherwise on Drawings.

.2 Pressure Class/Seal Class

.1 Fabricate duct work to SMACNA pressure classification as follows unless otherwise noted on Drawings.

.2 Seal duct work in accordance with SMACNA sealing requirements as follows:

.1 Seal Class “A”: All transverse joints, longitudinal seams, and duct wall penetrations.

.2 Seal Class “B”: All transverse joints, and longitudinal seams only.

.3 Seal Class “C”: Transverse joints only.

.4 Seal Class “D”: None.

System	Pressure Class	Sealing Class
Constant Volume Supply	+3” (750 Pa)	A
Variable Volume Supply, upstream of VAV boxes	+3” (500 Pa)	A
Variable Volume Supply, downstream of VAV boxes	+1” (250 Pa)	A
Building Return Air	+/-2” (500 Pa)	A
Building Exhaust (washroom exhaust, general exhaust)	+/-2” (500 Pa)	A
Fire Rated (exhaust)	+/-3” (750 Pa)	A
Kitchen Exhaust	-4” (1000 Pa)	A
Other Process Exhaust Systems	-4” (1000 Pa)	A

.3 Sleeves

.1 Install sleeves where ducts pass through walls or floors. Pack space between duct and sleeve with mineral wool and seal both ends with non-flammable fire resistant sealing compound. Install sheet metal closure plates on each side of wall to cover sleeve.

.2 Sleeves: Of the same sheet material and thickness as for duct work.

.4 Air Intakes and Exhausts

.1 Install removable galvanized screens securely fastened in place at air intakes, exhausts and open ends in duct work.

.5 Equipment Connections

.1 Install neoprene gasketted flanged joints at duct connections to air conditioning units, coils, etc. Fabricate flanges from mild steel angles to match equipment flanges.

.2 Install air terminal units (TU) and silencers (S) independent of duct work, with rods or angles of sizes adequate to support load.

.6 Paint Finish and Touch-Up

.1 In office areas paint interior of duct work for at least 300 mm behind supply and exhaust grilles with matte black paint to render duct work invisible from occupied space.

.2 Touch-up galvanized steel damaged as a result of fabrication, including welding, with zinc dust galvanized primer.

.7 Supports and Hangers

.1 Support intervals:

.1 Ducts up to 1.5 m in width: Minimum 2.4 m centres.

.2 Ducts 1.5 m in width and over: 1.2 m centres.

.2 Strap hangers:

.1 For duct size up through 760 mm width.

.2 3 mm x 25 mm mild steel bar stock. Bend strap hanger around bottom of duct for a minimum of 38 mm and attach to sides and bottom of duct.

.3 Steel angle hangers:

.1 For duct sizes over 760 mm in width.

.2 Mild steel rod hangers of 10 mm diameter minimum size, with 38 mm x 38 mm x 3 mm steel angle across bottom of duct and attach hanger to angle (not the duct).

.4 Install miscellaneous steel angles or channels as required between joists or building steel for structural support of duct where building framing spacing does not coincide with the required hanger spacing.

3.2 RECTANGULAR DUCT WORK

.1 General

.1 Material: Galvanized steel for unpainted duct work, unless otherwise shown on Drawings.

.2 Metal thickness and construction methods as specified herein for various size ranges of ducts.

.3 Cross-break flat surfaces of uninsulated duct between joints, or between joints and intermediate reinforcements, to prevent vibration or buckling.

.4 Seal joints on all rectangular duct work with high velocity duct sealer. Duct-tape will not be allowed.

.2 Joints

.1 Longitudinal joints: Pittsburgh Lock joints tightly closed along full length of seam.

.2 Transverse joints: Ductmate, Nexus or TDC connections of class to suit size of duct and pressure of system.

.3 Fittings

.1 Elbows, transition sections and take-off fittings: Use metal one gauge heavier than thickness specified for duct in which they are installed.

.2 Radius elbows: Standard radius design with inner radius equal to width of elbow unless shown otherwise, Pittsburgh Lock seams, and with ends to match transverse joints of duct.

.3 Square elbows: Where elbows are shown as square type, fit elbows with air turning vanes of double blade construction.

3.3 ROUND DUCT WORK

.1 General

.1 Shop-fabricate round duct work from helically wound galvanized steel sheet strips with spiral lock seam, of following thicknesses:

Duct Diameter	Thickness of Sheet Metal
200 mm or less	0.5 mm (26 ga.)
228 mm to 560 mm	0.6 mm (24 ga.)
600 mm to 810 mm	0.8 mm (22 ga.)
860 mm to 1010 mm	1 mm (20 ga.)
1060 mm and up	1.3 mm (18 ga.)

.2 In lieu of standard spiral lock seam duct work, "Uni-Rib" duct as manufactured by United Sheet Metal may be furnished for above floor installations in sizes 375 mm and larger.

.3 Secure joints with sheet metal screws and seal with approved sealant.

.2 Joints

.1 Longitudinal seam: Spiral wound seam type RL-1 (grooved lock) or RL-4 (butt weld)

.2 Transverse seam: Van Stone flange joint RT-2 or RT-2A

.1 Exception: Downstream of VAV boxes flange joint type RT-1 (beaded sleeve joint) may be used, with minimum three mechanical fasteners each side of joint.

.3 Seal joints in round duct work with high velocity duct sealer as specified for rectangular duct work.

.3 Fittings

.1 Ninety degree elbows: Smooth centre line radius of one and one-half times duct diameter. Alternatively, use elbows of five piece construction, subject to prior approval of Consultant.

.2 Forty-five degree elbows: Use three piece construction.

.3 Branch connections to mains: Eccentric conical configuration.

3.4 SPECIALTY DUCT WORK SYSTEMS

.1 Flexible Type Round Ducts

.1 Provide flexible duct work as follows:

.1 Between trunk supply duct and air terminal units, VAV boxes.

.2 At connection to certain ceiling diffusers.

.3 Where shown on Drawings.

.2 Use insulated type flexible duct work in non-return air plenums.

.3 Use non-insulated type flexible duct work in return air plenums.

.4 Seal joints between flexible duct and rigid duct work or equipment with non-flammable high velocity duct sealer, applied in accordance with duct manufacturer's recommendations, and make secure with gear type nylon strap connectors.

.2 Fire Rated Duct Work

.1 Construct and support fire rated duct work in strict conformance with the ULC listing requirements for two-hour fire rating.

.2 Where duct construction or support is not covered by ULC listing requirements, construct and support duct work as for rectangular duct work, specified herein.

.3 Waterproof Duct Work

.1 Slope fresh air intake ducts down at 1:100 to permit moisture induced by air intake to be drained. Install 38 mm drain flange in bottom of duct at low point. Continuously solder or seal joints in exterior air intake duct to prevent dripping of moisture through joints.

.2 In areas having high humidity, fabricate exhaust duct work without seams in bottom of duct for at least 3 m of duct run behind register and slope duct up away from register.

.4 Kitchen Exhaust Hood Duct Work

.1 Fabricate duct work, access door and cleanouts in accordance with NFPA 96.

.2 Material: 1.6 mm (16 gauge) black steel (or stainless steel) with externally welded seams, and flanged and gasketted joints at hood and fan.

3.5 INSPECTION, TESTING AND BALANCING

.1 Cleaning

.1 Prior to start-up of fans, blow out complete systems of duct work with high velocity air for not less than two hours using, where possible, the installed air handling equipment to full capacity and by blanking off duct sections to achieve required velocity. Do not install air filters prior to blow-out of duct work systems. Use auxiliary portable blowers for cleaning where installed fan systems are not adequate to blow out complete system free from dust and dirt.

.2 After duct systems have been blown out, clean interior of plenums, coils, and register, grille or diffuser outlet collars with industrial type vacuum cleaner. On completion of cleaning process, install filters before placing systems in final operation.

.2 Balancing of Air Systems

.1 Balance air handling systems in accordance with Section 23 08 16.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **RELATED SECTIONS**

.1 Division 25: Integrated automation:

.1 Automatic control damper operators

.2 Automatic control dampers

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

2 Products

2.1 **DUCT WORK ACCESSORIES**

.1 Flexible Duct Connections

.1 Material:

.1 Heavy glass fabric double coated with neoprene and attached to 0.6 mm (24 ga) metal strips 75 mm wide.

.2 Fabric length between metal strips:

.1 Minimum 75 mm for ducts of maximum size in either dimension or diameter of 750 mm or less

.2 150 mm for ducts of 775 mm size and larger.

.2 Acceptable Manufacturers:

.1 Duro-Dyne "Grip-Loc Type SMFN"

.2 Ventfabrics "Ventglas"

.2 Turning Vanes

.1 Material: Hollow airfoil type, fabricated of same material as duct in which they are installed.

.2 Acceptable Manufacturers:

.1 Duro-Dyne

.3 Access Doors in Duct Work and Plenums

.1 Hand door:

.1 Construction: 0.7 mm (24 ga) galvanized steel, double flanged frame and insulated door complete with insulation backing plate.

.2 Fasteners: Zinc plated cam-lock fasteners, minimum two per door, with safety retaining chain.

.2 Equipment and man doors:

.1 Minimum size, equipment: Where motors are installed within unit or duct, use an access door large enough to permit removal of motor.

.2 Minimum size, man door: 450 mm x 1.2 m or as shown on Drawings.

.3 Construction: 0.8 mm (22 ga) thick galvanized steel sheet double panel construction with approved 25 mm thick insulating filler, mounted in flanged die-formed collar flush with face of finished insulation, with flanged door frames welded in place.

.4 Hinges: Heavy zinc plated continuous hinge.

.5 Fasteners: Three heavy sash fasteners and neoprene gaskets.

.4 Probe Inlets

.1 Material:

.1 Ventlok No. 699 or Duro-Dyne IP-1 or IP-2 Test Opening Enclosures complete with locking cap, chain, gaskets, insulating plug and extensions for insulated duct work.

2.2 OPERATING DAMPERS

.1 Automatic Control Dampers

.1 General:

.1 Modulating control dampers: Opposed blades.

.2 Two position control dampers: Parallel blades.

.2 Damper blades and frames:

.1 Extruded aluminum 6063-T5

.2 Maximum blade length: 1.2 m without internal frame support.

.3 Maximum blade length: 1.2 m without internal frame support.

.4 Blade edge seals: EPDM gaskets.

.5 Frame side seals: Extruded TPE or cambered stainless steel.

.6 Frame style: Flanged to duct.

.7 Jack shaft: Extendable, combination of aluminum, and zinc/nickel coated steel.

.8 Damper leakage: 50 L/s per m² damper face area at 1 kPa differential static pressure.

.3 Bearings:

.1 Thermal plastic resin copolymer, nylon or oil impregnated bronze.

.2 At blade axles, linkage devices, etc.

.4 Damper blades and frame for outside exhaust and intake air applications:

.1 As above.

.2 Operating temperature: -40°C to +100°C (-40°F to +212°F).

.3 Thermally broken and insulated blades; expanded polyurethane foam insulation.

.4 Damper leakage: 21 L/s per m² damper face area at 1 kPa differential static pressure.

.5 Acceptable Manufacturer:

.1 Tamco - Series 1000

.2 Nailor Industries - Series 2000

.3 Tamco - Series 9000 (exhaust and air intake applications)

.4 Nailor - Series 2000IBF (exhaust and air intake applications)

.5 Ventex Alumavent

.2 Manual Balancing Dampers

.1 Rectangular duct work:

.1 Galvanized channel type frames, non-binding pre-lubricated type interconnecting and operating linkages.

.2 Blades: Minimum 1.6 mm (16 ga) thick material, opposed blade style.

.3 Manual operator and locking type quadrant as required for synchronous operation and setting of blades.

.4 Blade width: Maximum 200 mm.

.5 Blade length: Length coinciding with frame opening on horizontal plane to maximum length of 1.2 m.

.6 Locking quadrant: Galvanized steel locking quadrant with “Open – Closed” labels, 50 mm insulation stand-off.

.7 Acceptable Manufacturers:

.1 Nailor – Series 1810/1820 with HL2 quadrant

.2 Ventex Alumavent

.2 Round duct work - medium pressure butterfly damper:

.1 Galvanized steel frame 0.9 mm (22 ga) with stiffening beads up to 300 mm diameter; 0.9 mm (20 ga) over 300 mm duct size.

.2 Blade: Laminated galvanized steel 0.9 mm (22 ga), or single layer of 1.6 mm (16 ga), open and closed end stops, Celcon bearings, polyethylene blade edge seal, 13 mm diameter drive shaft.

.3 Locking quadrant: Galvanized steel locking quadrant with “Open – Closed” labels, 50 mm insulation stand-off.

.4 Acceptable Manufacturers:

.1 Nailor – Series 1000 with HL2 quadrant

.3 Round duct work - low pressure butterfly damper:

.1 Galvanized steel frame 0.9 mm (22 ga) with stiffening beads up to 300 mm diameter; 0.9 mm (20 ga) over 300 mm duct size.

.2 Blade: Galvanized steel 0.9 mm (22 ga) up to 300 mm diameter; 0.9 mm (20 ga) over 300 mm duct size, 6 mm diameter drive shaft.

.3 Locking quadrant: Galvanized steel locking quadrant with “Open – Closed” labels, 50 mm insulation stand-off.

.4 Acceptable Manufacturers:

.1 Nailor – Series 1890 with HLQ-SB quadrant

.4 Splitter damper:

.1 Material: Same material and thickness as ducts in which they are to be installed, minimum of 0.8 mm (22 ga).

.2 Form splitters of double thickness of metal and with rounded surface at air entering edge.

.3 Splitter length: At least one and one-half times width of smaller branch duct, but in no case less than 300 mm.

.4 Provide with locking type quadrant.

.3 Volume Extractors in Duct Work:

.1 Use where noted on Drawings

.2 Acceptable Manufacturers

.1 Titus Model AG225 with #3 manual operator.

2.3 FIRE AND SMOKE DAMPERS

.1 Fire Dampers

.1 ULC labelled fire dampers of hinged, fusible link type with channel frames, blades and housing and conforming to NFPA 90A and UL555 requirements. Use "Type B" fire dampers for rectangular or square duct work and "Type C" fire dampers for round duct work.

.2 Dynamic dampers: Designed to close while the system fans are operating.

.3 Static dampers: Designed to close with no airflow through damper.

.4 Closure link: Fusible link which can be released, tested and relatched for testing.

.5 Construct fire dampers and frames of same material as duct in which they are installed.

.6 Acceptable Manufacturers:

.1 Nailor – "D" series

.2 Ruskin

.3 Ventex Alumavent

.2 Smoke Dampers

.1 ULC labelled fire dampers of airfoil parallel blade type, with extruded aluminum channel frames and sleeve housing and conforming to NFPA 90A and 92A, and UL555S, leakage class I rating at 176°C (350°F).

.2 Blades: Extruded aluminum airfoil blade with concealed linkage outside of airstream, with self lubricating bronze type bearings, stainless steel camber style jamb seals, and mechanically locked in extruded edge seals

.3 Dampers designed to operate while the system fans are operating.

.4 Operator: Externally mounted, factory installed 120 VAC electric actuator with spring return, fail close position. Built-in high limit thermostat switch opens at 73°C (163°F).

.5 Accessories: 120 VAC proof-of-closure and proof-of-open end-switch, with two SPDT switches.

.6 Acceptable Manufacturers: Damper

.1 Nailor – Series 1280

.2 Ruskin

.3 Ventex Alumavent

.7 Acceptable Manufacturers: Operator

.1 Belimo – Model FSNF-120 US

.3 Combination Smoke and Fire Dampers

.1 ULC labelled fire dampers of airfoil parallel blade type, with extruded aluminum channel frames and sleeve housing and conforming to NFPA 90A and 92A, and UL 555 and UL555S, leakage Class I rating at 176°C (350°F).

.2 Blades: Extruded aluminum airfoil blade with concealed linkage outside of airstream, with self lubricating bronze type bearings, stainless steel camber style jamb seals, and mechanically locked in extruded edge seals

.3 Dampers designed to operate while the system fans are operating.

.4 Operator: Externally mounted, factory installed 120 VAC electric actuator with spring return, fail close position. Built-in high limit thermostat switch opens at 73°C (163°F).

.5 Accessories: 120 VAC proof-of-closure and proof-of-open end-switch, with two SPDT switches.

.6 Acceptable Manufacturers: Damper

.1 Nailor – Series 1220

.2 Ruskin

.7 Acceptable Manufacturers: Operator

.1 Belimo – Model FSNF-120 US

2.4 ACOUSTIC TREATMENT

.1 Acoustic Duct Insulation

.1 Material:

.1 Rigid coated duct liner conforming to NFPA 90A and 90B, 25 mm thick and 72 kg/m³ density.

.2 In duct work at velocities over 15 m/s, provide a perforated or expanded metal inner liner over acoustic insulation.

.2 Fasteners:

.1 Fasten acoustic liner to inside of duct with plate type impaling pins and self-locking washers, by Eckels Industries "Stic-Klips", "Tactoo Series T", or Continental Stud Welding weld pins and self locking washers.

.2 Use fasteners or securing pins of size and length as required by insulation weight, thickness, fastener spacing and design.

.3 In addition to mechanical type fasteners, adhere insulation to inside of duct with Foster No. 81-99 or Henry No. 230-04 fire retardant adhesive. Seal all joints with Foster No. 30-36 or Henry No. 120-09 mastic sealant.

.3 Acceptable Manufacturers:

.1 Owens Corning

.2 Manson

.3 Knauf

.4 Manville

2.5 ACOUSTIC SILENCERS (S)

.1 Rectangular and Elbow Silencers

.1 Material:

.1 Housing: Hot dip galvanized steel sheet, one gauge heavier than adjacent duct work but not less than 0.9 mm (20 ga).

.2 Duct size: External silencer dimension to match adjacent duct dimensions, unless otherwise shown.

.3 Inner liner: Hot dip galvanized perforated steel sheet, 0.8 mm (22 ga).

.4 Insulation: Glass fibre or mineral wool to ASTM E-84, class 1.

.2 Performance

.1 Silencers have been selected on basis of sound power levels of first listed equipment. Ensure that equipment of any other named manufacturer proposed for use has sound power levels equal to or lower than first listed equipment.

.2 Be responsible for reducing noise levels to below acceptable maximum without additional cost to Owner.

.2 Circular Silencers

.1 Same as for rectangular silencers and as follows:

.1 Internal bullet: Spun head and tapered tail, with airflow straightening vanes.

.2 Duct size: Duct flange connection same size as adjacent duct size.

.3 Acceptable Manufacturers

.1 Vibron

.2 Vibro-Acoustics

.3 Woods

3 Execution

3.1 **GENERAL**

.1 Refer to and comply with applicable requirements specified in Section 23 05 01.

.2 Install miscellaneous steel framing, supports, braces, etc. as required to hang or support equipment and duct work as specified herein, and as shown on Drawings.

