

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Use of mechanical systems during construction.

**1.2 USE OF SYSTEMS**

.1 Use of new and existing permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under following conditions:

- .1 Entire system is complete, pressure tested, cleaned, flushed out.
- .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
- .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
- .4 There is no possibility of damage.
- .5 Supply ventilation systems are protected by 60 % filters, inspected daily, changed every 2 weeks or more frequently as required.
- .6 Return systems have approved filters over openings, inlets, outlets.
- .7 Systems will be:
  - .1 Operated as per manufacturer's recommendations and instructions.
  - .2 Operated by Contractor.
  - .3 Monitored continuously by Contractor.
- .8 Warranties and guarantees are not relaxed.
- .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
- .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

Approved: 2009-06-30

**Part 1            General**

**1.1               RELATED REQUIREMENTS**

- .1        Section 23211301 – Hydronic Systems: Copper.
- .2        Section 23211302 – Hydronic Systems: Steel

**1.2               REFERENCES**

- .1        Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2        Canadian Standards Association (CSA International)
  - .1        CSA B139-04, Installation Code for Oil Burning Equipment.
- .3        Green Seal Environmental Standards (GSES)
  - .1        Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4        National Fire Code of Canada (NFCC 2005)
- .5        South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1        SCAQMD Rule 1113-A2007, Architectural Coatings.
  - .2        SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

**1.3               ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2        Product Data:
  - .1        Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.4               DELIVERY, STORAGE AND HANDLING**

- .1        Deliver, store and handle materials in accordance with Section 01 01 50 General Instructions and with manufacturer's written instructions.
- .2        Delivery and Acceptance Requirements:
  - .1        Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3        Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, paddling, and packaging materials in accordance with Section 01 01 50 General Instructions

**Part 2 Products**

**2.1 MATERIAL**

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
  - .1 Paints in accordance with manufacturer's recommendations for surface conditions.
  - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11 to SCAQMD Rule 1113.
  - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 to SCAQMD Rule 1113.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
  - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.
- .4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.
- .5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2 CONNECTIONS TO EQUIPMENT**

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

**3.3 CLEARANCES**

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer CSA B139 as indicated without interrupting operation of other system, equipment, components.

**3.4 DRAINS**

- .1 Install piping with grade in direction of flow except as indicated.



- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
  - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

### **3.5 AIR VENTS**

- .1 Install manual air vents to CSA B139 at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

### **3.6 DIELECTRIC COUPLINGS**

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

### **3.7 PIPEWORK INSTALLATION**

- .1 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
  - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Install globe valves in bypass around control valves.
  - .6 Use ball valves at branch take-offs for isolating purposes except where specified.
  - .7 Install butterfly valves on chilled water and related condenser water systems only.
  - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
  - .9 Install ball valves for glycol service.
  - .10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .16 Check Valves:
  - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
  - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

### **3.8 SLEEVES**

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

- .2 Other floors: terminate 25 mm above finished floor.
- .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere:
    - .1 Provide space for firestopping.
    - .2 Maintain fire rating integrity.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### **3.9 ESCUTCHEONS**

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one piece type with set screws.
  - .1 Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: outside diameter to cover opening or sleeve.
  - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

### **3.10 PREPARATION FOR FIRE STOPPING**

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 01 01 50 General Instructions
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fire stopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

### **3.11 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Flush system in accordance with Section 01 01 50 General Instructions.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 01 50 General Instructions supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

### **3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Departmental Representative hours minimum prior to performance of pressure tests.

- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Perform pressure tests on new gas service (5psi line) line on site and new gas pipes in building to meet code requirements and submit report. Clean and dry pipes prior to pressure tests.
- .4 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .5 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .6 Conduct tests in presence of Departmental Representative.
- .7 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .8 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

### **3.13 EXISTING SYSTEMS**

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

### **3.14 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 Electrical motors, drives and guards for mechanical equipment and systems.
- .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
- .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 01 50 - General Instructions.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 - General Instructions. Include product characteristics, performance criteria, and limitations.
  - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50- General Instructions.
  - .2 Shop Drawings: submit shop drawings.
- .3 Quality Control: in accordance with Section 01 01 50 - General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.4 Closeout Submittals

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 01 50 - General Instructions.

**1.4 QUALITY ASSURANCE**

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
- .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

**Part 2 Products**

**2.1 GENERAL**

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

**2.2 MOTORS**

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W (1/2 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, unless otherwise indicated.

**2.3 TEMPORARY MOTORS**

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

**2.4 BELT DRIVES**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW (10 HP) : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 01 50 - General Instructions.

**2.5 DRIVE GUARDS**

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
  - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.-
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
  - .2 Net free area of guard: not less than 80% of fan openings.
  - .3 Securely fasten in place.
  - .4 Removable for servicing.

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2 INSTALLATION**

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

**3.3 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 01 50 - General Instructions and submit report as described in 01 01 05 - General Instructions.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in 01 01 50- General Instructions.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in 01 01 50- General Instructions.

**3.4 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 - General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



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**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 23211301 – Hydronic Systems: Copper.
- .2 Section 23211302 – Hydronic Systems: Steel.