3.2 **FLEXIBLE DUCT CONNECTIONS**

.1 Use flexible duct connections between fans and/or air handling units and connecting duct work, between unit components, in ducts at building expansion joints, and in other locations shown on Drawings

.2 Install flexible connectors with fabric in folds, not drawn tight.

.3 Install internal guides to prevent flexible connection from collapsing on suction side of fans.

.4 For installation between sections of air handling units, install flexible connectors suitable for connecting to flanges of casings where so provided.

3.3 **TURNING VANES**

.1 Provide hollow airfoil type turning vanes in duct work where shown on Drawings and in ninety degree square duct elbows, fabricated of same material as duct in which they are installed.

3.4 **ACCESS DOORS**

.1 Provide access doors in duct work and for plenums to allow servicing, maintenance, and inspection of:

.1 Control dampers

.2 Fire dampers

.3 Smoke dampers

.4 Fire detectors

.5 Control elements

.6 Sprinkler heads mounted in duct work

.7 Motors

.8 Bearings

.9 As shown on Drawings

.2 Provide “Hand Doors” in duct work of sizes as follows:

Access Type	Duct Dimension	Access Door Size
One hand and sight	Less than 400 mm	300x150 mm
Two hands and sight	Between 400 mm and 500 mm	450x250 mm
Head and shoulders	Between 500 mm and 760 mm	530x356 mm
Body plus ladder	Between 760 mm and 1320 mm	635x430 mm

.3 Provide “Equipment and Man Doors” as follows:

.1 In duct work with duct dimension over 1320 mm.

.2 In plenums.

.3 As shown.

3.5 **BALANCING DAMPERS**

.1 Use rectangular opposed blade dampers at the following locations:

.1 At floor connections to riser shafts/ducts.

.2 In supply and return duct work where main ducts are split into two more trunks.

.3 At rectangular branch duct connections to main or trunk ducts.

.4 As shown.

.2 Use splitter dampers only where specifically shown on Drawings.

.3 Use medium pressure butterfly dampers at the following locations:

.1 At floor connections to supply air riser ducts.

.2 In supply and return duct work where main ducts are split into two more trunks.

.3 At branch duct connections to main or trunk ducts.

.4 At branch duct upstream of terminal box.

.5 As shown.

.4 Use low pressure butterfly dampers at the following locations:

.1 At branch connections on the downstream side of terminal boxes.

.2 At individual branch outlets serving grilles or diffusers.

.5 Dampers supplied with diffusers or grilles are to be used to balance ±10% of indicated airflow, are NOT in lieu of branch dampers.

3.6 **VOLUME EXTRACTORS IN DUCT WORK**

.1 Use where noted on Drawings.

3.7 **FIRE AND SMOKE DAMPERS**

.1 Install fire dampers in accordance with Suppliers instructions, and with retaining angles on both sides of wall or floor and fastened to damper collars.

.2 Install fire dampers with adjacent access door as required to permit re-opening of damper and replacement of fusible link.

.3 Provide dynamic fire dampers on all systems, unless otherwise shown on Drawings and specified below.

.4 Provide static dampers on return air transfer openings.

3.8 **PROBE INLETS**

.1 Install probe inlets in duct work at locations as follows:

.1 In main supply and return ducts.

.2 Inlet and outlet side of fans.

.3 Other locations as required by testing and balancing trade, to permit testing, balancing and measurement of air quantities and static pressure in air handling systems.

.2 Locate probe inlets a sufficient distance from elbows or transition sections to ensure stable readings of non-turbulent air and install 75 mm from corners and at 150 mm centres across long side of duct.

3.9 **ACOUSTIC DUCT INSULATION AND SILENCERS**

.1 Install internal acoustic insulation in specific sections of duct work and/or plenums as shown on Drawings as follows:

.1 Adhere insulation to duct work or plenums by bedding in strips of adhesive supplemented by impaling clips or weld pins spaced at 300 mm centres with self-locking washers.

.2 Apply adhesive at 50% coverage, in 150 mm strips.

.3 Cut off ends of welded impaling pins after application of self-locking washers.

.4 Seal butt joints of insulation with mastic sealant applied to edges of insulation.

.5 Coat joints and self-locking washers after installation with two coat application of mastic sealant, and with open mesh glass fabric embedded in mastic between first and second coat.

.6 In high velocity duct work install perforated or expanded metal inner liner over acoustic lining.

.2 Use silencers in duct work where shown on Drawings, to attenuate airborne noise generated in air distribution systems.

.3 Fabricate cross talk silencers:

.1 Housing: Galvanized steel, to SMACNA pressure class 1” standard.

.2 Liner: Rigid coated duct liner.

.3 Size: As shown on drawings.

.4 Shape: As shown on drawings.

.5 Provide a sheetmetal nosing at open ends of duct to close off cut edge of liner.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **REFERENCE STANDARDS**

.1 Comply with the latest edition of the standards referenced herein:

.1 Fans: Designed and constructed in strict conformity with the AMCA Standards and bearing the "Certified Rating Seal".

.2 Applicable sections of CSA C22.2 No. 113 for fan construction and installation.

.3 Occupational Health and Safety Act, O.Reg 851.

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Submit manufacturer's certified Shop Drawings to the Consultant and include:

.1 Complete information on fan construction and performance.

.2 Performance curves over full range from shut-off to free delivery.

.3 Drive details.

.4 Make, type and catalogue number of bearings.

.5 State hour rating of bearings when specified.

.2 Operation and Maintenance Data

.1 Submit printed operating instructions and maintenance data in accordance with Section 01 33 00.

.3 Maintenance Materials

.1 Provide and turn-over to Owner at time of Substantial Completion one V-belt set for each size used.

.1 Where more than one fan uses the same set size, provide only one set.

2 Products

2.1 **GENERAL REQUIREMENTS**

.1 Performance Ratings

.1 Type, size and capacity shown on Drawings for each specific application and conforming to requirements of manufacture, operation and performance as specified.

.2 Select fan size, operating rpm and rating point on stable head flow curve with smooth characteristics.

.3 Operating at least 20% below first critical speed when operating at maximum speed for class of construction.

.4 Dynamically and statically balance wheels of free standing or unitary fans to acceptable tolerances relative to size and speed.

.2 Cleaning and Metal Protection

.1 Thoroughly clean interior and exterior surfaces of fans including screens, at factory with approved de-greasing agent to CGBS 1-GP-181M+ Amdt-Mar-78.

.2 Apply a coating of red oxide or zinc chromate primer unless special protective coating is specified.

.1 Exception: Fans constructed of galvanized steel or aluminum.

.3 Materials

.1 Fan casings: Heavy gauge steel or spun aluminum construction, as specified by model number.

.1 Explosion proof construction (non-sparking) where listed in schedules.

.4 Bearings

.1 Service life

.1 To L10 life standard in accordance with latest AFBMA code.

.2 Unitary, axial and free standing fans: 200,000 (60,000) (80,000) (100,000) hour service.

.3 Other fan bearings: 8,000 hour service.

.2 Type

.1 Grease lubricated ball or roller type fan bearings with ample thrust provision to prevent end play during normal life of bearings.

.2 Smaller than 36 mm diameter: Cartridge type.

.3 36 mm diameter and larger: Shaft adapter sleeve type bearings utilizing horizontally split pillow blocks and mechanical flinger type grease valves.

.4 Shafts smaller than 56 mm diameter, interference fit bearings may be used in lieu of adapter sleeve type.

.3 Bearings in air stream

.1 Well secured extended grease lubricating lines unless bearing is easily accessible through man-size access door.

.2 Pack bearings with low temperature grease in factory.

.4 Axial flow fans

.1 Conform to these Specifications except where inner cylinder mounting methods are used or dimensions do not permit it and special or flange mounted type bearings are required.

.5 Grease fittings, for fans driven by motors 0.375 kW (1/2 HP) and larger

.1 Provide bearings with Zerk or Alemite grease fittings, with provision for automatic relief of lubricant pressure to outside of fan, away from wheel and visible from maintenance location.

.2 Use service fittings and relief fittings easily accessible from maintenance locations and at separate and opposite sides of bearing housing.

.5 Motors and Drives

.1 Motor ratings

.1 To Section 23 05 13.

.2 Type, kW (HP) rating, motor speed and electrical characteristics shown on Drawings.

.3 Capable of satisfactory operation over range of performance from shut-off to run-out at 110% of rated rpm at point of selection.

.2 Drive and belt guards: To Section 23 05 01.

.6 Accessories

.1 Fans with variable inlet vanes

.1 Operating mechanisms to provide simultaneous adjustment of vanes.

.2 Motor operated mechanisms to be suitable for adaptation of motor operator provided under Division 25.

.3 Quick opening access doors in scroll casing.

.4 On DWDI fans interconnect vanes in each inlet to operate in unison.

.5 Provide locking device for manual operation.

.2 Casing drains

.1 Fans discharging vertically through roof: Fitted with 38 mm casing drains.

.3 Roof mounted fans

.1 Factory mounted unfused disconnect switches wired to motor terminals.

.2 Conduit or wiring post running through fan housing so that wiring may be run to line side of disconnect switch from below roof without disturbing roof construction.

.4 Roof curbs for roof mounted fans and ventilators

.1 Prefabricated insulated galvanized steel sheet curbs for mounting to roof deck.

.2 Prefabricated insulated galvanized steel sheet curbs for mounting to roof deck.

.3 Minimum curb height: 300 mm on every side, or as dimensioned on Drawings.

2.2 FAN TYPES

.1 Centrifugal Fans

.1 Arrangements

Fan Type	Arrangement
Belt driven single inlet single width (SWSI) fans up to and including 915 mm wheel diameter	#1 or #2
Belt driven single inlet single width (SWSI) fans with wheel diameter larger than 915 mm diameter	#3
Belt driven double width double inlet (DWDI) fans	#3
Belt drive plenum (plug) fans, single width single inlet (SWSI) fans	#3
Direct connected double width double inlet (DWDI) fans	#7
Direct connected single inlet single width (SWSI) fans	#8
Utility sets	#10
Tubular single width single inlet (SWSI) fans	#1 or #9

.2 Fan wheels

.1 Backward curved or backward inclined for fan wheels less than 686 mm diameter.

.2 Single or double thickness backward curved air foil blades for fan wheels 686 mm diameter and larger.

.3 Fan casing

.1 Continuous seam welded.

.2 Inlet mounting collar.

.3 Outlet flanged collar.

.4 Plenum (plug) fans

.1 Safety screen enclosure around fan and motor fabricated from steel angle and expanded metal mesh.

.2 Access covers to fan and motor shaft ends for speed measurements.

.5 In-line cabinet fans

.1 Single wheel SWSI centrifugal fans with motor and V-belt drive.

.2 Removable panels for access to internal parts.

.3 Internally lined cabinet with 50 mm thick rigid acoustic insulation.

.4 Expanded metal mesh over insulation on floor.

.5 Motor pre-wired to external junction box.

.6 Mounting ring or brackets for vertical or horizontal suspension from overhead structure.

.7 Belt guard, motor and drive.

.8 Hanger brackets.

.9 Inlet and outlet cones.

.10 Quick-opening access door.

.11 External grease and relief fittings to each bearing.

.12 Variable inlet vanes and linkage where noted.

.6 Ceiling cabinet fan / in-line cabinet fan

.1 Fan wheel

.1 Centrifugal direct drive type.

.2 High strength polymer material.

.3 Forward curved.

.2 Motor

.1 Continuous duty, permanently lubricated, thermally protected.

.2 Resilient motor mounts to eliminate vibration.

.3 Casing

.1 Heavy gauge steel.

.2 Acoustic lining.

.3 Painted for corrosion resistance.

.4 Built-in backdraft damper.

.5 Outlet connection for round duct.

.6 Integral mounting flanges to allow for ceiling installation.

.7 Tubular centrifugal fans

.1 Characteristics and construction as for centrifugal fan wheels.

.2 (Direct drive motor) (Belt drive assembly).

.3 Smooth rounded inlet, and stationary guide vanes.

.2 Tube and Vane Axial Fans

.1 Fan

.1 Fabricated of welded steel with welded motor support.

.2 Quick-opening access door.

.3 External grease and relief fittings to each bearing.

.4 Streamlined inlet cone and discharge bell sections.

.5 Integral silencer casing.

.6 Reinforced legs for floor mounted units.

.7 Hanger brackets.

.8 Support bracket welded to side of casing for suspended units.

.2 Drives

.1 Direct driven: (Adjustable pitch) (Fixed pitch) (Fan blade with totally enclosed "air-over" motors and diameter of wheel hub at least equal to that of motor frame.

.2 Belt driven: (Fixed) (Adjustable) blade wheels with externally mounted open drip proof motors, internal belt fairing, external belt guards and adjustable motor mounts.

.3 Roof Top Fans and Ventilators

.1 Upblast exhaust and downward supply air fans

.1 Suitable for mounting on curbed roof openings.

.2 Heavy gauge galvanized steel housing and windband.

.3 Finished inside and outside with sprayed asphalt.

.4 Heavy gauge curb cap.

.5 Gravity or spring assisted steel dampers as required, with magnetic catches to dampers to prevent rattling in closed position.

.6 TEAO motor.

.7 Weatherproof protective motor cover and belt-drive.

.8 Supply fans complete with 25 mm throwaway filters.

.2 Spun aluminum dome type fans

.1 Belt or direct driven as indicated in schedules.

.2 Spun aluminum housing.

.3 Hinged or completely removable hood for access to motor and fan.

.4 Non-overloading centrifugal fan wheel.

.5 Multi-blade gravity backdraft damper and aluminum 13 mm mesh birdscreen.

.3 Gravity relief vents

.1 Spun aluminum cover.

.2 Welded aluminum curb cap.

.3 Galvanized bird screen.

.4 Exhaust air outlets complete with backdraft dampers.

.4 Penthouse type intake and exhaust hoods

.1 Extruded aluminum fixed louvres with birdscreens on inside.

.2 Insulated metal roof.

.3 Welded base to suit curbed opening and prefinished to later colour selection.

.4 Ceiling Fans

.1 Multi-bladed propellers of sheet or airfoil shape.

.2 Permanently lubricated ball bearings suited for operation in any position.

.3 Direct driven, variable speed, with EC motor complete with controllers.

.4 Acceptable manufacturers:

.1 Big Ass Fans

.2 Altra Air (Envira North)

.3 MacroAir

.5 Propeller Fans

.1 Wall type belt or direct driven propeller fans

.1 Multi-bladed propellers of sheet or airfoil shape steel within bell mouth entrance.

.2 Grease lubricated ball bearings suited for operation in any position.

.3 (Direct) (or) (belt) driven, with motor as indicated.

.4 Bird screen (and automatic backdraft dampers with gasketted edges).

.5 Wire guard on motor side.

.6 Support motor with substantial brackets or frame. Motors supported integrally with wire guard will not be accepted.

.6 Acceptable Manufacturers

.1 Industrial Type Construction (In-line, Propeller Utility Sets, Upblast, Fume)

.1 Twin City Fan

.2 Chicago Blower

.3 New York Blower

.4 Northern Blower

.5 Barry Blower

.6 Carnes

.7 Aeroflow

.8 Aerovent

.9 Howden Fan Co.

.10 American Fan Company (Flakt Woods)

.11 Wood Fans

.12 Canada Blower

.2 Ceiling Cabinet Fans

.1 Greenheck

.2 Twin City

.3 Carnes

.4 Aerovent

.5 PennBarry

.6 Loren Cook

.3 Small Propeller Fans

.1 Howden Fan Co.

.2 Greenheck

.3 Carnes

.4 American Fan Company (Flakt Woods)

.5 Wood Fans

.4 Spun Aluminum Fans

.1 Greenheck

.2 Jenn Air

.3 Carnes

.4 American Fan Company (Flakt Woods)

.5 Intake and Exhaust Hoods, Penthouses, Relief Vents

.1 Greenheck

.2 Jenn Air

.3 Carnes

.4 Loren-Cook

.5 American Fan Company (Flakt Woods)

3 Execution

3.1 **GENERAL**

.1 Fan Installation

.1 Install fans complete with resilient mountings and restraining snubbers in accordance with Section 23 05 48.

.2 Provide flexible connections on inlet and outlet ductwork in accordance with Section 23 33 00.

.3 Align shafts, belt drive and motor, adjust belt tension and check motor rotation before start-up.

.4 Protect motors and fans during construction and rotate fans, by hand, every month between delivery and acceptance of building.

.2 Air Balancing

.1 Adjust variable pitch fan/motor sheaves during balancing to achieve specified air quantities.

.2 Provide sheaves and belts for final air balance.

3.2 **FABRICATED GOOSENECK TYPE FRESH AIR INTAKE AND EXHAUST AIR HOODS**

.1 Fabrication: Black steel construction.

.2 Size, shape and arrangement as shown on Drawings.

.3 Finish interior and exterior surfaces finished with rust inhibitive primer.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **REFERENCE STANDARDS**

.1 Comply with the latest edition of the following:

.1 Insulation systems

.1 UL 181 (Air Erosion)

.2 UL 181 (Mold Growth and Humidity)

.3 UL 723 (25/50) (Flame and Smoke)

.4 ASTM E 84 (25/50) (Flame and Smoke)

.5 ASTM C665 (Fungi Resistance)

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00 and provide the following:

.1 Airflow and sound power data

.2 Motor load data

.3 Control systems

.2 Operation and Maintenance Data

.1 Submit printed operating instructions and maintenance data in accordance with Section 01 33 00.

1.4 **CODES AND REGULATIONS, PERMITS, COSTS AND FEES**

.1 Comply with municipal or provincial codes, rules and regulations and/or authorities having jurisdiction.

.1 Electrical certification

.1 CSA labeled or field approval

2 Products

2.1 **LOW PRESSURE TERMINAL UNITS - TO 750 PA (3” WG)**

.1 General

.1 Type, model and size as shown on Drawings

.2 Acceptable Manufacturers:

.1 E.H. Price

.2 Titus

.3 Trane

.4 Kreuger Division of Phillips Air Distribution Ltd.

.5 Nailor Industries Inc.

.6 Carnes

.7 Tuttle & Bailey

.3 Operating pressure

.1 Maximum inlet air pressure: 750 Pa (3" wg).

.2 Minimum inlet air pressure: 75 Pa (0.3" wg).

.3 Maximum pressure drop across unit including attenuator, at 10 m/s inlet velocity: 40 Pa (0.15” w.g.)

.4 Air leakage, close damper position: maximum 2% of nominal catalogue rating at an air inlet pressure of 750 Pa (3” w.g.)

.4 Acoustic ratings

.1 Maximum room NC sound pressure level (2×10^{-4} microbar reference) at maximum inlet pressure: Less than forty at discharge and forty-two radiated for box with attenuator mounted exposed (without ceiling).

.5 Performance ratings

.1 ARI 880 certified.

.2 Maintain air quantity within ±5% of set value, between zero and specified rating, and sound level below specified values when operating from minimum to maximum inlet static pressure as given above.

.6 Materials

.1 Stainless steel: 20 gauge type 316L stainless steel.

.2 Fibreglass insulation: 20 mm thick (unless otherwise specified), dual density fibreglass. Exposed/cut edges sealed with NFPA-90A approved sealant, or metal caps as specified.

.2 Single Duct Terminal Units (TU)

.1 Variable volume or constant volume as per equipment schedules

.2 Casing construction

.1 Casing: 22 gauge galvanized steel.

.2 Insulation Type 1: Fiberglass encapsulated in woven fabric liner, and wrapped edges.

.3 Insulation Type 2: Fiberglass with aluminum foil liner and sealed edges.

.4 Insulation Type 3: Fiberglass encapsulated in woven fabric liner, and galvanized steel perforated liner, and metal cap edges.

.5 Insulation Type 4: Fiberglass with galvanized steel solid liner, and metal edge caps.

.6 Insulation Type 5: Fiberglass with galvanized steel perforated liner, with metal edge caps.

.3 Control elements

.1 Pressure independent type.

.2 Velocity sensor, cross tree type, with an accuracy within 5% with a ninety degree elbow connected at the inlet to the assembly.

.3 Damper: Heavy gauge metal, with edge gasket, self-lubricating bearings, and adjustable minimum stop.

.4 Damper arranged "normally open" for morning warm-up.

.5 Controls and damper actuator as specified below.

.4 Discharge section

.1 Open end or multiple outlet attenuator on box discharge acoustically treated with insulation as described above for the unit casing.

.2 Reheat coils where scheduled, complete with access door in bottom of attenuator on inlet side of coil.

.3 Fan Powered Variable Air Volume Terminal Units (TUF)

.1 Type

.1 Variable volume primary air flow and constant volume supply air through fan operation.

.2 Casing construction

.1 Casing: 22 gauge galvanized steel up to 900 mm wide; 20 gauge minimum galvanized steel over 900 mm wide.

.2 Internal sound reduction baffle.

.3 Bottom access door with cam-lock fittings, for fan removal.

.4 Insulation Type 1: Fiberglass encapsulated in woven fabric liner, and wrapped edges.

.5 Insulation Type 2: Fiberglass with aluminum foil liner, galvanized steel perforated liner and metal cap edges.

.6 Insulation Type 3: Fiberglass encapsulated in woven fabric liner, and galvanized steel perforated liner, and metal cap edges.

.7 Insulation Type 4: Fiberglass with galvanized steel solid liner, and metal edge caps.

.8 Insulation Type 5: Fiberglass with galvanized steel perforated liner, with metal edge caps.

.3 Control elements

.1 Pressure independent type primary air regulator.

.2 Velocity sensor, cross tree type, with an accuracy within 5% with a ninety degree elbow connected at the inlet to the assembly.

.3 Damper: Heavy gauge metal, with edge gasket, and self-lubricating bearings and adjustable minimum stop.

.4 Single point electrical and control connection, in a single control box with access panel, sealed from the primary air section.

.5 Controls and damper actuator as specified below.

.4 Fan and motor assembly

.1 Forward curved, direct drive, statically and dynamically balanced centrifugal fan suspended on rubber in shear isolators.

.2 Electrically commutated motor, brushless DC design, with built-in inverter and microprocessor based motor controller, to maintain supply air volume independent of system static pressure, permanently lubricated ball bearings.

.3 Field manual adjustment of fan speed.

.4 4-20 mA or 0-10 VDC input for remote BMS fan speed reset.

.5 115 V, 1 phase, 60 Hz.

.5 Discharge section

.1 Open end or multiple outlet attenuator on box discharge acoustically treated with rigid acoustic insulation held in place with adhesive and pins.

.2 Open end secondary air inlet silencer acoustically treated with rigid acoustic insulation held in place with adhesive and pins.

.3 Reheat coils where scheduled, complete with access door in bottom of attenuator on inlet side of coil.

.6 Performance

.1 Maintain primary air quantity within ±5% of set value, between zero and specified rating.

.2 Radiated and discharge sound levels below values specified above when operating with maximum primary air, an inlet static pressure of 375 Pa (1.5” wg) and fan running on medium speed.

.4 Fan Powered Variable Air Volume Terminal Units - Low Noise, High Capacity (TUFQ)

.1 Type

.1 Variable volume primary air flow and constant volume supply air through fan operation.

.2 Acoustic performance

.1 Not to exceed the following radiated sound power levels at 250 Pa (1" w.c.) inlet pressure, and 60 Pa (0.25" w.c.) discharge pressure.

Airflow L/s	Sound Power Levels					
	2	3	4	5	6	7
425	62	56	46	39	37	36
570	64	59	47	42	40	39
750	68	62	51	45	43	42
940	68	63	53	48	44	43

.3 Casing Construction

.1 Casing: 20 gauge galvanized steel.

.2 Internal sound reduction baffle.

.3 Bottom access door with cam-lock fittings, for fan removal.

.4 Insulation Type 1: 50 mm thick fibreglass encapsulated in woven fabric liner, and wrapped edges.

.5 Insulation Type 2: Fiberglass with aluminum foil liner, galvanized steel perforated liner and metal cap edges.

.6 Insulation Type 3: Fiberglass encapsulated in woven fabric liner, and galvanized steel perforated liner, and metal cap edges.

.7 Insulation Type 4: Fiberglass with galvanized steel solid liner, and metal edge caps.

.8 Insulation Type 5: Fiberglass with galvanized steel perforated liner, with metal edge caps.

.4 Control elements

.1 Pressure independent type primary air regulator.

.2 Velocity sensor, cross tree type, with an accuracy within 5% with a ninety degree elbow connected at the inlet to the assembly.

.3 Damper: Heavy gauge metal, with edge gasket, and self-lubricating bearings and adjustable minimum stop.

.4 Controls and damper actuator as specified below.

.5 Fan and motor assembly

.1 Forward curved, direct drive, statically and dynamically balanced centrifugal fan suspended on rubber in shear isolators.

.2 Electrically commutated motor, brushless DC design, with built-in inverter and microprocessor based motor controller, to maintain supply air volume independent of system static pressure, permanently lubricated ball bearings.

.3 Field manual adjustment of fan speed.

.4 4-20 mA or 0-10 VDC input for remote BMS fan speed reset.

.5 115 V, 1 phase, 60 Hz.

.6 Discharge section

.1 Open end or multiple outlet attenuator on box discharge acoustically treated with rigid acoustic insulation held in place with adhesive and pins.

.2 Open end secondary air inlet silencer acoustically treated with rigid acoustic insulation held in place with adhesive and pins.

.3 Reheat coils where scheduled, complete with access door in bottom of attenuator on inlet side of coil.

.7 Return air section

.1 Acoustic return air section, to same construction as casing construction.

.8 Performance

.1 Maintain primary air quantity within ±5% of set value, between zero and specified rating.

.5 Reheat Coils

.1 Heating capacities: As shown in schedules

.2 Coil conditions:

.1 Entering air temperature: 18°C (65°F).

.3 Hot water coil construction

.1 Factory mounted.

.2 Serpentine, copper tube mechanically expanded into aluminum fins.

.3 Hydraulically pressure tested to 1550 kPa (225 psig).

.4 Galvanized steel coil casing.

.5 S-cleat flanges.

.6 Reheat coil positioned at downstream end of attenuator section.

.4 Electric reheat coils

.1 Factory mounted.

.2 CSA certified.

.3 Heater frame and cabinet: heavy gauge galvanized steel.

.4 Heating elements: 80/20 nickel-chromium wire, low density to limit hot spots and cycling of thermal protectors.

.5 Element insulation: Floating ceramic bushings.

.6 Primary protection: Automatic reset thermal cut-out.

.7 Secondary protection: Manual reset cut-out.

.8 Capacity control: Proportional pulsed output control using 4-20 mA, 0-10 VDC or pulsed input from thermostat or BMS system.

.9 Modulating control: Solid state switching with zero cross-over.

.10 Electronic air flow sensor to limit heater output dependant on volume of air supply.

.6 Controls

.1 Direct Digital Control (DDC)

.1 Provided by the terminal unit manufacturer.

.2 Dedicated microprocessor based controller, with integral damper actuator.

.3 Electronic flow transducer.

.4 Standalone operation, capable of interfacing with a Building Management System, and hand-held portable operator interface device.

.5 Actuator: 24 VDC bi-directional, direct coupled to the damper shaft.

.6 Factory wired, calibrated and pre-tested, for maximum and minimum air flows.

.7 Zone temperature sensor: Temperature setpoint adjustment, and access for connection of a hand-held operator terminal.

.7 Single Point Power Supply

.1 Provide single point power wiring for terminal units, at highest voltage and phases as shown on equipment schedules.

.2 Main control panel with power distribution:

.1 Fused primary/24 VAC secondary transformers for controls power, with internal disconnect switch.

.2 Fused primary/120 VAC secondary transformers for fan power, for fan powered terminal units, with internal disconnect switch.

.3 Fused disconnect switch for electric reheat coil.

.4 Clear Lexan plastic cover over live terminals on line-side of main disconnect switch.

.5 Note: electric heating coil control panel may be used as the main control panel.

.3 Provide power wiring to fan motor and DDC control unit.

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Install air terminal units with at least four duct diameters of straight duct upstream of inlet.

.2 Support terminal boxes from building structure with angles, hangers and supplementary steel before installation of piping and connecting ductwork.

.3 Connect supply and return piping to reheat coils with swing joints to allow for pipe expansion and contraction.

.4 Install isolating valve on supply and lock shield globe valve and automatic control valve on return of each reheat coil.

.5 Provide manual air vent with isolating cock at high point of piping to each coil.

.2 Electric and DDC Controls

.1 Provide 120 VAC and 24 VDC wiring, as required, from junction box provided under Division 26, near each terminal unit, and wire to terminal box fan and controls.

.3 Testing and Adjustment

.1 Adjust fan speed on fan powered terminal boxes to obtain final flow volumes, to minimize use of balancing dampers on downstream ductwork and diffusers.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

2 Products

2.1 **DIFFUSERS, REGISTERS AND GRILLES**

.1 General

.1 Neck size, dimensions and capacity as shown on Drawings. Catalogue numbers of first named Supplier are listed on Drawings to show required type and style.

.2 Acoustic and airflow performance is based on catalogued information of the indicated manufacturer and model as shown on Drawings or schedules. Other named manufacturer Products must match these implied performance criteria.

.3 Border and frame as required to suit wall and ceiling construction.

.2 Linear Diffusers and Grilles

.1 Extruded aluminum construction, unless otherwise shown on Drawings.

.2 Linear supply and return diffusers to have either natural anodized aluminum finish or baked enamel finish as listed on Drawings.

.3 Complete with engineered distribution plenum and internal opposed blade damper. Black finish on inside of plenums.

.4 Curved and custom shapes and finishes as detailed on Drawings.

.3 Square and Circular Pattern Diffusers

.1 Steel construction with baked white enamel finish, unless otherwise shown.

.2 True imperial or metric sizes.

.3 Radial opposed blade damper.

.4 Grilles

.1 Steel construction with baked white enamel finish, unless otherwise shown.

.2 Blade orientation parallel to the long dimension.

.3 Opposed blade damper in black finish.

.5 Door Grilles

.1 Door grilles will be supplied and installed by general trades.

.6 Acceptable Manufacturers:

.1 E.H. Price

.2 Nailor Industries Inc.

.3 Titus

.4 Carnes

.5 Tuttle & Bailey

3 Execution

3.1 **GENERAL**

.1 Supply diffusers and registers to deliver indicated air quantities shown with throw to reach intended space limits without increasing the sound level of room. Provide blank-off baffles where required and equalizing deflectors on diffusers and in other locations as shown or required.

.2 Coordinate placing of diffusers, registers and grilles in ceilings with electrical and ceiling installation trades and exact location to final approval of Consultant.

.3 For connection to specific light-air troffers in flat ceilings provide boots to connect flexible duct to lighting fixtures.

.4 For connection of air supply to coffered ceilings provide boots suitable for attachment to air slot on coffered ceilings as required and where shown on Drawings. Connect flexible supply air duct to neck of boot.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

2 Products

2.1 **ELECTRIC COOL/GAS HEAT ROOFTOP UNITS (1.5 TO 5 TONS)**

.1 General

.1 Roof mounted self-contained constant volume unit with DX refrigeration and gas burner. Unit shall bear CSA, CGA, and ULC labels.

.2 Completely factory assembled, piped, wired, tested and shipped to site in one piece. Units specifically designed for outdoor application.

.3 Ship units fully charged with refrigerant R410A.

.2 Construction

.1 Casing:

.1 Minimum 1 mm (20 gauge), zinc coated steel panels with backed enamel finish.

.2 Easily removable panels.

.3 Internally insulated cooling section panels with minimum 13 mm thick aluminum foil faced cleanable insulation.

.4 Unit casing with a sloped condensate pan.

.2 Fans:

.1 Double inlet type, forward curved, centrifugal type direct drive evaporator fan.

.2 Evaporator fan with steel construction and corrosion resistant finish.

.3 Propeller type, direct drive, aluminum blades condenser fan.

.4 Statically and dynamically balanced.

.3 Refrigeration system:

.1 Fully hermetic compressor with factory installed vibration isolation.

.2 Compressor safety controls including internal high pressure and overcurrent protection, short cycle protection, crankcase heater, and high/low pressure switches.

.3 Evaporator and condenser coils with aluminum plate fins mechanically bonded to seamless copper tubes.

.4 All interconnecting piping and accessories.

.4 Motors:

.1 Totally enclosed condenser fan motor.

.2 Refrigerant cooled compressor motor complete with line break thermal and overcurrent protection.

.3 Permanently lubricated evaporator motor with bearing and automatic reset thermal overload protection.

.5 Heating section:

.1 20 gauge, aluminized steel single stage heat exchanger.

.2 Direct spark ignition system.

.3 Aluminum coated steel burners.

.4 Induced draft combustion blower.

.5 All integrated controls.

.6 Provide gas pressure regulators in gas train to suit existing gas distribution pressure.

.6 Accessories:

.1 Factory mounted condenser coil guard.

.2 Single stage heat/cool thermostat with “Auto-On" fan and “Heat-Auto-Cool" system switching functions.

.3 Electronic seven-day programmable thermostat with setback and setup provisions.

.4 Prefabricated roof curb.

.5 Economizer with controls and relief damper.

.6 Manual outside air damper.

.7 25 mm thick fiberglass throwaway filters.

.8 Weatherproof factory-installed, externally accessible, 115 volt convenience outlet with independent fuse protection.

.7 Acceptable Manufacturers

.1 Johnson Controls

.2 Carrier

.3 Trane

.4 McQuay

.5 Lennox

2.2 ELECTRIC COOL/GAS HEAT ROOFTOP UNITS (7.5 TO 20 TONS)

.1 General

.1 Roof mounted self-contained constant volume unit with complete DX refrigeration system and gas burner.

.1 CSA, CGA, and ULC labels.

.2 Rated in accordance with ARI standards.

.3 Insulation and adhesives: To NFPA 90A requirements.

.2 Factory assembled, piped, wired, tested and shipped to site in one piece. Units specifically designed for outdoor application.

.3 Ship units fully charged with refrigerant R410A.

.2 Construction

.1 Casing:

.1 Minimum 1 mm (20 gauge), galvanized steel panels with backed enamel finish.

.2 Easily removable panels with gaskets.

.3 Internally insulated cooling section panels with minimum 13 mm thick, high density, neoprene coated, flexible fiberglass insulation.

.4 Internally insulated heating section compartment with high density, aluminum foil faced fiberglass insulation.

.5 Insulation to be permanently fastened to the cabinet interior.

.6 Heavy gauge, full perimeter base rail.

.7 Fully insulated sloped condensate pan.

.2 Evaporator fan:

.1 Steel, double inlet wheel with corrosion resistant finish.

.2 Belt driven, forward curved with adjustable-pitch motor pulley and adjustable base.

.3 Sealed and permanently lubricated bearings.

.4 Statically and dynamically balanced.

.3 Condenser fans:

.1 Aluminum blade, propeller type.

.2 Direct drive with totally enclosed, permanently lubricated ball bearings.

.3 Vertical or horizontal discharge.

.4 Statically and dynamically balanced.

.4 Refrigeration system:

.1 Two compressors with two independent refrigeration circuits and factory installed vibration isolation.

.2 Sequenced unloading and hot gas bypass system for each compressor.

.3 Compressor safety controls including internal high temperature and over current protection, short cycle protection, crankcase heater, and independent high/low pressure switches for each circuit.

.4 Evaporator and condenser coils with aluminum plate fins mechanically bonded to seamless copper tubes.

.5 All interconnecting piping and accessories.

.5 Motors:

.1 Totally enclosed condenser fan motors with thermal overload protection.

.2 Refrigerant cooled compressor motor complete with line break thermal and over current protection.

.3 Permanently lubricated evaporator motor with bearing and automatic reset thermal overload protection.

.6 Heating section:

.1 Indirect fired two-stage heating system.

.2 Twenty gauge, aluminized steel heat exchanger.

.3 Direct spark ignition system.

.4 Aluminum coated steel burners.

.5 Gas valve with internal pressure regulator.

.6 Induced draft combustion blower.

.7 High temperature limit switch.

.8 Flame proving control.

.9 Anti-cycle protection.

.10 Ventor motor speed sensor and flame rollout switch.

.11 Gas pressure regulators in gas train to suit existing gas distribution pressure.

.7 Roof curb:

.1 350 mm high curb constructed of galvanized steel and wood nailer.

.2 Duct support members and continuous gasket for weatherproof installation.

.8 Economizer:

.1 Factory or site installed.

.2 Fully modulating 0-100 percent with minimum position setting.

.3 Modulating dampers actuator of the spring return type.

.4 Capable of simultaneous operation with compressor.

.5 Barometric relief damper) or (power exhaust).

.6 All wiring and fixed dry bulb control.

.9 Filters:

.1 50 mm thick, fiberglass throwaway filters.

.10 Thermostats:

.1 Electronic seven-day programmable thermostat with setback and setup provisions.

.2 Lockable cover guard.

.11 Acceptable Manufacturers

.1 Johnson Controls

.2 McQuay

.3 Carrier

.4 Trane

2.3 ELECTRIC COOL/GAS HEAT ROOFTOP UNITS (25 TO 135 TONS)

.1 General

.1 Roof mounted self-contained unit with micro-processor based control system, two DX refrigeration systems, gas heating section, outside air system, return air system, filters, switches, supply air fan, return air fan, and all standard safety and operating controls.

.1 CSA, CGA, and ULC labels.

.2 Rated in accordance with ARI standards.

.3 Insulation and adhesives: to NFPA 90A requirements.

.2 Factory assembled, piped, wired, tested and shipped to site in one piece. Units specifically designed for outdoor application.