**1.2 REFERENCES**

- .1 ASTM International Inc.
  - .1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
  - .2 ASTM A105/A105M-05, Standard Specification for Carbon Steel Forgings, for Piping Applications.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Manufacturer, model number, line contents, pressure and temperature rating.
    - .2 Movement handled, axial, lateral, angular and the amounts of each.
    - .3 Nominal size and dimensions including details of construction and assembly.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance and operation data in accordance with Section 01 01 50 General Instructions
  - .1 Data to include:
    - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 01 50 General Instructions..

**Part 2 Products****2.1 SLIP TYPE EXPANSION JOINTS**

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150, 1MPa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with raised face slip-on flanges to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 minimum, PTFE or graphite impregnated non-asbestos.
- .9 Thermal plastic packing: PTFE or graphite impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
  - .1 Plunger body: heavy wall carbon steel welded to body.
  - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

**2.2 BELLOWS TYPE EXPANSION JOINTS**

- .1 For axial, lateral or angular movements, as indicated.
- .2 Maximum operating pressure: 862 kPa as indicated.
- .3 Maximum operating temperature: 210 degrees C as indicated.
- .4 Type A: controlled free flexing, factory tested to 1 1/2 times maximum working pressure. Provide test certificates.
- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 1/2 times maximum working pressure. Provide test certificates.

- .6 Bellows:
  - .1 Multiple bellows, hydraulically formed, single ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
  - .1 2 piece nickel iron.
- .8 Ends:
  - .1 For butt welding flanges to match pipe.
- .9 Liner:
  - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
  - .1 Carbon steel, painted.

## **2.3 GROOVED END EXPANSION JOINTS**

- .1 Packless, Gasketed, Slip, Expansion Joints:
  - .1 2413 kPa maximum working pressure.
  - .2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.
  - .3 PTFE modified polyphenylene sulfide coated slide section.
  - .4 Suitable for axial end movement to 75 mm.
- .2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

## **2.4 FLEXIBLE CONNECTION**

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated
- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket].
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
  - .1 Working pressure: 1034 kPa.
  - .2 Working temperature: 210 degrees C.
  - .3 To match system requirements.
- .7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

**2.5 ANCHORS AND GUIDES**

- .1 Anchors:
  - .1 Provide as indicated.
  - .2 Concrete: to Section 01 01 50 General Instructions.
  - .3 Reinforcement: to 01 01 50 General Instructions.
- .2 Alignment guides:
  - .1 Provide as indicated by conduit manufacturer.
  - .2 To accommodate specified thickness of insulation.
  - .3 Vapour barriers, jackets to remain uninterrupted.

**Part 3 Execution****3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2 INSTALLATION**

- .1 Install expansion joints with cold setting, as instructed by Departmental Representative. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150 % of axial thrust.
- .4 Do welding in accordance with section 23 05 17 – Pipe Welding.

**3.3 PIPE CLEANING AND START-UP**

- .1 In accordance with Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems.

**3.4 PERFORMANCE VERIFICATION**

- .1 In accordance with Section 23 08 01 – Performance Verification: Mechanical Piping Systems.

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

Approved: 2008-12-31

**Part 1            General**

**1.1               RELATED REQUIREMENTS**

.1

**1.2               REFERENCES**

.1       American National Standards Institute/American Society of Mechanical Engineers  
(ANSI/ASME)

- .1       ANSI/ASME B31.1-2007, Power Piping.
- .2       ANSI/ASME B31.3-2006, Process Piping.
- .3       ANSI/ASME Boiler and Pressure Vessel Code-2007:
  - .1       BPVC 2007 Section I: Power Boilers.
  - .2       BPVC 2007 Section V: Nondestructive Examination.
  - .3       BPVC 2007 Section IX: Welding and Brazing Qualifications.

.2       American National Standards Institute/American Water Works Association  
(ANSI/AWWA)

- .1       ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.

.3       American Welding Society (AWS)

- .1       AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.
- .2       AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
- .3       AWS W1-2000, Welding Inspection Handbook..

.4       Canadian Standards Association (CSA International)

- .1       CSA W47.2-M1987(R2008), Certification of Companies for Fusion Welding of Aluminum.
- .2       CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- .3       CSA B51-03(R2007), Boiler, Pressure Vessel and Pressure Piping Code.
- .4       CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.
- .5       CSA W178.1-2008, Certification of Welding Inspection Organizations.
- .6       CSA W178.2-2008, Certification of Welding Inspectors.

**1.3               ACTION AND INFORMATIONAL SUBMITTALS**

.1       Provide submittals in accordance with Section 01 01 50 General Instructions.

**1.4               QUALITY ASSURANCE**

.1       Qualifications:

- .1       Welders:
  - .1       Welding qualifications in accordance with CSA B51.

- .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
- .3 Submit welder's qualifications to Departmental Representative.
- .4 Each welder to possess identification symbol issued by authority having jurisdiction.
- .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
  - .1 Inspectors qualified to CSA W178.2.
- .3 Certifications:
  - .1 Registration of welding procedures in accordance with CSA B51.
  - .2 Copy of welding procedures available for inspection.
  - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 01 50 General Instructions.

## **Part 2 Products**

### **2.1 ELECTRODES**

- .1 Electrodes: in accordance with CSA W48 Series.