.3 Shipped fully charged with refrigerant R410A.

.4 Units shall be variable air volume.

.2 Construction

.1 Casing and frame:

.1 Fourteen gauge galvanized steel base with formed recess, lifting brackets and lifting holes.

.2 Seventeen gauge or heavier, galvanized steel panels painted with a baked-on enamel.

.3 Insulated cabinet with 25 mm neoprene coated glass fiber insulation secured to all panels with adhesive and mechanical fasteners.

.4 Floor with double wall construction and 50 mm neoprene coated fiberglass insulation sandwiched between inner and outer liners.

.5 Unit cabinet designed to operate at total static pressure up to 5.5" w.g.

.6 Hinged access doors with flush mounted, single lever latching mechanisms, stainless steel hinges and vinyl gasketting.

.7 Minimum one access door for each unit section.

.8 1.2 m long empty section between standard filter and supply fan sections to house variable speed drive.

.2 Supply and return fans:

.1 Double width double inlet.

.2 Centrifugal forward curved type or Class II airfoil type.

.3 Cold rolled steel or continuous galvanized steel forward curved wheel and housing.

.4 Aluminum airfoil fan wheel with blades continuously welded to back plate and end rim.

.5 Solid steel fan shaft mounted in heavy duty 200,000 hour greaseable ball bearings.

.6 Completely isolated fan assembly from unit bulkhead.

.7 Fan assembly mounted on 50 mm. Deflection spring isolators.

.8 High efficiency motors, open drip-proof type with greaseable ball bearings.

.9 Motors with variable pitch sheaves and mounted on adjustable base.

.10 Statically and dynamically balanced.

.3 Condensing section:

.1 Heavy duty compressors with reversible positive displacement oil pump, suction and discharge service valves, crankcase heaters and solid state thermal overload protection.

.2 Independent refrigeration circuit for each compressor.

.3 Spring isolators for each compressor.

.4 Pump down on all refrigerant circuits.

.5 Hot gas bypass with solenoid valve and hot gas bypass valve.

.4 Each refrigeration circuit:

.1 Sight glass and filter dryer.

.2 Vibration line isolators.

.3 Manual shut off valve.

.4 Spring type high pressure relief valve.

.5 Each compressor control:

.1 Liquid line solenoid valve.

.2 Oil pressure switch.

.3 High/low pressure switches.

.4 Compressor control circuit switch.

.5 Pumpdown switch.

.6 Adjustable timer lockout.

.7 Minimum stages of refrigeration system capacity control as follows:

Unit size (Tons)	Stages
25, 30, 35	100/66/33/0
40, 45, 50, 60	100/75/50/25/0
70, 75, 80, 90	100/83/67/50/33/10/0
105, 115, 125, 135	100/88/75/63/50/38/25/12/0

.8 Multi-row type condenser coil fabricated from seamless copper tubing mechanically bonded to aluminum fins.

.9 Direct drive, steel construction, propeller type condenser fans.

.10 Heavy duty condenser fan motors, inherently protected, three-phase non reversing type, with permanently lubricated ball bearings and rain shield.

.6 Cooling coil section:

.1 Multi-row type evaporator coil fabricated from seamless copper tubing mechanically bonded to aluminum fins.

.2 Adjustable thermal expansion valve per refrigeration circuit.

.3 Mastic coated primary drain pan extended underneath the coil connections.

.4 Secondary mastic coated drain pan connected to primary drain pan.

.7 Gas heating section:

.1 Welded stainless steel primary and secondary heat exchangers.

.2 Flame observation port opposite the burner.

.3 Condensate drain for the heat exchanger.

.4 Factory fired and tested burner suitable for final site adjustments.

.5 Fully modulating forced draft burner with minimum 3:1 turndown.

.6 Burner accessories to include flame supervision, combustion air proving switch, integral prepurge timing, intermittent pilot with spark ignition and a complete gas train.

.7 Complete gas train to include main gas valve, main pressure regulator, main shut off cock, pilot gas valve, pilot gas pressure, pilot cock, and electronic flame supervision.

.8 Burner and controls housing vestibule with hinged access door.

.9 Gas pressure regulators in gas train to suit existing gas distribution pressure.

.8 Filter section:

.1 Galvanized steel filter racks as an integral part of the unit.

.2 Accessible from both sides on unit.

.3 Refer to schedules on Drawings.

.9 Economizer and return air section:

.1 Outside, return, and exhaust air dampers sized to handle 100% outside air.

.2 Dampers of low leakage type with gasketted blade to blade contact and spring side seals.

.3 Adjustable potentiometer and adjustable enthalpy control.

.4 Modulating spring return type damper motor.

.10 Roof curb:

.1 Minimum 400 mm high manufactured by the unit manufacturer.

.2 Twelve gauge galvanized steel with 50 x 100 mm wood nailer.

.3 Suitable for complete air handling section support and condensing section rail support.

.4 Continuous gasket for weatherproof installation.

.3 Controls

.1 Variable speed drive control system:

.1 Factory wired, mounted and adjusted system.

.2 Heavy duty, reversible, electric type actuators with feedback capability.

.3 Microprocessor controlled system.

.4 Factory mounted high pressure switch with programmable pressure setpoint.

.5 Duct high limit safety switch.

.6 Remote static pressure sensor(s).

.2 Morning warm-up cycle:

.1 Fully controlled by the rooftop unit DDC controller.

.4 Unit Mounted DDC Controls

.1 Standalone DDC microprocessor based, bi-directional communicating control system to operate the cooling, heating, minimum outside air and economizer operation as shown on the control sequence.

.1 A thirty-two character display.

.2 Keypad access to all information and controls.

.3 Capability to accept a remote 4-20 mA signal for air temperature reset and demand limit.

.4 Fourteen day time clock.

.5 Current and past alarm storage capability.

.6 Night set back control.

.7 Adjustable override timer.

.8 A setback sensor (room sensor) with override button for field installation.

.2 Monitor the following conditions:

.1 Refrigerant high pressure.

.2 Loss of charge.

.3 Loss of air flow.

.4 Dirty filters.

.5 Minimum outside air.

.6 Furnace status.

.7 Compressor short cycle.

.8 Low pressure.

.9 High or low voltage.

.10 Air and refrigerant temperature.

.11 Phase loss or reversal.

.12 Supply and return fans VSD status.

.13 Duct static pressure.

.3 Unit controller communicates directly with building management system to monitor the following:

.1 Discharge and return temperature.

.2 Space and outside air temperature.

.3 Filter differential pressure.

.4 Fan, compressor run hours.

.5 Unit status.

.6 Outside air damper position.

.7 Mixed air temperature.

.8 Alarm status.

.9 Supply and return fans VSD status.

.10 Duct static pressure.

.4 Unit controller to permit change in setpoint or status of the following:

.1 Discharge air temperature setpoint and reset parameters.

.2 Minimum outdoor air setpoint.

.3 Occupied heat/cool setpoint.

.4 Control mode.

.5 Space temperature setpoint.

.6 Filter differential pressure setpoint.

.7 Unoccupied override.

.8 Unit status - start/stop/clear fault.

.9 Static pressure setpoints.

.10 VSD and fan tracking setpoints.

.5 Remote Monitoring Panel

.1 One panel per rooftop unit complete with:

.1 Heat-Off-Cool system switch.

.2 On-Off switch.

.3 Supply fan operation signal light.

.4 Cooling and heating malfunction signal lights.

.5 Clogged filters signal light

.6 Two additional indicating lights for field hook-up.

3 Execution

3.1 **INSTALLATION**

.1 Install rooftop units as per manufacturer's instructions on roof curbs provided by the manufacturer.

.2 Manufacturer to certify installation, supervise start-up and commission units.

.3 Install and wire all accessories shipped lose with units for fully operating systems.

End of Section

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1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **REFERENCE STANDARDS**

.1 Comply with the latest edition of the following:

.1 ANSI/ASHRAE/IESNA 90.1

.2 ANSI/ARI Standard 390

.3 CSA C22.2

1.3 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **SPLIT-SYSTEM HEAT PUMP UNIT**

.1 Capacity, performance requirements, and configuration shall be as scheduled and specified.

.2 Provide fully packaged and factory tested indoor evaporator unit complete with control system, DX refrigeration system, supply air fan, filters.

.3 Provide fully packaged and factory tested remote outdoor condensing unit complete with built-in starter, contactors, controls, transformers, and weatherproof disconnect switch.

.4 Compressor to be inverter.

.5 Ship units fully charged with refrigerant R410A.

.6 Interconnect indoor evaporator unit and outdoor condensing unit with liquid and suction refrigerant lines. Refrigerant lines shall be insulated with cellular elastomer.

.7 Provide wired controller. Controller to be interlocked with electric heater where indicated on Drawings.

.8 Provide low (-20°C) ambient operation kit.

.9 Auto restart after power failure.

.10 Acceptable Manufacturers

.1 Mitsubishi

.2 Daikin

3 Execution

3.1 **GENERAL**

.1 Install unit and accessories as per manufacturer's instructions.

.2 Manufacturer to certify installation, and start-up and commission units.

.3 Install miscellaneous steel framing, supports, braces, etc. as required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.

.4 Install and wire all accessories shipped lose with units for fully operating systems.

End of Section

1 General

1.1 **REFERENCES**

.1 CSA, Canadian Standards Association.

.2 ULC, Underwriters' Laboratories of Canada.

1.2 **SUBMITTALS**

.1 Submit the following Product data and Shop Drawings in one package.

.1 Product Data:

.1 Submit copies of manufacturer's product data in accordance with Section 01 33 00 Submittal Procedures, indicating:

.1 Product characteristics.

.2 Performance criteria, minimum operating air flow.

.3 Mounting methods, unit support.

.4 Physical size.

.5 KW rating, voltage, phase.

.6 Cabinet material thicknesses.

.7 Limitations, clearance to combustibles.

.8 Colour and finish.

.2 Shop Drawings:

.1 Submit Shop Drawings in accordance with Section 01 33 00 Submittal Procedures, indicating:

.1 Equipment, capacity and piping connections.

.2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

.3 Commissioning

.1 Submit Commissioning Plan, Commissioning Procedures, Certificate of Readiness, Deficiency Report and Commissioning Closeout Report, in accordance with Division 23.

.2 Submit design data and test reports.

.3 Submit inspection and test reports.

.4 Closeout Submittals

.1 Submit the following for incorporation into Operation and Maintenance Manuals in accordance with Section 01 33 00 Submittal Procedures.

.1 Identification: Manufacturer name, type, year, serial number, number of units, and capacity.

.2 Functional description detailing operation and control.

.3 Performance criteria and maintenance data.

.4 Operating instructions and precautions.

.5 Component parts availability including names and addresses of spare part Suppliers.

.6 Lubrication schedule, maintenance and troubleshooting guidelines.

.2 Manufacturer's installation instructions for the following items:

.1 Force flow heater.

.3 Submit As-Built Drawings in accordance with Section 01 33 00 Submittal Procedures.

2 Products

2.1 **ELECTRIC FORCED AIR HEATER (FAH)**

.1 Manufacturers:

.1 Ouellet

.2 Chromalox (Dimplex)

.3 Stelpro

.2 Construction: 0.8 mm thick steel (20 ga) removable and tamperproof panel, glass fibre insulation and integral air outlet and inlet.

.3 Finish: Polyester epoxy powder coat, white.

.4 Electric coils: durable tubular heating element with fins.

.5 Fans: statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted,

.6 Motor: Totally enclosed type with permanently lubricated bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.7 Capacity: As per Drawing.

.8 Built-in disconnect switch.

.9 Controls

.1 On-off switch with integral overloads in cabinet.

.2 Remote wall-mounted thermostat.

.3 120 V control circuit with magnetic contactor and transformer.

.4 High temperature limit switch.

.10 Units must be UL and CSA approved.

2.2 **ELECTRIC UNIT HEATER**

.1 Manufacturers:

.1 Ouellet Model OAS

.2 Chromalox (Dimplex)

.3 Stelpro

.2 Construction: 18 gauge steel cabinet with threaded connections for hanger rods.

.3 Finish: Epoxy powder coat, white.

.4 Heating coil: Low surface temperature, seamless copper sheathed tubular elements, low-watt density.

.5 Fan: Propeller type, dynamically and statically balanced, epoxy coated aluminum construction and fan guard.

.6 Motor: Totally enclosed type with permanently lubricated bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.7 Air outlet: Two-way adjustable louvres.

.8 Capacity: As per Drawing schedule.

.9 Built-in disconnect switch.

.10 Controls

.1 Remote wall-mounted thermostat.

.2 120 V control circuit with magnetic contactor and transformer.

.3 High temperature limit switch.

.11 Units must be UL and CSA approved

3 Execution

3.1 **EXAMINATION**

.1 Review proposed locations on-site and co-ordinate installation requirements with general trades, architectural finishes and power requirements.

3.2 **INSTALLATION**

.1 Install in accordance with manufacturer's instructions.

.2 Check final location with Consultant if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Consultant's direction.

.3 Clean finned tubes and comb straight.

.4 Provide supplementary suspension steel as required.

.5 Install thermostats in locations indicated.

.6 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.3 **COMMISSIONING**

.1 Perform Commissioning in accordance with Section 23 08 23 Mechanical Commissioning.

.2 Verify operational performance in general conformance with the following outline:

.1 Operational performance outline:

.1 Thermostat operation.

.2 Element response.

.3 Fan operation.

.4 Disconnect.

.5 Other unit control features/devices.

.2 Functional performance outline:

.3 Interlocks with associated equipment.

.4 Interface with adjacent building components.

3.4 **PROTECTION**

.1 Protect from damage during construction. Do not operate during construction or until unit and area thoroughly cleaned and inspected.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section including, but not limited to, the following:

.1 Radiant ceiling panels

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Operation and Maintenance Data:

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 33 00.

2 Products

2.1 **RADIANT CEILING PANELS**

.1 General

.1 Extruded aluminum radiant heating ceiling panels of the size and output shown on Drawings. Refer to architectural reflected ceiling plans, room finish schedules, and Mechanical Drawings to determine location, quantity, and finish of radiant panels.

.2 Panel to run continuously from wall to wall as shown on Drawings.

.3 Output based on a mean water temperature of 82°C (180°F) and room temperature of 21°C (70°F)

.2 Construction

.1 Tube saddles integral part of extruded panels.

.2 0.625 mm OD copper tubing mechanically fastened to panel. Apply non-hardening heat transfer paste between tubing and panel.

.3 Panels interlock with tongue and groove connection without visible joints and reinforced with aluminum cross channels. All panel section interlocking preformed at the factory with return bends installed and pressure tested. Field connections limited to connections to mains and connections to adjacent panel.

.4 Finish panels in white high emissivity paint suitable for repainting to colour specified later, or silkscreen finish to match adjacent acoustic tile ceiling.

.3 Accessories

.1 Provide built in linear diffuser over the entire length of the panel. Refer to HVAC floor plans for diffuser details. Diffuser and supply air boot by same manufacturer.

.4 Acceptable Manufacturers

.1 Airtex Radiant Systems (Engineered Air)

.2 Twa Panel Systems (R&D Energy Savers)

.3 Rosemex (Kilmer Environmental Inc.)

3 Execution

3.1 **PANELS**

.1 Install units as per manufacturer's instructions and as shown on Drawings.

.2 Install accessories shipped lose with units for fully operating systems.

3.2 **RADIANT CEILING PANELS**

.1 Coordinate with Division 9 and Ceiling Contractor to assure proper division of Work. Support panels on moldings to match ceiling finish and supports.

.2 Install hanger supports for safety independent of the ceiling support system. Follow manufacturers' recommendations for size and quantity of hangers except provide a minimum of four wire supports per panel.

.3 Install miscellaneous steel framing, supports, braces, etc. as required to hang or support equipment as specified herein, and as shown on Drawings.

.4 Field trim panels to length where necessary to provide a continuous wall to wall appearance. Allow adequate expansion allowance.

.5 Connect panels with manufacturer supplied copper pigtail connections.

.6 Clean flush and pressure test system as specified elsewhere in Division 23 Specifications.

.7 Install minimum 25 mm thick fiberglass insulation on top of radiant panels, with aluminum foil facing faced down to radiant panel.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the Work of this section.

1.2 **SUBMITTALS**

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

2 Products

2.1 **SELF GENERATING ELECTRIC TYPE STEAM HUMIDIFIERS**

.1 General

.1 Self-contained, electronically controlled, complete with all controls and distribution headers suitable for the specified application.

.1 ULC and CSA approved.

.2 Refer to schedule on Drawings for performance.

.2 Electric Pan Type

.1 Construction:

.1 Stainless steel vaporizing chamber with removable cover and gasket.

.2 Immersion type alloy sheathed heaters.

.3 Factory mounted and wired manual reset temperature switch.

.4 Factory mounted and wired door interlock safety switch.

.5 Electronic water level control with automatic refill, low water cut-off and bleed off functions.

.6 Clean out tray.

.7 Surface water skimmer system.

.8 Three levels of heater protection.

.9 Factory mounted control cabinet including microprocessor controller, contacts, control circuit, transformer and fuses.

.10 Electronic water level control complete with solenoid operated automatic refill, low water cut-off and skimmer bleed off functions.

.2 Controls:

.1 Fully modulating control 0 to 100% capacity.

.2 Duct mounted air proving switch.

.3 Duct high limit humidistat.

.4 Modulating duct mounted humidistat.

.3 Unit mounted microprocessor based control panel with the following features:

.1 Software self-diagnosis.

.2 Water level control.

.3 Timer operated drain/flush sequence.

.4 End of season drain down.

.5 Four position manual override.

.6 Multiple heater cycling.

.7 Connection terminals for remote fault indication.

.8 Field adaptable humidistat input signal.

.9 Fully modulating steam output control.

.4 Acceptable Manufacturers:

.1 DriSteam

.2 Armstrong

.3 Electrode Type

.1 Construction:

.1 Two independent compartments with front access doors.

.2 Disposable cylinder type.

.3 Independent control circuit and safety for each cylinder.

.4 Manual output adjustments (20 to 100%).

.5 Auto adaptive control.

.6 Full front access.

.7 Alphanumeric LCD display and keypad.

.8 Self diagnostics control.

.9 Solenoid control of supply and drain water.

.10 Automatic off season shut down.

.11 Steam distributor with condensate separator and return leg.

.12 Fill cup with internal 25 mm air gap.

.2 Controls:

.1 Fully modulating control 0 to 100% capacity.

.2 Wall mounted electronic humidistat with locking cover, concealed adjustment and locking stops.

.3 Duct mounted air flow proving switch.

.4 Modulating duct mounted high limit control.

.3 Acceptable Manufacturers:

.1 Nortec

.2 Carnes

.4 Element Type

.1 Construction:

.1 Two independent compartments with hinged lockable doors.

.2 14 gauge aluminum casing with backed enamel finish.

.3 Easily removable stainless steel cleanable evaporation container.

.4 Electric heating immersion element.

.5 Level control.

.6 Internal electronic temperature sensor.

.7 External bimetallic temperature sensor.

.8 Water supply solenoid valve.

.9 Port motorized drain line ball valve with adjustable timer.

.10 Electronic level sensing assembly.

.11 Manual reset high temperature safety cut-out switch.

.12 Quick disconnect safety overflow connection and drain port.

.13 Electrical wiring quick connectors.

.14 Stainless steel steam distributor suitable for the application and complete with condensate separator and return leg.

.2 Micro-Processor Controller:

.1 Unit mounted microprocessor controller with alphanumeric display of the actual steam output, water level, and special diagnostics parameters such as abnormal operation, time delays, etc.

.2 Percent relative humidity.

.3 Set point.

.4 Frequency of drain cycles.

.5 Output span control.

.6 Number of actual service hours.

.3 Controls:

.1 Field adjustable fully modulating control to provide 0 to 100% capacity.

.2 Wall mounted electronic humidistat.

.3 High limit humidistat.

.4 Pressure differential switch.

.5 Field adjustable fully modulating control to provide 0 to 100% capacity.

.6 Wall mounted electronic humidistat.

.7 Duct mounted proportional high limit humidistat.

.8 Pressure differential switch.

.4 Acceptable Manufacturers

.1 Neptronic

.2 DriSteam

.3 Pure Steam

.4 Armstrong

3 Execution

3.1 **INSTALLATION**

.1 General

.1 Install humidifiers in accordance with manufacturer's instructions.

.2 Manufacturer to certify installation, supervise start-up and commission units.

.3 Install and wire all accessories shipped lose with units for fully operating systems.

.2 Self Generating Electric Type

.1 Connect cold water make-up line to solenoid valve and provide drain piping as per manufacturer's instruction. Run drain piping to nearest drain.

.2 Install steam piping between generator and steam distributor using schedule 40 black steel with malleable iron screwed fittings.

.3 Install condensate piping from pan and generator using type L hard drawn copper with copper solder joint fittings.

.3 Injection Type Humidifiers

.1 Install steam trap, strainer, control valve, piping and internal steam distributor support for each humidifier.

End of Section

1 General

1.1 **SUMMARY**

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the work of this section.

.2 Section includes, but is not necessarily limited to, the following:

.1 Wire or pipe remote instrumentation required to operate package systems supplied by others. Modulating thermostats for these systems must match the system component characteristics.

.2 Supply, install and connect all control wiring for the systems described.

.3 Control wiring of components for systems listed herein requiring 120V or less. Included are such items as remotely mounted interlocks, sensors, 120V supply to refrigerated air dryers, seven day timers, etc.

.3 Coordinate the work of this Division with other trades to obtain their electrical input for the electrical control schematics.

.4 Advise and coordinate this Work with all associated trades and balancing technicians.

.2 Intent

.1 It is the Owner's intent to expand the existing BAS network to accommodate the new HVAC equipment and other specified controlled or monitored points.

.2 The new Work associated with this Project shall seamlessly integrate to the existing BAS, maintaining all existing controls, system operations and control strategies. Update and upgrade the existing web servers (hardware and software) to include new system graphics and floor plans to conform to the new system and floor plan layouts.

.3 The new Work of this Project shall reside on the existing high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. Operators shall be able to perform all normal operator functions through the web browser interface from any operator terminal.

.4 The system shall directly control HVAC equipment as specified in this Section as well as integrate to mechanical and electrical systems using the open BACnet communication protocol.

.5 Provide energy conservation features such as optimal start and stop, night setback, request-based logic, and demand level adjustment of setpoints as specified.

.6 Dynamic colour graphics shall be provided as specified in this Section, including indication of thermal comfort on floor plan summary graphics using dynamic colours to represent zone temperature relative in zone setpoint and zone (7 colour levels).

.7 To ensure interoperability with all systems building automation system shall be 100% native-BACnet (at all levels) as specifically detailed by this Section.

System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules. Schedules, setpoints, trends and alarms specified in this Section shall be BACnet objects.

1.2 **CODES, REGULATIONS AND STANDARDS**

.1 Comply with municipal or provincial codes, rules and regulations and/or authorities having jurisdiction.

.2 Comply with the National Building Code in areas where municipal or provincial regulations and/or codes are not mandatory.

.3 All Work shall conform to the following Codes and Standards, as applicable:

.1 National Fire Protection Association (NFPA) Standards

.2 Ontario Electric Safety Code

.3 National Electrical Code

.4 Underwriters Laboratories Canada (ULC) listing and labels.

.5 UL 916 Energy Management

.6 NFPA 90A – Standard for the Installation of Air Conditioning and Ventilation Systems

.7 ASHRAE 90.1

.8 Occupational Health and Safety Act (OHSA)

.9 Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.

.10 ASHRAE 195 (BACnet)

.4 In the case of conflicts or discrepancies, the more stringent regulation shall apply.

.5 All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.3 **MATERIAL APPROVALS**

.1 Obtain special inspection and approvals by CSA and/or local authorities, for materials where specified.

.2 Obtain such approval for the particular installation with the cooperation of the material supplier.

1.4 **PERMITS AND INSPECTIONS**

.1 Obtain permits required for the installation of mechanical trades work including:

.1 Electrical inspection

.2 Arrange for inspections and tests and pay all fees and costs for the permits, inspections and tests. Obtain permits immediately after notification of award of Contract.

.1 Obtain copies of Drawings from the Consultant for submission with application for permits.

1.5 **RELATED WORK**

.1 The following equipment will be supplied and installed under other sections or divisions.

.1 Manual balancing dampers, fire dampers, combination fire and smoke dampers, and gravity dampers: Division 23.

.2 Automatic control dampers supplied as an integral part of equipment. E.g. mixing box dampers and face and bypass dampers unless otherwise noted: Division 21, 22, 23 and 26.

.3 Direct expansion cooling valves: Division 23.

.4 Refrigerant solenoid valves: Division 23.

.5 Multizone dampers unless otherwise noted: Division 23.

1.6 **ITEMS TO BE SUPPLIED UNDER THIS SECTION AND INSTALLED UNDER OTHER SECTIONS**

.1 Supply the following equipment to the appropriate mechanical trades for installation in accordance with instructions from, and under the supervision of, the Automatic Controls Subcontractor:

.1 Motorized dampers.

.2 Variable volume terminal unit operators. (These operators will be installed on the terminal units by the terminal unit Supplier)

1.7 **WORK UNDER OTHER CONTRACTS OR DIVISIONS**

.1 The following equipment will be supplied and installed by other trades or Contractors:

.1 Door limit switches for automatic temperature controls.

.2 Electrical items of work as defined hereinafter

.3 All line/load side power wiring.

.4 Combination starters or contractors complete with integral pushbuttons, Hand-Off-Auto switches, etc. unless otherwise specified.

.5 All controls and wiring for:

.1 Fire alarm control system

1.8 **PRODUCT AVAILABILITY**

.1 Product Development

.1 All Products to be new, currently under manufacture, and have been applied in similar installations for a minimum of two years.

.2 The installation shall not be used as a test site for new Products unless explicitly approved by the Owner's Representative in writing prior to bid date.

.2 Spare Parts

.1 Spare parts to be available for at least five years after completion of this Contract.

1.9 **COORDINATION AND EXAMINATION**

.1 Examination

.1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences.

.2 Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.

.2 Coordination

.1 Coordinate Work of this division such that items will properly interface with Work of other divisions. Prepare Installation Drawings of critical locations and submit to Consultant for review.

.2 Architectural Drawings, or in their absence, Mechanical Drawings govern all locations.

1.10 **SUBMITTALS**

.1 Shop Drawings, Product Data and Samples

.1 The BMS contractor shall submit a list of all Shop Drawings with submittal dates within 30 days of Contract award.

.2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

.3 Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

.4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS correspondence and permits to the Owner.

.5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a Shop Drawing identification number, Contract Documents reference and item description.

.6 The BMS Contractor shall correct any errors or omissions noted in the first review.

.7 At a minimum, submit the following:

.1 BMS network architecture diagrams including all nodes and interconnections;

.2 Systems schematics, sequences and flow diagrams;

.3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type and Address;

.4 Samples of Graphic Display screen types and associated menus;

.5 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions and optional features;

.6 Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting and Actuator Type;

.7 Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address;

.8 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure and Actuator Type;

.9 Details of all BMS interfaces and connections to the work of other trades; and

.10 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

.2 Record Documentation

.1 Operation and Maintenance Manuals

.1 Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:

.1 Table of contents;

.2 As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal;

.3 Manufacturer's product data sheets or catalog pages for all products including software;

.4 System Operator's manuals;

.5 Archive copy of all site-specific databases and sequences;

.6 BMS network diagrams; and

.7 Interfaces to all third-party products and work by other trades.

.2 The Operation and Maintenance Manual CD shall be self-contained and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom and search all documents.

1.11 **TRADE QUALIFICATIONS**

.1 Applicable to the following trades:

.1 Electricians.

.2 Requirements

.1 Trade workers to have a certificate of qualification as journeyman or apprentice registration for the province where the Work is performed, or an interprovincial certificate.

.2 Ratio of journeyman to apprentice: Note to exceed the defined ratio in the Apprenticeship Act of Ontario.

.3 Certificates and registration must be provided to the Consultant on request.

.4 Maintain on-site an up-to-date record listing journeyman and apprentices working on site.

.5 Electricians to be part of IBEW. Electricians not part of IBEW need to submit reference letter with minimum 3 references at least 48 hours in advance of tender closing.

1.12 **PRODUCT DELIVERY, STORAGE AND HANDLING**

.1 Seal instruments after manufacture and inspection and remain sealed until ready for installation.

.2 Handle instruments and equipment carefully handled and protect from weather, dust and construction materials.

2 Products

2.1 **MATERIALS AND EQUIPMENT**

.1 Use new materials and equipment, free from defects impairing strength and durability, as specified or specified equivalent.

.2 Manufactured in Canada wherever possible.

.3 Labelled or listed as required by code and/or inspection authorities.

2.2 **STANDARD SPECIFICATIONS**

.1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all Products provided comply with the latest issue of applicable standard Specifications issued by authorities having jurisdiction.

.2 Do not apply such standard Specifications to decrease the quality of workmanship, Products and services required by the Contract Documents.

2.3 **BMS GENERAL SYSTEM PERFORMANCE REQUIREMENTS**

.1 Suppliers/Installers

.1 Supplied and installed by a Control Subcontractor specializing in such work. AS far as practical, all control equipment to be the products of a single manufacturer.

.2 Bids by Wholesalers, Contractors, Franchised Dealers or any firm whose principal business is not that of manufacturing and installing automatic temperature control systems shall not be acceptable.

.3 Single source responsibility of supplier shall be the complete installation and proper operation of the (BMS and) control system, including commissioning and proper calibration of each component in the entire system.

.4 An in-place support facility within 50 kilometers of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

.5 Standard of Acceptance:

.1 Johnson Controls

.2 Honeywell

.3 Automated Logic

.2 General Description

.1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

.2 The Building Management System shall consist of the following:

.1 Standalone Network Automation Engine(s)

.2 Field Equipment Controller(s)

.3 Input/Output Module(s)

.4 Local Display Device(s)

.5 Portable Operator's Terminal(s)

.6 Distributed User Interface(s)

.7 Network processing, data storage and communications equipment

.8 Other components required for a complete and working BMS

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

.4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

.1 The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.2 The System shall maintain all settings and overrides through a system reboot.

.5 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

.3 BMS Architecture

.1 Automation Network

.1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

.2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

.3 All BMS devices on the automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

.4 Network Automation Engines (NAE) shall reside on the automation network.

.5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.2 Control Network

.1 Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support at the minimum both of the following communication protocols:

.1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9

.1 The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

.2 LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).

.2 Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

.3 DDC Controllers shall reside on the control network.

.4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

.5 A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.6 The PICS shall be submitted 10 days prior to bidding.

.3 Integration

.1 Hardwired

.1 Analog and digital signal values shall be passed from one system to another via hardwired connections.

.2 There shall be one separate physical point on each system for each point to be integrated between the systems.

.2 Direct Protocol (Integrator Panel)

.1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems.

.2 All data required by the application shall be mapped into the Network Automation Engine's database, and shall be transparent to the operator.

.3 Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

.3 BACnet Protocol Integration – BACnet

.1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135.

.2 A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

.3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

.4 User Interface

.1 Dedicated Web Based User Interface

.1 All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.

.2 Dedicated User Interface Architecture: The architecture shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.

.1 Microsoft Internet Explorer or other web browser for user interface functions

.2 Microsoft Office Professional or equal for creation, modification and maintenance of reports, sequences other necessary building management functions.

.3 Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events and reports.

.4 Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

.3 Operating System Software

.1 Windows 10

.2 Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.

.3 Provide software registration cards to the Owner for all included software.

.2 Distributed Web Based User Interface

.1 All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.

.2 The software shall run on the Microsoft Internet Explorer (6.0 or higher) or other web browser supporting the following functions:

.1 Configuration

.2 Commissioning

.3 Data Archiving

.4 Monitoring

.5 Commanding

.6 System Diagnostics

.3 Minimum hardware requirements:

.1 1GB RAM

.2 2.0 GHz Clock Speed Pentium 4 Microprocessor

.3 100 GB hard drive

.4 1 keyboard with 83 keys (minimum)

.5 SVGA 1024x768 resolution display with 64K colours and 16 bit colour depth

.6 Mouse or other pointing device

.3 Site Management User Interface Application Components

.1 Operator Interface

.1 An integrated browser based client application shall be used as the user operator interface program.

.2 The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.

.3 All Inputs, Outputs, Setpoints, and all other parameters as defined within this section, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

.4 The user interface software shall provide help menus and instructions for each operation and/or application.

.5 The system shall support customization of the UI configuration and a home page display for each operator.

.6 The system shall support user preferences in the following screen presentations:

.1 Alarm

.2 Trend

.3 Display

.4 Applications

.7 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

.8 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

.1 User access for selective information retrieval and control command execution

.2 Monitoring and reporting

.3 Alarm, non-normal, and return to normal condition annunciation

.4 Selective operator override and other control actions

.5 Information archiving, manipulation, formatting, display and reporting

.6 BMS internal performance supervision and diagnostics

.7 On-line access to user HELP menus

.8 On-line access to current BMS as-built records and documentation

.9 Means for the controlled re-programming, re-configuration of BMS operation and for the manipulation of BMS database information in compliance with the prevailing codes, approvals and regulations for individual BMS applications

.9 The system shall support a list of application programs configured by the users that are called up by the following means:

.1 The Tools Menu

.2 Hyperlinks within the graphics displays

.3 Key sequences

.10 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

.2 Navigation Trees

.1 The system shall have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

.2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

.3 The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar. A simple keystroke will reattach the navigation to the primary display of the user interface.

.3 Alarms

.1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

.1 Log date and time of alarm occurrence.

.2 Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.

.3 Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

.4 Provide the ability to direct alarms to an e-mail address, phone number or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

.5 Configuration of which NAE offline alarms are seen by each user

.6 Any attribute of any object in the system may be designated to report an alarm.

.2 The BMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.

.3 The BMS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.

.4 The BMS shall annunciate application alarms at minimum, as required by Specifications and Drawings.

.4 Reports and Summaries

.1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

.1 All points in the BMS

.2 All points in each BMS application

.3 All points in a specific controller

.4 All points in a user-defined group of points

.5 All points currently in alarm

.6 All points locked out

.7 All user defined and adjustable variables, schedules, interlocks and the like.

.2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

.3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on

the system printer for use as a building management and diagnostics tool.

.4 Provide the capability to view, command and modify large quantities of similar data in tailored summaries created online without the use of a secondary application like a spreadsheet. Summary definition shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported. Summary viewing shall be available over the network using a standard Web browser.

.5 Reports shall be selectable by date, time, area and device. Each report shall include a color visual summary of essential energy information.

.5 Schedules

.1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

.1 Weekly schedules

.2 Exception Schedules

.3 Monthly calendars

.2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

.3 It shall be possible to define one or more exception schedules for each schedule including references to calendars.

.4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

.5 Changes to schedules made from the User Interface shall directly modify the network automation engine schedule database.

.6 Schedules and calendars shall comply with ASHRAE Standard 135 BACnet Standard.

.7 The calendar object supports an option to add a reference to another calendar object that is designated to be the master for the facility. Any Supervisory and BAC calendars can be configured to reference a single master global calendar. Changes to the master global

calendar are automatically synced with all calendars that are referenced.

.8 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

.9 Software shall be provided to configure and implement optimal start and stop programming based on existing indoor and outdoor environmental conditions as well as equipment operating history.

.10 The system solar clock shall support the scheduling and energy management functions. The solar clock will calculate the sunrise, sunset, and sun angle values for a specified latitude and longitude. A time offset can also be specified. An example would be to use the solar clock object as a master to an interlock to turn lights on 30 minutes after sunset and off 30 minutes before sunrise.

.6 Security/Passwords

.1 Multiple-level passwords access protection shall be provided via roles and permissions. The feature will allow the system to base access on a user's job title or role and allow the user/manager access interface control, display, and database manipulation capabilities based on an assigned password.

.2 Roles may be copied and altered to meet specific roles and permissions based on the particular policies.

.3 Each user shall have the following: A user account name, a complex password or passphrase, other user account policies (such as session timeout), timesheet access based on day of the week and time of day, and specific user view.

.4 The system shall allow each user to change his or her password at will.

.5 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

.6 A maximum of 150 categories may be used to determine or assign areas of responsibilities to each user account. A maximum of 13 (of the 150) named categories which are specifics such as "No Access, View, Advanced Review, Operate, Intervene, Diagnostic, Manage Item Events, Manage Every, and Configure Items".

.7 A minimum of 100 unique passwords shall be supported.

.8 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items

defined for the access level of the password used to log-on.

.9 Operators shall be further limited to only access, command, and modify those buildings, systems, and subsystems for which they have responsibility. Provide a minimum of 100 categories of systems to which individual operators may be assigned.

.10 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

.11 After successful login to the Site Management Portal (SMP) the last time and date that user name was previously logged in is shown on the screen.

.12 Each login attempt is recorded in the system Audit Log with the option to record the IP address of the PC that made the login.

.7 Screen Manager

.1 The system shall allow a customized image on the login screen (i.e. organization name, logo).

.2 User View navigations can be displayed as either a set of tabs or a drop down list.

.3 Allows user preference for assigning of a background color for when an object is Out of Service which will enable the operator to quickly distinguish points that have been commanded to this state.

.4 The user interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

.8 Dynamic Color Graphics

.1 The graphics application program shall be supplied as an integral part of the user interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

.2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed. The graphics shall be able to display and

provide animation based on real-time data that is acquired, derived, or entered.

.3 Graphics runtime functions: A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:

.1 All graphics shall be fully scalable

.2 The graphics shall support a maintained aspect ratio.