## **Part 3 Execution**

### **3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 QUALITY OF WORK**

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Division 15 applicable requirements of provincial authority having jurisdiction.

### **3.3 INSTALLATION REQUIREMENTS**

- .1 Identify each weld with welder's identification symbol.

- .2 Backing rings:
  - .1 Where used, fit to minimize gaps between ring and pipe bore.
  - .2 Do not install at orifice flanges.
- .3 Fittings:
  - .1 NPS 2 and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.

### **3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

### **3.5 SPECIALIST EXAMINATIONS AND TESTS**

- .1 General:
  - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
  - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
  - .3 Inspect and test % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests] and spot full gamma ray radiographic (hereinafter referred to as "radiography") tests.
- .2 Hydrostatically test welds to ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
  - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative of total of up to 10 % of welds, selected at random by Departmental Representative by radiographic particle tests.
- .5 Full radiographic tests for piping systems.
  - .1 Spot radiography:
    - .1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Departmental Representative from welds which would be most difficult to repair in event of failure after system is operational.
  - .2 Radiographic film:



- .1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality.
- .3 Interpretation of radiographic films:
  - .1 By qualified radiographer.
- .4 Failure of radiographic tests:
  - .1 Extend tests to welds by welder responsible when those welds fails tests.
- .6 Magnetic particle tests for piping systems.

### **3.6 DEFECTS CAUSING REJECTION**

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems below kPa:
  - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
  - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
  - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
  - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8mm.
  - .5 Repair cracks and defects in excess of 0.8mm in depth.
  - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic particle tests.

### **3.7 REPAIR OF WELDS WHICH FAILED TESTS**

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

### **3.8 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

Approved: 2006-09-30

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and components for metering steam and chilled/hot water including installation.

**1.2 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition 1971.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
    - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
- .3 Submittals to include:
  - .1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.
  - .2 Service conditions.
  - .3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.
  - .4 Accuracy statements for each component at specified flow rates and other conditions.
  - .5 Flow and temperature ranges.
  - .6 Signal processor calibration data.
  - .7 Minimum turndown ratio.
- .4 Samples:

- .1 Submit sample in accordance with Section 01 01 50 General Instructions.
- .2 Samples to include:
  - .1 Full size samples of recorder charts, integrator readings.
- .5 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.
- .6 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .1 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .7 Closeout Submittals:
  - .1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 01 50 General Instructions.

#### **1.4 QUALITY ASSURANCE**

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

### **Part 2 Products**

#### **2.1 SUSTAINABLE REQUIREMENTS**

- .1 Materials and products in accordance with Section 01 01 50 General Instructions.
  - .1

#### **2.2 ACCURACY**

- .1 Calculate overall accuracy of each installation using following expression: Overall accuracy =  $(E (\text{accuracy of individual components of system})^2)^{1/2}$ .
- .2 Components to include:
  - .1 Primary flow measuring elements.

- .2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
- .3 RTD's.
- .4 Signal processors, recorders.
- .5 Calibration of signal processors: assume 0.20% per processor.
- .6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.
- .3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.
- .4 Indicate minimum measurable flow rate.

## **2.3 HOT WATER METERING**

- .1 Type of metering:
  - .1 Wide range thermal power (i.e. demand), thermal energy consumption, supply and return temperature, compensated for specific gravity.
- .2 Design data:
  - .1 Flow rates:
    - .1 100% Design: kg/h.
    - .2 Normal design flow rate: 70% of 100% design flow rate.
    - .3 Minimum flow rate: 10 % of maximum.
  - .2 Pressure: 820 kPa.
  - .3 Supply temperature: 93 degrees C.
  - .4 Return temperature: 83 degrees C.
- .3 State in proposal:
  - .1 Point of change-over.
  - .2 How change-over will be achieved.
- .4 Design differential pressure at normal design flow rate: 25kPa.
- .5 Maximum accuracy of complete meter installation at normal design flow and design temperatures to be plus or minus %.
- .6 Primary flow measuring elements:
  - .1 Type stainless steel square edged thin plate orifice plate mounted between 2000 kPa raised face slop-on orifice flanges having differential NPS 3/4 pressure taps.
  - .2 Type: stainless steel venturi.
  - .3 Type: stainless steel nozzle.
  - .4 Averaging velocity pressure type pitot tube (Annubar).
  - .5 Magnetic.
  - .6 Full bore or Insertion type or turbine.
- .7 Flow transmitters may form an integral part of primary flow measuring element.