.3 Multiple fonts shall be supported.

.4 Unique background shall be assignable on a per graphic basis.

.5 The color of all animations and values on displays shall indicate the status of the object attribute.

.6 Graphics that represent buildings or systems shall allow natural links and transitions between related detailed tabular views of data that compliment the graphic.

.4 Operation from graphics: It shall be possible to change values (setpoints) and states in system controlled equipment directly from the graphic.

.5 Floor Plan graphics: The user interface shall provide graphic applications that summarize conditions on a floor. Floor plan graphics shall indicate thermal comfort using dynamic colors to represent zone temperature deviations from zone setpoint(s). Floor plan graphics shall display overall metrics for each zone in the floor.

.6 Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

.7 Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

.1 The graphic editing tool shall provide a library of standard HVAC equipment, floor plan, lighting, security and network symbols.

.2 The graphic editing tool shall provide for the creation and positioning of library symbols by dragging from tool bars or drop-downs and positioning where required.

.3 The graphics editing tool shall permit the importing of AutoCAD drawings for use in the system.

.4 The graphic editing tool shall be able to add additional content to any graphic by importing images in the SVG, PNG or JPG file formats.

.9 Historical trending and data collection

.1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

.1 Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:

1. Defined time interval
2. Upon a change of value

.2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

.2 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

.3 The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in SQL database format.

.4 The system shall provide data to enable optimization capabilities including fault detection and diagnostics, advanced analytics and central plant optimization without the need of a gateway or additional hardware.

.10 Trend data viewing and analysis

.1 Provide a trend viewing utility that shall have access to all database points.

.2 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.

.3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends.

.4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.

.5 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.

.6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

.7 The Display shall support the user's ability to change colors, sample sizes, and types of markers.

.11 Database Management

.1 Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.

.2 Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.

.3 The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

.1 Backup

.2 Purge

.3 Restore

.4 The Database Manager shall support four tabs:

.1 Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.

.2 Maintenance – shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database,

and allowing for the retention of a selected number of day's data.

.3 Backup – Shall provide the means to create a database backup file and select a storage location.

.4 Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.

.5 The Status Bar shall appear at the bottom of all Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:

.1 Ready

.2 Purging Record from a database

.3 Action Failed

.4 Refreshing Statistics

.5 Restoring database

.6 Shrinking a database

.7 Backing up a database

.8 Resetting internet information Services

.9 Starting the Device Manager

.10 Shutting down the Device Manager

.11 Action successful

.6 The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.

.7 The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

.8 The Monitoring Settings window shall have the following sections:

.1 General – Shall allow the user to set and review scan intervals and start times.

.2 Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.

.3 Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.

.4 Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.

.5 Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.

.9 The Monitoring Settings Taskbar shall provide the following informational icons:

.1 Normal – Indicates by color and size that all databases are within their limits.

.2 Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.

.3 Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.

.10 The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

.12 Demand Limiting and Load Rolling

.1 The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.

.2 The System shall support both Sliding Window and Fixed Window methods of predicting demand.

.3 The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.

.1 Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.

.2 Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.

.3 High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.

.4 The System shall have both a Shed Mode and a Monitor Only Mode of operation.

.1 When the Shed Mode is engaged, the System shall actively control the Demand.

.2 When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.

.5 The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.

.6 The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.

.7 The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.

.8 The System shall support a Maximum Shed Time for each load as determined by the user. The system shall restore the load before the Maximum Shed time has expired.

.9 The System shall support a Minimum Shed Time for each load as determined by the user. The system shall not restore the load sooner than the Minimum Shed Time has expired.

.10 The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.

.11 The System shall support three user defined options if the meter goes unreliable.

.1 Shedding – The currently shed loads will be released as their Maximum shed Times expire.

.2 Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.

.3 Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.

.12 The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.

.13 The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.

.14 The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.

.15 The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.

.16 The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:

.1 Load is Offline

.2 Load is Disabled

.3 Load is Shed

.4 Load is Locked

.5 Load is in Comfort Override

.17 The Load Summary shall include a Load Summary Runtime view listing the following load conditions:

.1 Load Priority

.2 Shed Strategy

.3 Load Rating

.4 Present Value

.5 Ineligibility Status

.6 Active Timer

.7 Time Remaining

.8 Last Shed Time

.4 System User Interface

.1 BMS Contractor shall provide and install all computer hardware and software required for the purpose of configuration and consolidation of information and programs required for the delivery of a Task Focused, Web Based Portal to the BMS. The system User Interface shall provide a natural, complementary extension to the site management user interface previously described.

.2 The user interface architecture shall be implemented to conform to industry standards, so that is can accommodate the required applications provided by the BMS Contractor as well as communicate information to and from any size control system.

.3 The exact same user interface shall be accessible from any type of personal computer or mobile device running any type of operating system (ex. iOS, Android, Windows).

.4 The interface shall automatically adapt and optimize the information displayed to fit the screen size of the client device and shall also be touch friendly.

.5 The user interface shall organize and display information using customer specific locations and spaces. At a minimum, the user interface shall provide:

.1 Organization of all space, equipment and point information in a familiar way, reducing the need for extensive training prior to use.

.2 A navigation mechanism for users to select the specific location or space to display information for – only spaces and locations in the navigation tree, nothing more.

.3 The ability to search for and/or bookmark any location or space by name for quick access to critical or troublesome areas.

.4 The same navigation mechanisms apply across any client device (ex. Smart phone, tablet, personal computer) for consistency and ease of use.

.6 Plug-ins and special native app software (ex. Downloaded and installed from an app store) shall not be required to conduct daily operations of buildings and equipment.

.7 The user interface shall clearly display equipment relationships without custom graphic generation.

.8 The user interface shall provide a single display of all potential issues in a facility including items currently in alarm, warning, override, out-of-service and offline.

.9 The user interface shall provide a single display of all activity related to a specific piece of equipment including user changes,

discarded user changes, pending alarms, discarded alarms and acknowledged alarms.

.10 The user interface shall provide support for up to 100 concurrent users from an unlimited number of individuals with defined password access to the system.

.11 Provide the capability to view, command and modify large quantities of similar data in tailored summaries without the use of a secondary application, like a spreadsheet. These summaries shall be automatically generated or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels. Up to 100 rows per summary shall be supported.

.12 Operator Interface

.1 Password access shall be as described previously for management portal UI

.2 Once logged in, the System shall display a pre-selected screen tailored to the task requirements of the individual user.

.3 The User Interface shall utilize an intuitive navigation and display method designed for operators who access the system for casual information and control or on an infrequent basis. It shall feature three basic components.

.1 Radio buttons for selection of the type of information to be displayed including Alerts, Summary, Schedules and Diagnostics

.2 Navigation tree for selection of the specific data to be displayed on screen for the selected type. The navigation tree may be hidden and expanded by the operator to optimize the display of information

.3 A display window that provides the selected information by type in a pre-configured tabular format

.4 The user interface software shall provide help menus and instructions for each operation and/or application.

.5 The system shall provide support for up to 100 concurrent users from an unlimited universe individuals with defined password access to the system

.6 The system shall utilize Secure Sockets Level (SSL) support as required to allow the ready access portal to communicate across a network in a way designed to prevent eavesdropping, tampering, and message forgery. It provides endpoint authentication and

communications privacy over the network using cryptography

.7 The system shall have the capability to display multiple navigation trees that correspond to the user views configured in the management portal UI.

.8 The alert summary of the ready access portal shall, at the minimum, provide the following information

.1 Alert (Alarm) type

.2 Date and time of alert occurrence

.3 Priority (color coded to level)

.4 Item name.

.5 Item value (if applicable)

.6 Message

.7 Any attribute of any object in the system may be designated to report an alarm

.9 A standard summary on the ready access portal shall, at the minimum, provide the following information

.1 Point type graphic icon

.2 Item name

.3 Item value

.4 Item status

.5 Access to the change value window (if applicable) for the purpose of setting, holding or releasing an item value

.10 A custom summary on the ready access portal shall display user-specified summaries of key data sets that can be quickly filtered and sorted. Items within these custom summaries can be commanded.

.11 A graphic view on the ready access portal shall display as described previously for management portal UI.

.12 The schedule detail summary of the ready access portal shall, at the minimum, provide the following information

.1 Scheduled occurrences including time and value

.2 Scheduled overrides including start time, end time and value

.3 A list of all scheduled items including name and attribute, value, status and priority

.4 Access to the Add Temporary Override window for the purpose of adding a temporary override to the schedule

.13 The diagnostic (trend) summary of the ready access portal as viewed on a personal computing device shall provide the following information.

.1 Item name

.2 Item status

.3 Trend name

.4 Trend status

.5 Full path name

.6 Access to trend detail summary including trended value, time and date arranged in a user selectable format of 1 hour, 12 hours, 24 hours, 48 hours or 72 hours

.4 Network Automation Engines (NAE)

.1 Network Automation Engine

.1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

.2 Automation network: The NAE shall reside on the automation network and shall support a subnet of system controllers.

.3 User interface: Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

.1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

.2 The NAE shall support a minimum of two (2) concurrent users.

.3 The web based user shall have the capability to access all system data through one NAE.

.4 Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

.5 Systems that require the user to address more than one NAE to access all system information are not acceptable.

.6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

.7 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

.8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer and/or other web browser:

.1 Configuration

.2 Commissioning

.3 Data Archiving

.4 Monitoring

.5 Commanding

.6 System Diagnostics

.9 Systems that require workstation software or modified web browsers are not acceptable.

.10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

.4 Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

.5 Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

.6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-Based, real-time clock.

.7 The NAE shall include troubleshooting LED indicators to identify the following conditions:

.1 Power - On/Off

.2 Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic

.3 Ethernet Connection Speed – 10 Mbps/100 Mbps

.4 Field Communication (FC) Bus – Normal Communications/No Field Communications

.5 Peer Communication – Data Traffic between NAE Devices

.6 Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running

.7 Bat Fault – Battery Defective, Data Protection Battery Not Installed

.8 Fault – General Fault

.8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

.1 USB port

.2 RS-232 serial data communication port

.3 RS-485 port

.4 Ethernet port

.9 Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

.10 Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

.1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

.2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

.11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).

.12 Controller network – The NAE shall support the following communication protocols as a minimum on the controller network:

.1 The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

.3 A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.

.4 The Conformance Statements shall be submitted 10 days prior to bidding.

.5 The NAE shall support a minimum of 50 control devices.

.2 The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.

.1 All LonWorks controls devices shall be LonMark certified.

.2 The NAE shall support a minimum of 64 LonWorks enabled control devices.

.5 Network Control Engine (Building Controller Unit (BCU))

.1 The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Control Engines.

.2 The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.

.3 Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.

.4 User Interface – Each NCE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

.1 The web based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

.2 The NCE shall support a minimum of two (2) concurrent users.

.3 The NCE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NCE.

.4 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

.5 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer and/or other web browser:

.1 Configuration

.2 Commissioning

.3 Data Archiving

.4 Monitoring

.5 Commanding

.6 System Diagnostics

.6 Systems that require workstation software or modified web browsers are not acceptable.

.7 The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

.5 The NCE shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

.6 The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.

.7 The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.8 The NCE shall support the following minimum number and types of inputs and outputs:

.1 Ten Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Eight Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Four Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, Current Mode

.4 Seven Binary Outputs - shall output the following:

.1 24 VAC Triac

.5 Four Configurable Outputs - shall be configured to output either of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output, 24 VAC Triac Mode

.9 The NCE shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

.1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The SA Bus shall support a minimum of 10 devices.

.3 The SA Bus shall operate at a maximum distance of 360 metres between the NCE and the furthest connected device.

.10 The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.

.11 The NCE shall support, but not be limited to, the following applications:

.1 Central Equipment including chillers and boilers

.2 Lighting and electrical distribution

.3 Built-up air handling units for special applications

.4 Power generation and energy monitoring equipment

.5 Interfaces to security and fire detection systems

.12 The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NCE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.

.13 The NCE shall employ an industrial single board computer.

.14 Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

.15 The NCE shall include an integrated, hardware-based, real-time clock.

.16 The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.

.17 The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.

.18 The NCE shall include troubleshooting LED indicators to identify the following conditions:

.1 Power

.2 Fault

.3 SA Bus

.4 FC Bus

.5 Battery Fault

.6 Ethernet

.7 10 LNK

.8 100 LNK

.9 Run

.10 Peer Com

.19 Communications Ports: The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

.1 USB port

.2 RS-232 serial data communication port

.3 RS-485 port

.4 RJ-45 Ethernet port

.5 RJ-12 jack

.20 Diagnostics: The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

.21 Power Failure: In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

.1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

.2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

.22 Certification: The NCE shall be listed by Underwriters Laboratories (UL). UL 916, Energy Management Equipment. FCC Compliant to CFR47, Part 15, Subpart B, Class A

.23 Field Controller Bus: The NCE shall support the following communication protocols on the Field Controller Bus:

.1 The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The NCE shall be tested and certified as a BACnet Building Controller (B-BC).

.3 A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.

.4 The Conformance Statements shall be submitted 10 days prior to bidding.

.5 The NCE shall support a minimum of 32 control devices.

.2 The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).

.1 All LonWorks controls devices shall be LonMark certified.

.2 The NCE shall support a minimum of 32 LonWorks enabled control devices.

.6 DDC System Controllers

.1 Advanced Application Field Equipment Controller (FAC) / Equipment Controller Unit (ECU)

.1 The Advanced Application Field Equipment Controller (FAC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol or optionally via N2Open.

.1 The FAC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 The FAC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The FAC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

.3 A BACnet Protocol Implementation Conformance Statement shall be provided for the FAC.

.4 The Conformance Statement shall be submitted 10 days prior to bidding.

.2 The FAC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

.3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The FAC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.4 The FAC shall include an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

.1 Schedules

.2 Calendars

.3 Alarms

.4 Trends

.5 The FAC can continue time-based monitoring when offline for extended periods of time from the system network.

.6 The FAC can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the field controllers.

.7 The FAC shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Field Controller Bus - Normal Data Transmission

.7 Field Controller Bus - No Data Transmission

.8 Field Controller Bus - No Communication

.9 Sensor-Actuator Bus - Normal Data Transmission

.10 Sensor-Actuator Bus - No Data Transmission

.11 Sensor-Actuator Bus - No Communication

.8 The FAC shall accommodate the direct wiring of analog and binary I/O field points.

.9 The FAC shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, Current Mode

.4 Binary Outputs - shall output the following:

.1 Line-voltage relay outputs

.5 24 VAC Triac

.6 Configurable Outputs - shall be capable of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output Mode

.10 The FAC shall have the ability to reside on a Field Controller Bus (FC Bus).

.1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The FC Bus shall support communications between the FACs and the NAE.

.3 The FC Bus shall also support Input/Output Module (IOM) communications with the FAC and with the NAE.

.4 The FC Bus shall support a minimum of 100 IOMs and FACs in any combination.

.5 The FC Bus shall operate at a maximum distance of 4500 metres. between the FAC and the furthest connected device.

.11 The FAC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

.1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.

.2 The SA Bus shall support a minimum of 10 devices per trunk.

.3 The SA Bus shall operate at a maximum distance of 360 metres. between the FAC and the furthest connected device.

.12 The FAC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

.13 The FAC shall support, but not be limited to, the following applications:

.1 Chiller plant applications

.2 Heating central plant applications

.3 Built-up air handling units for special applications

.4 Terminal & package units

.5 Special programs as required for systems control

.7 Field Equipment Controller (FEC) / Equipment Controller Unit (ECU)

.1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol or optionally via N2Open.

.1 The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

.3 A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

.4 The Conformance Statement shall be submitted 10 days prior to bidding.

.2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

.3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.4 The FEC shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Field Controller Bus - Normal Data Transmission

.7 Field Controller Bus - No Data Transmission

.8 Field Controller Bus - No Communication

.9 Sensor-Actuator Bus - Normal Data Transmission

.10 Sensor-Actuator Bus - No Data Transmission

.11 Sensor-Actuator Bus - No Communication

.5 The FEC shall accommodate the direct wiring of analog and binary I/O field points.

.6 The FEC shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, current Mode

.4 Binary Outputs - shall output the following:

.1 24 VAC Triac

.5 Configurable Outputs - shall be capable of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output Mode

.7 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).

.1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The FC Bus shall support communications between the FECs and the NAE.

.3 The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.

.4 The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.

.5 The FC Bus shall operate at a maximum distance of 4500 metres between the FEC and the furthest connected device.

.8 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

.1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.

.2 The SA Bus shall support a minimum of 10 devices per trunk.

.3 The SA Bus shall operate at a maximum distance of 360 metres between the FEC and the furthest connected device.

.9 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

.1 The FEC shall support, but not be limited to, the following applications:

.1 Built-up air handling units

.2 Terminal & package units

.3 Special programs as required for systems control

.8 Field Devices

.1 Input/Output Module (IOM)

.1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC and FAC.

.2 The IOM shall communicate with the FEC/FAC over the FC Bus or the SA Bus.

.3 The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.2 The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).

.3 A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.

.4 The Conformance Statement shall be submitted 10 days prior to bidding.

.4 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.5 The IOM shall have a minimum of 4 points to a maximum of 17 points.

.6 The IOM shall support the following types of inputs and outputs:

.1 Universal inputs shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary inputs shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog outputs shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, current Mode

.4 Binary outputs shall output the following:

.1 24 VAC Triac

.5 Configurable outputs shall be capable of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output Mode

.7 The IOM shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Normal Data Transmission

.7 No Data Transmission

.8 No Communication

.2 Networked Thermostat (Type 1)

.1 The networked thermostat shall be capable of controlling air handling unit

.2 Communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol

.3 BACnet Testing Labs (BTL) certified and carry the BTL Label.

.4 Support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.

.5 Include an intuitive User Interface providing plain text messages.

.1 Two line, 8 character backlit display

.2 LED indicators for Fan, Heat, and Cool status

.3 Five (5) User Interface Keys

.1 Mode

.2 Fan

.3 Override

.4 Degrees C/F

.5 Up/Down

.4 The display shall continuously scroll through the following parameters:

.1 Room Temperature

.2 System Mode

.3 Schedule Status – Occupied/Unoccupied/Override

.4 Applicable Alarms

.6 The Networked Thermostat shall provide the flexibility to support any one of the following inputs:

.1 Integral Indoor Air Temperature Sensor

.2 Duct Mount Air Temperature Sensor

.3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator

.4 Two configurable binary inputs

.7 The Networked Thermostat shall provide the flexibility to support any one of the following outputs:

.1 Fan Speed

.2 Two On/Off

.3 Two Floating

.4 Two Proportional (0 to 10V)

.8 The Networked Thermostat shall provide a minimum of six levels of keypad lockout.

.9 The Networked Thermostat shall provide the flexibility to adjust the following parameters:

.1 Adjustable temporary occupancy from 0 to 24 hours

.2 Adjustable heating/cooling deadband from 0.5ºC to 1.5ºC (1ºF to 3ºF)

.3 Adjustable heating/cooling cycles per hour from 4 to 8

.10 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

.3 Networked Thermostat (Type 2)

.1 The Networked Thermostat shall be capable of controlling a pressure dependent Variable Air Volume System or other similar zoning type systems employing reheat including local hydronic reheat valves.

.2 Communicate over the FC Bus using BACnet Standard protocol.

.3 The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.4 Capable of remote read/write and parameter adjustment from the web based User Interface (UI) through an NAE.

.5 The Networked Thermostat shall include an intuitive UI providing plain text messages.

.1 Two line, eight character backlit display

.2 LED indicators for Heating, and cooling status

.3 Three User Interface Keys

.1 Override

.2 Up

.3 Down

.6 The display shall continuously scroll through the following parameters:

.1 Room Temperature

.2 System Mode

.3 Schedule Status – Occupied/Unoccupied/Override

.4 Applicable Alarms

.7 The Networked Thermostat shall provide the flexibility to support any one of the following inputs:

.1 Integral Indoor Air Temperature Sensor

.2 Duct Mount Air Temperature Sensor

.3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator

.8 Two configurable binary inputs

.9 The Networked Thermostat shall provide the flexibility to support either of the following outputs:

.1 Two On/Off or Floating

.2 Two Proportional (0 to 10V)

.10 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.

.11 The Networked Thermostat shall provide the flexibility to adjust the following parameters:

.1 Adjustable Temporary Occupancy from 0 to 24 hours

.2 Adjustable heating/cooling deadband from 1ºC to 3ºC (2ºF to 5ºF)

.3 Adjustable heating/cooling cycles per hour from 4 to 8

.12 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

.4 VAV Modular Assembly (VMA)

.1 The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.

.2 The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.3 The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol.

.4 The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.

.5 The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

.6 The VAV Modular Assembly shall be assembled in a plenum-rated housing.

.7 The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

.8 The controller shall determine airflow by a state-of-the-art digital non-flow pressure sensor to provide 14-bit resolution with bidirectional flow operation that supports automatic correction for polarity on high- and low-pressure DP tube connections; this pressure sensor eliminates high- and low-pressure connection mistakes.

.9 Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

.10 The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

.11 Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle.

.12 The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.

.13 Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

.14 The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

.15 The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.

.16 The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain (“K” factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

.17 Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop’s sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.

.1 Absolute temperature loop error

.2 Signed temperature loop error

.3 Absolute airflow loop error

.4 Signed airflow loop error

.5 Average damper actuator duty cycle

.18 The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:

.1 Unreliable space temperature sensor

.2 Unreliable differential pressure sensor

.3 Starved box

.4 Actuator stall

.5 Insufficient cooling

.6 Insufficient heating

.19 The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA shall also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.

.20 The controller shall provide a compliant interface for ASHRAE Standard 62.1 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.

.21 The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

.22 Inputs:

.1 Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:

.1 0-10 VDC Sensors

.2 1000ohm RTDs

.3 NTC Thermistors

.2 Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”

.3 For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.

.4 Provide side loop application for humidity control.

.23 Outputs

.1 Analog outputs shall provide the following control outputs:

.1 0-10 VDC

.2 Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.

.3 For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

.24 Application Configuration

.1 The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

.25 Sensor Support

.1 The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.

.2 The VMA shall support an LCD display room sensor.

.3 The VMA shall also support standard room sensors as defined by analog input requirements.

.4 The VMA shall support humidity sensors defined by the AI side loop.

.5 Network Sensors (NS)

.1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

.1 Zone Temperature

.2 Zone Humidity

.3 Zone Setpoint

.4 Discharge Air Temperature

.5 Zone CO2

.2 The NS shall transmit the information back to the controller using BACnet Standard protocol.

.3 The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

.4 The Network Zone Sensors shall include the following items:

.1 A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint (if indicated on drawings)

.2 An LED to indicate the status of the Override feature

.3 A button to toggle the temperature display between Fahrenheit and Celsius

.4 A button to program the display for temperature or humidity

.5 A button to initiate a timed override command

.6 Available in either surface mount, wall mount, or flush mount

.7 Available with either screw terminals or phone jack

.5 The Network Discharge Air Sensors shall include the following:

.1 4 inch or 8 inch duct insertion probe

.2 10 foot pigtail lead

.3 Dip Switches for programmable address selection

.4 Ability to provide an averaging temperature from multiple locations

.5 Ability to provide a selectable temperature from multiple locations

.6 The Network CO2 Zone Sensors shall include the following:

.1 Available in either surface mount or wall mount

.2 Available with screw terminals or phone jack

.3 in NEMA 1 plastic housings.

2.4 SENSORS AND TRANSMITTERS

.1 General Requirements

.1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

.2 Acceptable manufacturers:

.1 Johnson Control Inc

.2 Honeywell

.3 Automated Logic

.2 Temperature Sensors

.1 General Requirements:

.1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

.2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

.3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Room Temp	± 0.3°C.
Duct Temperature	± 0.3°C.
All Others	± 0.5°C.

.2 Room Temperature Sensors

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have the following options when specified:

.1 Setpoint warmer/cooler dial or reset slide switch providing a ± 1ºC (adjustable) range.

.2 Individual heating/cooling setpoint switches.

.3 A momentary override request push button for activation of after-hours operation.

.4 Analog thermometer.

.3 Room Temperature Sensors with Integral Display

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:

.1 Display room air temperatures.

.2 Display and adjust room comfort setpoint.

.3 Display and adjust fan operation status.

.4 Timed override request push button with LED status for activation of after-hours operation.

.5 Display controller mode.

.6 Password selectable adjustment of setpoint and override modes.

.4 Thermowells

.1 Thermowell manufacturer shall have models available in stainless steel, brass body, and copper bulb.

.2 When thermowells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and sensor.

.3 Thermowells shall be pressure rated and constructed in accordance with the system working pressure.

.4 Thermowells and sensors shall be mounted in a direct mount (no adapter) offering faster installation or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

.5 Thermowells constructed of 316 stainless steel shall comply with Canadian Registration Number (CRN) pressure vessel rating.

.5 Outside Air Sensors

.1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

.2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

.3 Temperature transmitters shall be of NEMA 3R or NEMA 4 construction and rated for ambient temperatures.

.4 The outdoor sensor shall be easily mounted on a roof, pole or side of a building utilizing its already assembled mounting bracket.

.5 Outside Relative Humidity sensors 0-100% full range of accurate measurement. Operating temperature -20 to 60°C (-4 to 140°F).

.6 Outside temperature sensors operating temperature range is -40 to 60°C (-40 to 140°F), +/- 0.3°C (+/- 0.5°F).

.6 Duct Mount Sensors

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

.7 Averaging Sensors

.1 For ductwork greater in any dimension that 1200 mm and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

.2 For plenum applications, such as mixed air temperature measurements, a continuous averaging sensor or a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 3000 mm long segment.

.3 Capillary supports at the sides of the duct shall be provided to support the sensing string.

.3 Humidity Sensors

.1 The sensor shall be a solid-state type, relative humidity sensor of the Thin Film Capacitance or Bulk Polymer Design. The sensor element shall resist service contamination.

.2 The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.

.3 The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 25°C unless specified elsewhere.

.4 Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R or NEMA 4 enclosure with sealtite fittings.

.5 A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.

.6 Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

.4 Differential Pressure Transmitters

.1 General Air and Water Pressure Transmitter Requirements:

.1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

.2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

.3 Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.

.4 A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

.2 Building Differential Air Pressure Applications (-250 Pa to +250 Pa)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

.1 -250 Pa to +250 Pa input differential pressure ranges.

.2 4-20 mA output.

.3 Maintain accuracy up to 20 to 1 ratio turndown.

.4 Reference Accuracy: +0.2% of full span.

.3 Low Differential Air Pressure Applications (0 to 625 Pa)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

.1 0 to 500 Pa input differential pressure ranges.

.2 4-20 mA, 0-5 VDC, 0-10 VDC, output.

.3 Maintain accuracy up to 20 to 1 ratio turndown.

.4 Reference Accuracy: +0.25%, or 0.5% of full span.

.5 Power Monitoring Devices

.1 Current Measurement (Amps)

.1 Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.

.2 Current Transformer: A split core current transformer shall be provided to monitor motor amps.

.1 Operating frequency – 50 - 400 Hz.

.2 Insulation – 0.6 Kv class 10Kv BIL.

.3 UL recognized.

.4 Five amp secondary.

.5 Select current ration as appropriate for application.

.6 Acceptable manufacturers: Setra

.3 Current Transducer: A current to voltage or current to mA transducer shall be provided. The current transducer shall include:

.1 6X input over amp rating for AC inrushes of up to 120 amps.

.2 Manufactured to UL 1244.

.3 Accuracy: +.5%, Ripple +1%.

.4 Minimum load resistance 30kOhm.

.5 Input 0-20 Amps.

.6 Output 4-20 mA.

.7 Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).

.8 Acceptable manufacturers: Setra

.6 Smoke Detectors

.1 Ionization type air duct detectors shall be furnished as specified elsewhere in Division 26 for installation under Division 23. All wiring for air duct detectors shall be provided under Division 28, Fire Alarm System.

.7 Status and Safety Switches

.1 General Requirements

.1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Acceptable manufacturers:

.1 Johnson Control Inc

.2 Honeywell

.3 Automated Logic

.2 Current Sensing Switches

.1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

.2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

.3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.3 Air Filter Status Switches

.1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

.3 Provide appropriate scale range and differential adjustment for intended service.

.4 Air Flow Switches

.1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

.5 Air Pressure Safety Switches

.1 Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.

.6 Low and High Temperature Limit Switches

.1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

.2 The sensing element shall be a minimum of 4.5 metres in length and shall react to the coldest or hottest section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

.4 Acceptable manufacturers:

.1 Johnson Controls Ltd.

.2 Honeywell

.3 Automated Logic

.8 Control Relays

.1 Control Pilot Relays

.1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

.2 Mounting Bases shall be snap-mount.

.3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

.4 Contacts shall be rated for 10 amps at 120VAC.

.5 Relays shall have an integral indicator light and check button.

.9 Electronic Signal Isolation Transducers

.1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.

.2 The signal isolation transducer shall provide ground plane isolation between systems.

.3 Signals shall provide optical isolation between systems.

.4 Acceptable manufacturers: Advanced Control Technologies

.10 Thermostats

.1 Electric room thermostats of the heavy-duty type shall be provided for electric heaters. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

2.5 CONTROL AIR DAMPERS

.1 Type

.1 Modulating control dampers

.1 Opposed blades

.2 Two position control dampers

.1 Parallel blades

.2 Construction

.1 Bearings

.1 Thermal plastic resin copolymer, nylon or impregnated bronze

.2 At blade axles, linkage devices, etc.

.2 Damper blades and frames

.1 Extruded aluminum

.2 Maximum blade length: 1.2 m without internal frame support

.3 Blade edge seals: EPDM gaskets

.4 Frame side seals: extruded TPE

.5 Frame style: flanged to duct

.6 Jack shaft: extendable, combination of aluminum and zinc/nickel coated steel

.7 Damper leakage: 50 L/s per m² damper face area at 1 kPa differential static pressure

.3 Damper blades for outside air applications

.1 As above

.2 Operating temperature: -40°C to 100°C

.3 Thermally broken and insulated blades; expanded polyurethane foam insulation

.4 Damper leakage: 21 L/s per m² damper face area at 1 kPa differential static pressure

.4 Acceptable manufacturer:

.1 Tamco – Series 1000

.2 Tamco – Series 9000 (outside air applications)

.3 Nailor

.4 Ruskin

.5 Alumavent

2.6 VALVE AND DAMPER OPERATORS

.1 General

.1 Provide valves and dampers with metal body operators sized to assure smooth, positive operation over the entire operating range, without chatter or slamming, and to give tight shutoff at end positions against the system pressures to be encountered.

.2 Failure position:

.1 Spring return, normally open or normally closed sequence as required so that systems will “Fail-safe” in case of control air pressure or power failure.

.2 On 2-way butterfly valves, Provide double acting or reversible actuators.

.3 Sequencing by spring range will not be approved for valves or dampers.

.4 Furnish valves and dampers with operators and spring ranges designed to match as linearly as possible the full scale operating range of the control valve.

.5 Adequately size operators and in sufficient quantity to ensure smooth damper operation.

.2 Selection

.1 Indoor

.1 Electric

.2 Outdoor

.1 Electric

.3 Ancillary devices

.1 End switches as detailed

.2 Pilot positioner relays

.3 Interconnection piping

.3 Electronic Actuators

.1 General

.1 Low torque, fully modulating or two position as indicated.

.2 Time for full open to full close: two minutes nominal

.3 Current limiting, digital motor rotation sensing circuits, or adjustable end of travel switches to provide motor protection.

.4 Tandem mounting of actuators for higher torque requirements are acceptable.

.5 Spring return with manual override unless otherwise indicated or specified.

.6 On loss of control signal, valve will fail to the designated normally open or closed position.

.2 Terminal equipment

.1 Non-spring return type

.3 Power and communications

.1 Positive positioning at 2-10 VDC or 4-20 mA signal

.2 Visual position indicator

.3 Built-in rotation reversing switch

.4 Actuator generated 2-10 VDC electronic feedback signal

.5 Capacity to add auxiliary switches when required

.6 Power: 24 VAC or VDC for proportional control, 24 or 120 VAC for 2 position, maximum 15 VA.

2.7 GAS DETECTION SYSTEM

.1 Gas Detection Control panel

.1 CSA approved

.2 Microprocessor based central gas detection system control to provide gas detection and control functionality as described herein, in the controls sequences, and as shown on the drawings.

.3 Capable of communication with gas detection sensors through -485 communications bus.

.4 Capable of activating up to 32 separate relay modules.

.5 Capable of communication with a separate annunciator panel.

.6 Control panel shall include a backlit, alphanumeric, LCD to indicate the detected levels for each sensor.

.7 The control panel shall include separate LED indication as follows:

.1 Green LED: Normal operation

.2 Red LED: Alarm (level 1 and 2)

.3 Amber/Yellow LED: Sensor or control failure.

.8 Integrated 65 dBA alarm.

.9 Manufacturers

.1 Vulcain / Honeywell

.2 MSA

.3 Critical Environment Technologies Canada

.2 Gas Detection Sensors - general

.1 Standalone gas detection transmitter with 120/24 built-in step down transformer, remote gas sensor.

.2 NEMA 4X or approved equivalent enclosure.

.3 Capable of activating up to 32 separate relay modules.

.4 Capable of communication with a separate annunciator panel.

.5 Control panel shall include a backlit, alphanumeric, LCD to indicate the detected levels for each sensor.

.6 Transmitter

.1 Remote electrochemical cell for monitoring listed gas as per Drawings.

.2 Complete with local LED indication for high and low alarm as well as a green LED power “ON” light

.3 Power: 24 VDC

.4 Replaceable gas cartridge with smart sensor capable of self-testing.

.5 Accuracy: ±3%

.6 Capable of operating within 5-95% RH and -20°C to 40°C

.7 Factory calibrated and certified without the requirement for Site calibration.

.8 On-board audible alarm with 85 dBA at 3 metres.

.9 LCD display to provide local gas concentration reading.

.10 Sufficient relays to activate exhaust fans.

.11 Minimum three (3) relays.

.7 Location: The Drawings indicate approximate quantity and layout of sensors. The detector manufacturer shall review the application and locations and revise

as necessary. The Contractor shall allow for a minimum of five more detectors than shown on Drawings.

.8 System supplier to provide site inspection, operating and maintenance instructions and a trained technician to perform system start-u and calibration checks.

.9 Manufacturer

.1 Vulcain (Honeywell)

.2 MSA

.3 Critical Environment Technologies Canada

.10 Sequence of Operation

.1 Refer to Drawings.

.2 At low level alarm, low alarm LED lights on. Low level alarm remains until gas concentration level below first alarm set point.

.3 At high level alarm, high alarm LED lights on and audible alarm horn activates.

.4 Alarm setting: refer to drawings

.3 CO Detectors

.1 Carbon monoxide (CO) sensors

.2 Powered from separate 120V power supply

.3 Capable of communicating with a central gas detection system control panel from the same manufacturer as the sensors.

.4 Location: The drawings indicate approximate quantity and layout of sensors. The detector manufacturer shall review the application and layout and revise as necessary to suit the detector supplied. The Contractor shall allow for a minimum of five more detectors than shown on the drawings.

.5 Measuring range: 0 - 250 PPM.

.6 Alarm setting range: 0 - 250 PPM.

.7 System performance: Repeatability: +/-1.0% full scale. Accuracy: +/- 5% full scale

.8 Outputs: 4 - 20mA, linear

.9 Power input: 24 VAC, 60 Hz, 200 VA Max.

.10 Sensor enclosure: Heavy duty aluminum.

.11 Sensor life: Sensors shall be warranted to have a minimum useful life of one year.

.12 Sensor distance: Maximum distance from sensor to controller shall be 610 m.

.13 Sensors in wash areas shall be complete with splash guards. Sensors in truss space complete with remote sensing and remote calibration.

.14 Manufacturer:

.1 Vulcain (Honeywell)

.2 MSA Instrument Div.

.3 Critical Environment Technologies Canada

.4 CO_2 Detectors

.1 Carbon dioxide (CO_2) sensors.

.2 Simultaneously monitor the temperature (either in Celsius or Fahrenheit) and the relative humidity in addition to carbon dioxide

.3 Powered from separate 24 V power supply. Provide 120/24 low voltage control transformer mounted adjacent to sensor.

.4 Capable of communicating with a central gas detection system control panel from the same manufacturer as the sensors.

.5 The detection unit, digital version, shall be able to communicate with a BAS using a BACnet MS/TP.

.6 Location: The drawings indicate approximate quantity and layout of sensors. The detector manufacturer shall review the application and layout and revise as necessary to suit the detector supplied. The contractor shall allow for a minimum of five more detectors than shown on the drawings.

.7 Measuring range: 0 – 2000 ppm. Response time of less than 60 seconds (adjustable).

.8 Alarm setting range: 1200 ppm alarm.

.9 System performance: Repeatability: +/-1.0% full scale. Accuracy: +/- 5% full scale

.10 Outputs: 4 - 20mA, linear

.11 Power input: 24 VAC, 60 Hz, 200 VA Max.

.12 Graphic LCD 122 x 32 displays and programmable by three buttons in the front panel

.13 Sensor enclosure: Heavy duty aluminum.

.14 Sensor life: Sensors shall be warranted to have a minimum useful life of one year.

.15 Sensor distance: Maximum distance from sensor to controller shall be 600 m.

.16 Wall mounted where shown on the drawings

.17 Manufacturer:

.1 Vulcain (Honeywell)

.2 MSA Instrument Div.

.3 Critical Environment Technologies Canada.