- .8 Standard of design for venturi primary flow measuring elements: ASME Fluid Meter Handbook.
- .9 State in proposal maximum irrecoverable head loss (IHL).
- .10 Available lengths of straight pipe to first fitting, and intrusion: as indicated.
- .11 State in proposal minimum lengths of straight pipe required upstream and downstream of primary element to meet specified accuracy requirements.
- .12 Diameter of main for installation of primary element: NPS High flow range: NPS; low flow range: NPS.
- .13 If meter to be smaller than main size, state in proposal size of pipe required.
- .14 Temperature sensors:
  - .1 100 ohm RTD.
  - .2 Thermowells to NPS 3/4 stainless steel thermowell filled with conductive paste with following insertion lengths:
    - .1 Up to NPS 6: 75 mm.
    - .2 NPS 8 and over: 150 mm.
  - .3 Sensors for temperature difference measurements to be matched pairs.
- .15 Acceptable types of transmitters, signal conditioners and computing devices:
  - .1 Transmitters:
  - .2 Signal conditioners:
  - .3 Computing devices:
- .16 Acceptable types of readout instruments:
  - .1 Integrators: 6-digit, 8 mm high lettering, non-reset:
  - .2 Recorders: 250mm diameter circular 100 mm high, 19mm/hour, 30 day roll Z-fold 3-pen strip chart.
    - .1 Pen #1: thermal power
    - .2 Pen #2: water flow rate
    - .3 Pen #3: temperature difference
- .17 Read-out instrument display:
  - .1 Thermal power: 0 -kJ/s kW.
  - .2 Thermal energy consumption: 0 -999999 MJ.
  - .3 Water flow rate: 0 - L/s.
  - .4 Temperature difference: 0 -degrees C.
- .18 Ambient conditions at transmitters: temperature: degrees C; RH: %.
- .19 Signal transmission between primary measuring element and signal conditioners:
  - .1 Power: 24 VDC.
  - .2 Signal: 4-20 mA 0-10 VDC.

- .3 Cable: colour coded, twisted and shielded pair with grounding wire.
  - .20 Locations:
    - .1 Transmitters:
    - .2 Signal conditioners:
    - .3 Computing devices:
    - .4 Readout instruments:
  - .21 Connection to Building Automation System (BAS):
  - .22 Installation mountings:
    - .1 Transmitters:
    - .2 Signal conditioners:
    - .3 Computing devices:
    - .4 Readout instruments:
- 2.4 GAS METERS**
  - .1 Refer section 23 11 23.
  - .2 Provide provisions for EMCS monitoring the gas consumption.
- Part 3 Execution**
  - 3.1 MANUFACTURER'S INSTRUCTIONS**
    - .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
  - 3.2 PREPARATION**
    - .1 Before final calculations for orifice diameter, and before purchase of orifice plate, nozzle, venturi, measure:
      - .1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
      - .2 For concentricity of pipe.
  - 3.3 INSTALLATION OF PRIMARY ELEMENT**
    - .1 Follow manufacturer's instructions.
  - 3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING**
    - .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.
    - .2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

**3.5            INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF  
PRIMARY ELEMENT**

- .1        Mount on pipe stand installed and located to ensure no damage by passing traffic.

**3.6            INSTALLATION OF SIGNAL TRANSMISSION CABLE**

- .1        Ground shielding at one point only.
- .2        Protect against RF interference.
- .3        Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

**3.7            START-UP**

- .1        Follow manufacturer's recommendations.

**3.8            FIELD QUALITY CONTROL**

- .1        Verification requirements in accordance with Section 01 01 50 General Instructions:  
Contractor's Verification, include:
  - .1        Materials and resources.
  - .2        Storage and collection of recyclables.
  - .3        Construction waste management.
  - .4        Resource reuse.
  - .5        Recycled content.
  - .6        Local/regional materials.
  - .7        Certified wood.
  - .8        Low-emitting materials.

**3.9            CLEANING**

- .1        Proceed in accordance with Section
- .2        Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**THERMOMETERS AND PRESSURE GAUGES - PIPING SYSTEMS**

**TWENTY BED LIVING UNIT**

Page 1

**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Materials and installation for thermometers and pressure gauges in piping systems.

**1.2 RELATED SECTIONS**

- .1 Section 01 01 50 General Instructions.
- .2 Section 23 05 53.01 - Mechanical Identification.

**1.3 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME).
  - .1 ASME B40.100-01, Pressure Gauges and Gauge Attachments.
  - .2 ASME B40.200-01, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
  - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

**1.4 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50 General Instructions.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
  - .1 Thermometers.
  - .2 Pressure gauges.
  - .3 Stop cocks.
  - .4 Syphons.
  - .5 Wells.

**1.5 HEALTH AND SAFETY**

- .1 Do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.

**1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.



**THERMOMETERS AND PRESSURE GAUGES - PIPING SYSTEMS**

**TWENTY BED LIVING UNIT**

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- .2 Collect, separate and place in designated containers for reuse and recycling paper, plastic, polystyrene, corrugated cardboard, packaging metal, and plastic in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed, labelled and stored safely for disposal away from children.

**Part 2 Products**

**2.1 GENERAL**

- .1 Design point to be at mid point of scale or range.
- .2 Ranges: as indicated.

**2.2 DIRECT READING THERMOMETERS**

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB14.4 ASME B40.200.

**2.3 REMOTE READING THERMOMETERS**

- .1 100 mm diameter mercury-free liquid filled vapour activated dial type: to CAN/CGSB-14.5 ASME B40.200 , accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.

**2.4 THERMOMETER WELLS**

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

**2.5 PRESSURE GAUGES**

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
  - .1 Siphon for steam service.
  - .2 Snubber for pulsating operation.
  - .3 Diaphragm assembly for corrosive service.
  - .4 Gasketed pressure relief back with solid front.
  - .5 Bronze stop cock.
  - .6 Oil filled for high vibration applications .