.5 NO_2 Detectors

.1 Nitrogen oxide (NO_2) sensors

.2 Powered from separate 120V power supply

.3 Capable of communicating with a central gas detection system control panel from the same manufacturer as the sensors.

.4 Location: The drawings indicate approximate quantity and layout of sensors. The detector manufacturer shall review the application and layout and revise as necessary to suit the detector supplied. The Contractor shall allow for a minimum of five more detectors than shown on the drawings.

.5 Measuring range: 0 - 10 PPM.

.6 Alarm setting range: 0 - 10 PPM.

.7 System performance: Repeatability: +/-1.0% full scale. Accuracy: +/- 5% full scale.

.8 Outputs: 4 - 20mA, linear.

.9 Power input: 24 VAC, 60 Hz., 200 VA Max.

.10 Sensor enclosure: Heavy duty aluminum.

.11 Sensor life: Sensors shall be warranted to have a minimum useful life of one year.

.12 Sensor distance: Maximum distance from sensor to controller shall be 610 m.

.13 Sensors in wash areas shall be complete with splash guards. Sensors in truss space complete with remote sensing and remote calibration.

.14 Manufacturer:

.1 Vulcain (Honeywell)

.2 MSA Instrument Div.

.3 Critical Environment Technologies Canada

.6 VOC Detectors

.1 Volatile Organic Compound (VOC) sensors

.2 Powered from separate 24 V power supply

.3 Capable of communicating with a central gas detection system control panel from the same manufacturer as the sensors.

.4 Location: The drawings indicate approximate quantity and layout of sensors. The detector manufacturer shall review the application and layout and revise as necessary to suit the detector supplied. The Contractor shall allow for a minimum of five more detectors than shown on the drawings.

.5 Measuring range: 0 – 100% LEL.

.6 Alarm setting range: 25% LEL first alarm, second alarm 50% LEL.

.7 System performance: Repeatability: +/-1.0% full scale. Accuracy: +/- 5% full scale

.8 Outputs: 4 - 20mA, linear

.9 Power input: 24 VAC, 60 Hz, 200 VA Max.

.10 Sensor enclosure: Heavy duty aluminum.

.11 Sensor life: Sensors shall be warranted to have a minimum useful life of one year.

.12 Sensor distance: Maximum distance from sensor to controller shall be 610 m.

.13 Manufacturer:

.1 Vulcain (Honeywell)

.2 MSA Instrument Div.

.3 Critical Environment Technologies Canada.

2.8 **EQUIPMENT SUPPORTS**

.1 Support Frames: galvanized modular framing system: Unistrut.

.2 Backboards: 20 mm fire rated plywood.

3 Execution

3.1 **EXAMINATION**

.1 Thoroughly examine the design documentation for control devices and equipment. Notify the Consultant of any discrepancies, conflicts or omissions prior to commencement of rough-in work.

3.2 **INSTALLATION**

.1 Execute work in accordance with requirements specified in the various sections of Division 25, and where referenced to other divisions.

.2 Lay out the work so that it does not interfere with Work under other divisions of Specifications.

.3 Make good any damage to Owner’s property or other trade’s work caused by improperly locating or carrying out of work.

.4 Location of pipes, ductwork, raceways and equipment may be altered without extra cost provided alteration is made before installation.

3.3 **PROTECTION**

.1 Protect work and materials before, during and after erection from weather and other hazards and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

3.4 **PAINTING**

.1 With the exception of prime painting of miscellaneous steel or any other specific requirements as specified under the respective sections of this Work, or equipment otherwise factory painted, all painting will be provided under Division 09.

.2 Field Prime Painting

.1 Mechanical rooms, boiler rooms, fan rooms, crawl spaces, pipe tunnels and penthouses; paint exposed galvanized metal surfaces with one coat of zinc dust galvanized primer and one coat of 100% alkyd base enamel.

.2 Clean rust and oil from exposed iron and steel work provided under this division whether or not it has been factory prime painted. Paint this equipment with one coat of chrome oxide phenolic base primer and one coat of 100% alkyd base enamel in an approved colour.

3.5 **CONSTRUCTION REVIEW**

.1 The construction review will include milestone and periodic reviews.

.2 Milestone Reviews

.1 Specific milestone reviews will be performed by the Consultant for compliance with the Ontario Building Code, including any or all of the following:

.1 Equipment Demonstration and Training

.2 Substantial Performance and Deficiency Review

.3 Total Performance

.2 Some or all of these reviews are of portions of the Work which may be concealed. If Work is enclosed before the Consultant can review the installation, the Consultant may direct the Contractor to expose the Work for it to be examined, at no additional cost to the project including rework affecting other Trades.

.3 If deficiencies are noted during any review where work will be enclosed, correct noted deficiencies and have them reviewed by the Consultant prior to the Work being enclosed.

.4 Provide a minimum of seven (7) calendar days' written notice to the Consultant when requesting each review date.

.5 The Consultant will provide a checklist to the Contractor of required milestone reviews which must be completed. Maintain this list on site along with identified test reports, and make available for Consultant's review when requested. When

completed, include this checklist form with the Test Reports forms specified in this Division.

.3 Periodic Reviews

.1 The Consultant will conduct periodic reviews, as required for the project. These reviews are for the benefit of the Owner to describe the progress and workmanship of the Work, and are not intended as any form of quality assurance for the Contractor.

.2 Deficiencies will generally not be reported as part of this review, as the work has not been reported by the Contractor as being complete. However, deficiencies may be reported where it may not be possible to correct the work at a later date, or at a great expense.

.3 The Contractor shall not relay on these Periodic Reviews to identify deficiencies during the progress of the Work.

.4 Deficiency Review

.1 The Consultant will conduct a deficiency review only after the Contractor submits an application for Substantial Performance. As part of this application, the Contractor shall submit its own comprehensive deficiency list of incomplete or incorrect work. Failure by the Contractor to list any deficiency does not relieve the Contractor from correcting or completing the Work.

.2 The Consultant shall review the work and any deficiencies noted will be classified as Major or Minor.

.1 Major deficiencies are required to be corrected as part of obtaining Substantial Performance.

.2 Minor deficiencies may be corrected before or after Substantial Performance.

.5 Final Review

.1 The Consultant will conduct a final review only after the Contractor submits a declaration that all of the following has been completed:

.1 Noted deficiencies have been corrected.

.2 Final as-built drawings have been submitted to the Owner.

.3 Final Operating and Maintenance manuals have been submitted to the Owner.

.4 Final Test reports, including Alternate season tests have been submitted to the Owner.

.6 The Consultant will only review the deficiency list to confirm these deficiencies have been corrected.

.7 Tubing and Conduit

.1 Tubing and conduit: Follow horizontal and perpendicular building lines to fit into the layout of the area. Properly support and install in a neat and workmanlike manner throughout.

.2 Install panels in readily accessible locations. Unless otherwise shown, mount control panels at a height of 1800 mm from the floor to the top of the cabinet for units without operator input devices (LCD screens, keypads, etc). For units with operator input devices, mount unit so that the horizontal centerline of the LCD display is location 1650 mm above the floor.

.3 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

3.6 **LOCAL CONTROL PANELS**

.1 Install BCU and ECU controllers in separate EEMAC 4 or 12 panels, to suit location. Install operator LCD screen, where specified, on the front panel door to allow operator access without opening door.

.2 Support local control panels from fixed masonry or concrete walls. Do not support from drywall partition walls. Provide free standing support frames in other locations.

3.7 **WIRING COORDINATION**

.1 Provide wiring and conduit under this Section of the work as follows:

.1 Between ceiling mounted junction boxes and terminal unit controllers.

.2 Between MCC mounted receptacle panels in mechanical rooms and controllers and control devices within the same area.

.3 Provide circuit breakers in “RP” and “ERP” panels; provide breaker locks to prevent unauthorized use of the breaker.

.2 Power wiring provided under Division 26 as follows:

.1 120 VAC power and conduit to a junction box located in the ceiling adjacent to each terminal unit.

.2 120 VAC normal power panels labeled “RP” with spaces available for use.

.3 120 VAC emergency power panels labeled “ERP” with spaces available for use.

.3 Termination at Packaged Equipment and Systems:

.1 Terminate wiring at packaged equipment and system controllers provided under Division 23.

.2 For equipment or systems panels provided under other Divisions of the Work, pull wire into control panel as per OEM manufacturer’s instructions. Final termination at equipment or panel will be by the trade Contractor providing/installing the equipment.

3.8 **WIRING**

.1 Maximum Control Voltage: 120 V.

.2 Supply, install and connect power transformers as required for each system.

.3 Sizing of conduit and selection of size and type of wire is by the Contractor under this Section of the Work.

.4 Flexible Metal and Liquid Tight Conduit

.1 Maximum 1000 mm length

.2 Minimum size: 20 mm.

.3 Supported at each end.

.5 Control and Status Relays

.1 Provide relays in designated enclosures only. Relays may be installed within packaged equipment control panels.

.2 Do not install relays within motor starter enclosures. Install relays in spare MCC sections, or provide a NEMA 1 (4) (12) enclosure mounted adjacent to the MCC or starter.

.6 Control and interlock wiring: comply with Electrical Safety Code and Division 26, and as specified herein.

.7 Wire

.1 All cables ULC listed for application

.2 Exposed cable in ceiling plenums: FT6 plenum rated.

.8 Conduit

.1 Wiring in ceiling plenum spaces to be in conduit or be FT6 plenum rated cable.

.2 Wiring in all other areas to be in conduit.

.3 Wiring for rated smoke venting/control system to be FT6 plenum rated cable AND be installed conduit.

.9 Sleeves

.1 Provide wall sleeves for plenum rated cable passing through walls.

.2 Maintain fire rating at all penetrations.

3.9 FIBRE OPTIC CABLE SYSTEM

.1 Install cable to maintain the minimum cable and unjacked fiber bend radii as specified by the manufacturer.

.2 Do not exceed maximum pulling tensions as specified by the manufacturer. Do not exceed manufacturer's ratings for post installation residual cable tension.

.3 Install fiber optic cabinets, hardware and cable entering the cabinet as per manufacturer's instructions.

3.10 ARCHITECTURE

.1 Refer to drawings for system architecture schematic. The system architecture shown provides a general summary of the design intent and does not show all control devices.

.1 Obtain a CAD design file from the Consultant and complete the development of the system architecture drawing. In the absence of a design architecture, provide an architecture drawing as required.

.2 Include on the architecture drawing the following:

.1 Operator work stations

.2 Building LAN network

.3 Field LAN network

.4 NAE, NCE and BCU, with identification label, and room location.

.5 FAC, FEC and ECU, with identification label, and room location.

.6 LAN system repeaters.

.2 Controllers

.1 Provide a separate FEC for each piece of major equipment.

.2 Provide a separate FAC for each major system, including hydronic system water pumps.

.3 A universal programmable style FAC or FEC may be used to terminate miscellaneous I/O including system instrumentation, freestanding fans and pumps, etc. which may not form part of a more complex system.

.4 Select ECU's to provide a minimum of 15% spare capacity for each point type at each controller, but in no case less than 1 spare point.

3.11 **PROGRAMMING**

.1 General

.1 Point Naming: modular description without written point index.

.1 Use manufacturer's standard naming convention.

.2 Provide programming for the system as specified and control sequence requirements. Include for additional programming necessary for the operation of the system but not specifically identified herein.

.3 Imbed sufficient comments in programming logic to clearly describe each section of the program. Comment statements to reflect language used in the sequences of operation.

.4 Enter all computer programs and data files into the related computers including English descriptors, control programs, approved parameters and settings.

.2 Graphics

.1 Provide graphics for each major piece of equipment/system and for each floor plan in the building. Design CAD files will be provided to the controls Contractor for this purpose. Equipment to include:

.1 Air handling units with associated condensing unit

.2 Terminal box units

.3 Sump pumps

.4 Any integrated system including fire alarm, lighting control, security, etc.

.3 Reporting information

.1 Implement samples of the following featueres:

.1 Bar chart (four different bars on one chart)

.2 Curve plot (five curves on one plot)

.3 Trend log

.4 Alarm message (action taking message)

.5 Run time maintenance message

.6 Trouble action message

3.12 NAMEPLATES

.1 Provide Nameplates

.1 Lamacoid type:

.1 On each BMS control device, indicating device number.

.2 On the panel front to identify each system being controlled and to identify each front mounted component.

.2 Laminated data card

.1 Field devices

.2 Damper actuators

.3 DDC terminal unit box controllers

.4 Automatic control valve actuators.

.2 Warning Labels

.1 Provide plastic adhesive-backed labels, black lettering on yellow background, on each starter and equipment automatically controlled through the BMS system, as follows:

CAUTION
This equipment is operating under automatic control and may start at any time without warning.

.2 Securely fasten Lamacoid nameplates to the equipment or adjacent to the equipment, with round-head cadmium plated steel self-tapping screws.

3.13 OPERATING INSTRUCTIONS

.1 Provide the services of a competent technician qualified to instruct the operating personnel in maintenance and operating procedures, after commissioning, for a period of not less than one day. Training to include:

.1 Overall operational program.

.2 Equipment functions.

.3 Commands.

.4 Graphics generation.

.5 Appropriate operator intervention following system's operation.

.2 Provide Operating instructions for the control system in accordance with this Section and include a description of the sequence of operation and reproducible drawings of the "as-built" system schematics.

.3 Maintain CD-R copies of all data file and application software for reload use in the event of a system crash or memory failure. Delivery one copy to the Owner during training sessions, and archive one copy in the control manufacturer's local software vault.

.4 "As-built" system schematics:

.1 Changes made during construction.

.2 Component final set points.

.3 Controller sensitivity and authority settings.

.4 Include maintenance instructions for control components supplied under this Section.

3.14 ADJUSTMENT AND DEMONSTRATION OF SYSTEMS

.1 After completion of the installation, regulate and adjust all sensors, motors and other equipment provided under this contract and place them in complete operating condition. Coordinate this work with the Mechanical Contractor and system balancing technicians.

.2 During the balancing and adjustment of the heating and ventilation systems, assist the Mechanical Contractor and system balancing technicians in the complete balancing of the systems.

.3 After this work is completed, advise the Consultant in writing that the installation is complete and ready for inspection.

3.15 TESTING AND REPORTING

.1 Conduct complete performance tests to demonstrate to the Consultant the correct operation of each individual control system and each item of control equipment. Repeat performance tests as necessary until all systems are proven satisfactory.

.2 Report Format

.1 Prepare test forms in MS Excel, Word, Access or other Database format.

.2 Include the following header information for each test report:

.1 Owner Name

.2 Project Name

.3 Contractor Name

.4 Consultant Name

.5 Name of Test Report

.3 Include the following on the front sheet of the consolidated report:

.1 Contractor Company Name

.2 Name and signature of the person submitting the report.

.3 Date of report

.4 The following statement: *"The undersigned certifies that the test results recorded in this report are correct, and that results have been witnessed by the trade responsible for the test".*

.4 Submit the above tests in a hardcopy form, separately bound from the Operations and Maintenance manuals, and in Adobe Acrobat PDF format, in accordance with Section 01 33 00.

.3 Controls Report

.1 Provide a test report in spreadsheet format which summarizes the following data for each piece of controls operation.

.1 Equipment ID and name.

.2 Device Location.

.3 ECU reference.

.4 BCU reference.

.5 I/O reference.

.2 Record the following tests for each device as applicable:

.1 Communications Loop Integrity Test.

.2 Sensor Range Test

.3 Actuator Stroke Test

.4 Controls logic function test – single loop.

.5 Controls logic function test – equipment or system test.

.3 Communications Loop Integrity Test

.1 Check communications between DDC controller and remote I/O device.

.4 Sensor Range Calibration Test

.1 Provide data for minimum and maximum sensor values, setpoint value and current value at time of test.

.5 Actuator Stroke Test

.1 Provide data on actuator stroke from 0-100% full stroke.

.2 Indicate output value vs. actuator position (i.e. 20 mA = 100% open).

.6 Controls Logic Function Test – Single Loop

.1 Two position actuators: use manual control function from operator's workstation to change current state of controller output

.2 Modulating valves: Vary Setpoint of control variable to modulate valve from 0-100% opening, at nominal 25% increments.

.7 Controls Logic Function Test – Equipment or System Test

.1 Create a point form checklist of the Sequence of Operation for each system.

.2 Operate system through each control sequence element specified.

.3 Operate each system through an actual power outage, and restart on power resumption.

.4 Operate each applicable system for automatic restart on emergency power.

.5 Operate each system through scheduled operation.

3.16 **COMMISSIONING ASSISTANCE**

.1 Provide fifteen days of eight hours each (net of travel time) after Substantial Performance for on-site programming in conjunction with the Owner's commissioning agent.

.2 Perform commissioning of the controls system in accordance with Section 25 05 00.

3.17 **SERVICE AND GUARANTEE**

.1 The controls systems herein specified shall be free from defects in workmanship and material under normal use and service after commissioning and acceptance of the complete control system.

.2 After acceptance of the systems by the Consultant, provide any service required for the proper performance of the control systems for a period of one year or one complete heating and cooling cycle.

.3 This service shall include readjustment of the controls for proper balance of the systems under the direction of the testing and balancing firm six months after the initial adjustment. The controls shall be adjusted and set for optimum performance under the changed operating conditions during this system rebalancing.

.4 Include replacement parts for defective components and any labour to remove and replace such parts at no cost to the Owner.

3.18 **SENSOR AND SWITCHES**

.1 Duct installation

.1 Do not mount in dead air space

.2 Thermally isolate elements from brackets and supports so as to respond to air temperature only.

.3 Support sensor element independently from coils and filter racks.

.2 Averaging Duct Type Sensor Switch

.1 Sensor length: not less than 1000 mm for each square meter of duct cross-sectional area.

.2 Wire multiple sensors in parallel for freeze protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.3 High Limit Controls

.1 Coverage

.1 Provide a temperature sensitive head for approximately every 1.5 sw. m of duct cross sectional area.

.2 Install heads in a staggered arrangement to give complete coverage of the duct.

.4 Low Limit Controls

.1 Coverage:

.1 String horizontally across the full width of duct or coil with runs at a maximum of 300 mm centres.

.2 Where one control is insufficient to provide the specified coverage, provide two or more controls to be wired in series.

.3 Coordinate with other trades so that the capillary does not obstruct access from access openings or doors to other duct mounted equipment.

.4 Coordinate with other trades so that the capillary does not obstruct access from access openings or doors to other duct mounted equipment.

.5 Airflow Stations

.1 Locate airflow stations in accordance with manufacturer’s guidelines so as to approach ideal laboratory conditions.

.2 Cap off manifold until cleaning of ducts is complete.

.6 Pressure and Differential Switches

.1 Install isolation valve and snubber between sensor and pressure source.

.2 Protect sensing elements on steam and high temperature greater than 98°C with pigtail syphon between valve and sensor.

End of Section

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