**THERMOMETERS AND PRESSURE GAUGES - PIPING SYSTEMS**

**TWENTY BED LIVING UNIT**

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**Part 3 Execution**

**3.1 GENERAL**

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

**3.2 THERMOMETERS**

- .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Heat exchangers.
  - .2 Water heating and cooling coils.
  - .3 Water boilers.
  - .4 DHW tanks .
- .3 Install wells as indicated only for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

**3.3 PRESSURE GAUGES**

- .1 Install in following locations:
  - .1 Suction and discharge of pumps.
  - .2 Upstream and downstream of PRV's.
  - .3 Upstream and downstream of control valves.
  - .4 Inlet and outlet of coils.
  - .5 Inlet and outlet of liquid side of heat exchangers.
  - .6 Outlet of boilers.
  - .7 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

**3.4 NAMEPLATES**

- .1 Install engraved lamicoid nameplates as specified in Section 23 05 53.01, identifying medium.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
  - .1 ASTM A276-08, Standard Specification for Stainless Steel Bars and Shapes.
  - .2 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .3 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
  - .4 ASTM B505/B505M-08a, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
  - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
  - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 01 50 General Instructions
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Submit data for valves specified in this Section.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials/Spare Parts:
  - .1 Furnish following spare parts:
    - .1 Valve seats: one for every 10 valves each size, minimum 1.
    - .2 Discs: one for every 10 valves, each size. Minimum 1.
    - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
    - .4 Valve handles: 2 of each size.
    - .5 Gaskets for flanges: one for every 10 flanged joints.
  - .2 Tools:
    - .1 Furnish special tools for maintenance of systems and equipment.
    - .2 Include following:
      - .1 Lubricant gun for expansion joints.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 01 50 General Instructions and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 01 50 General Instructions.

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Valves:
  - .1 Except for specialty valves, to be single manufacturer.
  - .2 Products to have CRN registration numbers.
- .2 End Connections:
  - .1 Connection into adjacent piping/tubing:
    - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
    - .2 Copper tube systems: solder ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
  - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
  - .1 Requirements common to gate valves, unless specified otherwise:
    - .1 Standard specification: MSS SP-80.

- .2 Bonnet: union with hexagonal shoulders.
  - .3 Connections: screwed with hexagonal shoulders.
  - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
  - .5 Packing: non-asbestos.
  - .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
  - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
  - .2 Operator: Handwheel.
- .3 NPS 2 and under, rising stem, split wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
  - .3 Operator: handwheel.
- .4 NPS 2 and under, rising stem, solid wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Operator: handwheel.
- .5 Globe Valves:
  - .1 Requirements common to globe valves, unless specified otherwise:
    - .1 Standard specification: MSS SP-80.
    - .2 Bonnet: union with hexagonal shoulders.
    - .3 Connections: screwed with hexagonal shoulders.
    - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
    - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
    - .6 Handwheel: non-ferrous.
    - .7 Handwheel Nut: bronze to ASTM B62.
  - .2 NPS 2 and under, composition disc, Class 125:
    - .1 Body and bonnet: screwed bonnet.
    - .2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
    - .3 Operator: handwheel
- .6 Check Valves:
  - .1 Requirements common to check valves, unless specified otherwise:
    - .1 Standard specification: MSS SP-80.
    - .2 Connections: screwed with hexagonal shoulders.
  - .2 NPS 2 and under, swing type, bronze disc, Class 125:
    - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
    - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
  - .3 NPS 2 and under, swing type, bronze disc:

- .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
- .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 NPS 2 and under, vertical lift type, bronze disc, Class 125:
  - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
  - .1 NPS 2 and under:
    - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
    - .2 Pressure rating: Class 125.
    - .3 Connections: screwed ends to ANSI B1.20.1 and with hex shoulders.
    - .4 Disc and seat: renewable rotating disc.
    - .5 Stainless steel spring, heavy duty.
    - .6 Seat: regrindable.
- .8 Ball Valves:
  - .1 NPS 2 and under:
    - .1 Body and cap: cast high tensile bronze to ASTM B62.
    - .2 Pressure rating: Class 125, 860 kPa steam.
    - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders solder ends to ANSI.
    - .4 Stem: tamperproof ball drive.
    - .5 Stem packing nut: external to body.
    - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
    - .7 Stem seal: TFE with external packing nut.
    - .8 Operator: removable lever handle.
- .9 Butterfly Valves:
  - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
    - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
    - .2 Disc: elastomer coated ductile iron with integrally cast stem.
    - .3 Operator: lever or handwheel.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

**3.2 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASTM International Inc.
  - .1 ASTM A49-01(2006), Standard Specification for Heat-Treated Carbon Steel Joint Bars.
  - .2 ASTM A126-04, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - .3 ASTM A536-84(2004)e1, Standard Specification for Ductile Iron Castings.
  - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .6 ASTM B85/B85M-08, Standard Specification for Aluminum-Alloy Die Castings.
  - .7 ASTM B209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1 MSS SP-61-03, Pressure Testing of Steel Valves.
  - .2 MSS SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4 MSS SP-82-1992, Valve Pressure Testing Methods.
  - .5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 – General Instructions
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.

**1.3            CLOSEOUT SUBMITTALS**

- .1 Submit maintenance data for incorporation into manual specified in Section 01 01 50 – General Instructions.



**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 01 50 – General Instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return of pallets, and packaging materials in accordance with Section 01 01 50 – General Instructions..

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
  - .1 Valve seats: one for every 10 valves each size, minimum 1.
  - .2 Discs: one for every 10valves, each size, minimum 1.
  - .3 Stem packing: one for every 10 valves, each size, minimum 1.
  - .4 Valve handles: 2 of each size.
  - .5 Gaskets for flanges: one for every 10 flanged joints.
- .3 Tools:
  - .1 Furnish special tools for maintenance of systems and equipment.
  - .2 Include following:
    - .1 Lubricant gun for expansion joints.

**Part 2 Products**

**2.1 MATERIAL**

- .1 Valves:
  - .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
  - .1 Gate valves: MSS SP-70.
  - .2 Globe valves: MSS SP-85.
  - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
  - .1 Body, bonnet: cast iron to ASTM B209 Class B, ductile iron to ASTM A536 Grade 65-45-12.
  - .2 Connections: flanged ends plain face to ANSI B16.1.
  - .3 Inspection and pressure testing: to MSS SP-82.
  - .4 Bonnet gasket: non-asbestos.

- .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
- .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
- .7 Gland packing: non-asbestos.
- .8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
- .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

## **2.2 GATE VALVES**

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc:
  - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
  - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
  - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
  - .4 Stem: bronze to ASTM B62.
  - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem for gas services.
  - .6 Seat: integral with body.
  - .7 Stem: wrought steel.
  - .8 Operator: handwheel.
  - .9 Bypass: complete with union and NPS globe valve as Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
  - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
  - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
  - .3 Seat rings: renewable bronze screwed into body.
  - .4 Stem: manganese-bronze.
  - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection for gas services.
  - .6 Seat rings: integral with body.
  - .7 Stem: nickel-plated steel.
  - .8 Pressure-lubricated operating mechanism.
  - .9 Operator: handwheel.
  - .10 Bypass: complete with union and NPS globe valve as Section 23 05 05 - Installation of Pipework.

## **2.3 UNDERWRITERS APPROVED GATE VALVE**

### **.1 NPS 2 1/2 - 14, OS&Y:**

- .1 Approvals: UL and FM approved for fire service.
- .2 UL and FM Label: on valve yoke.
- .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B), ductile iron to ASTM A536 Grade 65-45-12.
- .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
- .5 Packing gland: bronze.
- .6 Stem: manganese bronze. Diameter to ULC C-262 (B).
- .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
- .8 Bosses for bypass valve, drain: on NPS 4 and over.
- .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.
- .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
- .11 Pressure rating:
  - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
  - .2 NPS 14-1.2: 1.2 MPa CWP.
- .12 Operator: handwheel.
- .13 Bypass: complete with union and NPS gate valve as Section 23 05 23.01 - Valves - Bronze.

## **2.4 GLOBE VALVES**

### **.1 NPS 2 1/2 - 10, OSY:**

- .1 Body: with multiple-bolted bonnet.
- .2 WP: 860 kPa steam, 1.4 MPa CWP.
- .3 Bonnet-yoke gasket: non-asbestos.
- .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
- .5 Seat ring: renewable, regrindable, screwed into body.
- .6 Stem: bronze to ASTM B62.
- .7 Operator: handwheel.
- .8 Bypass: complete with union and NPS globe valve as Section 23 05 23.01 - Valves - Bronze.

## **2.5 BYPASSES FOR GATE AND GLOBE VALVES**

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves:.
- .3 Size of bypass valve:
  - .1 Main valve up to NPS 8: NPS 3/4.
  - .2 Main valve NPS 10 and over: NPS 1.
- .4 Type of bypass valves:

- .1 On gate valve: globe, with bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.
- .2 On globe valve: globe, with bronze disc, bronze trim, to Section 23 05 23.01 - Valves – Bronze. Pressure rating to match main valve.

## **2.6 VALVE OPERATORS**

- .1 Install valve operators as follows:
  - .1 Handwheel: on valves except as specified.
  - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

## **2.7 CHECK VALVES**

- .1 Swing check valves, Class 125:
  - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.
    - .1 Up to NPS 16: cast iron to ASTM A126 Class B, ductile iron ASTM A536 Grade 65-45-12.
  - .2 Ratings:
    - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
  - .3 Disc: rotating for extended life.
    - .1 Up to NPS 6: bronze to ASTM B62, stainless steel type 316.
  - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
  - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
  - .6 Seat: cast iron, integral with body.
  - .7 Hinge pin: exelloy; bushings: malleable iron.
  - .8 Identification tag: fastened to cover.
  - .9 Hinge: stainless steel.

## **2.8 SILENT CHECK VALVES**

- .1 Construction:
  - .1 Body: malleable or ductile iron] with integral seat.
  - .2 Pressure rating: Class 125, WP = 860 kPa.
  - .3 Connections: grooved ends.
  - .4 Disc: bronze or stainless steel renewable rotating disc.
  - .5 Seat: renewable, EPDM.
  - .6 Stainless steel spring, heavy duty.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.

**3.2 CLEANING**

- .1 Clean in accordance with Section 01 01 50 – General Instructions.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 – General Instructions.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.
- .2 Sustainable requirements for construction and verification.

**1.2 REFERENCES****.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)**

- .1 ANSI/ASME B31.1-07, Power Piping.

**.2 American Society for Testing and Materials International (ASTM)**

- .1 ASTM A125-1996(R2007), Specification for Steel Springs, Helical, Heat-Treated.
- .2 ASTM A307-07b, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .3 ASTM A563-07a, Specification for Carbon and Alloy Steel Nuts.

**.3 Factory Mutual (FM)****.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)**

- .1 Material Safety Data Sheets (MSDS).

**.5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)**

- .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
- .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
- .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

**.6 Underwriter's Laboratories of Canada (ULC)****1.3 SYSTEM DESCRIPTION****.1 Design Requirements:**

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by MSS SP58.ASME B31.1 or
- .3 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .4 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

.2 Performance Requirements:

- .1 Design supports, platforms, catwalks, hangers, to withstand seismic events as specified Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

**1.4 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 01 50 - General Instructions.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
- .3 Submit shop drawings and product data for following items:
- .1 Bases, hangers and supports.
- .2 Connections to equipment and structure.
- .3 Structural assemblies.
- .4 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.
- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
- .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .5 Closeout Submittals:
- .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 - General Instructions.

**1.5 QUALITY ASSURANCE**

- .1 Health and Safety:
- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
- .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

**Part 2 Products****2.1 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

**2.2 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized after manufacture.
  - .2 Use electro-plating galvanizing process.
  - .3 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9 mm ULC listed.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, ULC listed and FM approved.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate ULC listed and FM approved to MSS SP69.
- .5 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
  - .3 Do not use 22 mm or 28 mm rod.
- .6 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel black or galvanized.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.
  - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP69 ULC listed and FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.



- .1 Finishes for steel pipework: black or galvanized.
- .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion plastic coated.

## **2.3 RISER CLAMPS**

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, ULC listed and FM approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

## **2.4 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

## **2.5 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

- .1 Provide templates to ensure accurate location of anchor bolts.

## **2.6 HOUSE-KEEPING PADS**

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

## **2.7 OTHER EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports from structural grade steel meeting structural requirements.
- .2 Submit structural calculations with shop drawings.

# **Part 3 Execution**

## **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

## **3.2 INSTALLATION**

- .1 Install in accordance with:
  - .1 manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to industry standards.
  - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

### 3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code, Provincial Code and authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	

- .6 Pipework greater than NPS 12: to MSS SP69.

### 3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

### 3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

### **3.6 FINAL ADJUSTMENT**

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

### **3.7 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 01 50 for Quality Control and submit report as described in 01 01 50 – Submittal Procedures.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in 01 01 50 – Submittal Procedures.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in 01 01 50 – Quality Control.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Vibration isolation materials and components, seismic control measures and their installation.

**1.2 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada (NBC) - 2010

**1.3 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 01 50 - General Instructions.
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 - General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 - General Instructions.
- .2 Submit shop drawings in accordance with Section 01 01 50 - General Instructions.
  - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
  - .3 Provide detailed drawings of seismic control measures for equipment and piping.
- .3 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
  - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

**1.4 QUALITY ASSURANCE**

- .1 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

### **2.2 ELASTOMERIC PADS**

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

### **2.3 ELASTOMERIC MOUNTS**

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

### **2.4 SPRINGS**

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for outdoor installations.
- .4 Colour code springs.

### **2.5 SPRING MOUNT**

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring; support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

## **2.6 HANGERS**

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

## **2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES**

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

## **2.8 SEISMIC CONTROL MEASURES**

- .1 General:
  - .1 Seismic control systems to work in every direction.
  - .2 Fasteners and attachment points to resist same maximum load as seismic restraint.
  - .3 Drilled or power driven anchors and fasteners not permitted.
  - .4 No equipment, equipment supports or mounts to fail before failure of structure.
  - .5 Supports of cast iron or threaded pipe not permitted.
  - .6 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
  - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
  - .2 Suspended equipment:
    - .1 Use one or more of following methods depending upon site conditions and as indicated:
      - .1 Install tight to structure.
      - .2 Cross brace in every direction.
      - .3 Brace back to structure.
      - .4 Cable restraint system.
    - .3 Seismic restraints:
      - .1 Cushioning action gentle and steady.

- .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
  - .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 As indicated.
- .4 Piping systems:
  - .1 Fire protection systems: to NFPA 13.
  - .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
  - .3 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
  - .1 Approved by Departmental Representative.
  - .2 Structural angles or channels.
  - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.
- .6 Service and utilities entrance into building: to meet code requirements.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

#### **3.2 INSTALLATION**

- .1 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
  - .1 Up to NPS4: first 3 points of support.
  - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.

- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

### **3.3 FIELD QUALITY CONTROL**

- .1 Inspection and Certification:
  - .1 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
  - .2 Submit complete report of test results including sound curves.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 - General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including fire protection, communications, equipment and systems, both vibration isolated and statically supported.
- .2 Related Requirements :
  - .1 Section 23 05 29 – Hangers and Supports for Piping and Equipment.
  - .2 Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA G40.20/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .3 National Building Code of Canada (NBC) – 2010

**1.3 DESCRIPTIONS**

- .1 Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2 SRS: acronym for Seismic Restraint System.

**1.4 SYSTEM DESCRIPTION**

- .1 SRS fully integrated into, and compatible with:
  - .1 Noise and vibration controls specified elsewhere.
  - .2 Structural, mechanical, electrical design of project.
- .2 Systems, equipment not required to be operational during and after seismic event.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.

**1.5 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 01 50 - General Instructions.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in British Columbia, Canada.
- .3 Submit design data including:

- .1 Full details of design criteria.
- .2 Working drawings (prepared to same standard of quality and size as documents forming these tender documents), materials lists, schematics, full specifications for components of each SRS to be provided.
- .3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
- .4 Separate shop drawings for each SRS and devices for each system, equipment.
- .5 Identification of location of devices.
- .6 Schedules of types of SRS equipment and devices.
- .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
- .8 Installation procedures and instructions.
- .9 Design calculations including restraint loads to NBC and Supplement.
- .10 Detailed work sheets, tables
- .11 Detailed design of SRS including complete working drawings prepared to same standard of quality and size as Contract Documents, materials lists, design calculations, schematics, specifications.
- .4 Submit additional copy of shop drawings and product data to Structural Engineer for review of connection points to building structure.
- .5 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .6 Closeout Submittals:
  - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 01 50 - General Instructions.

## **1.6 QUALITY ASSURANCE**

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 01 50 - General Instructions.

**Part 2 Products****2.1 SRS MANUFACTURER**

- .1 SRS from one manufacturer regularly engaged in SRS production.

**2.2 GENERAL**

- .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS of Piping systems compatible with:
  - .1 Expansion, anchoring and guiding requirements.
  - .2 Equipment vibration isolation and equipment SRS.
- .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .6 Attachments to RC structure:
  - .1 Use high strength mechanical expansion anchors.
  - .2 Drilled or power driven anchors not permitted.
- .7 Wet pipe sprinkler systems: refer to Section 21 13 13 - Wet Pipe Sprinkler Systems.
- .8 Seismic control measures not to interfere with integrity of firestopping.

**2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS**

- .1 Floor-mounted equipment, systems:
  - .1 Anchor equipment to equipment supports.
  - .2 Anchor equipment supports to structure.
  - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
    - .1 Install tight to structure.
    - .2 Cross-brace in every direction.
    - .3 Brace back to structure.
    - .4 Slack cable restraint system.
  - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

**2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT**

- .1 Floor mounted equipment, systems:
  - .1 Use one or combination of following methods:

- .1 Vibration isolators with built-in snubbers.
  - .2 Vibration isolators and separate snubbers.
  - .3 Built-up snubber system approved by Departmental Representative, consisting of structural elements and elastomeric layer.
- .2 SRS to resist complete isolator unloading.
- .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
- .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
  - .1 Use one or combination of following methods:
  - .2 Slack cable restraint system.
  - .3 Brace back to structure via vibration isolators and snubbers.

## **2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)**

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

## **2.6 SERVICE UTILITIES ENTRANCE INTO BUILDING**

- .1 Provide flexibility to prevent breakage in the event of earthquake activity.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 INSTALLATION**

- .1 Attachment points and fasteners:
  - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .2 Slack Cable Systems (SCS):
  - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
  - .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.

- .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
- .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
- .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
- .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
- .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .3 Install SRS at least 25 mm from equipment, systems, services.
- .4 Miscellaneous equipment not vibration-isolated:
  - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.
- .6 Vertical tanks:
  - .1 Anchor through house-keeping pad to structure.
  - .2 Provide steel bands above centre of gravity.
- .7 Horizontal tanks:
  - .1 Provide at least two straps with anchor bolts fastened to structure.

### 3.3 CLEANING

- .1 Proceed in accordance with Section 01 01 50 - General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1    Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

**1.2            REFERENCES**

- .1    Canadian Gas Association (CGA)
  - .1    CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2    Canadian General Standards Board (CGSB)
  - .1    CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
  - .2    CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3    National Fire Protection Association (NFPA)
  - .1    NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

**1.3            ACTION AND INFORMATION SUBMITTALS**

- .1    Product Data.
- .2    Submittals: in accordance with Section 01 01 50 - General Instructions.
- .3    Product data to include paint colour chips, other products specified in this section.
- .4    Samples:
  - .1    Submit samples in accordance with Section 01 01 50 - General Instructions.
  - .2    Samples to include nameplates, labels, tags, lists of proposed legends.

**1.4            QUALITY ASSURANCE**

- .1    Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.
- .2    Health and Safety:
  - .1    Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.5            DELIVERY, STORAGE, AND HANDLING**

- .1    Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

**Part 2 Products**

**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
  - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2 SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Hazardous: red letters, white background.
  - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
  - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
  - .1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

- .2 Use maximum of 25 letters/numbers per line.
- .3 Locations:
  - .1 Terminal cabinets, control panels: use size # 5.
- .4 .2 Equipment in Mechanical Rooms: use size # 9.
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
  - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
  - .2 Equipment in Mechanical Room:
    - .1 Main identifier: size #9.
    - .2 Source and Destination identifiers: size #6.
    - .3 Terminal cabinets, control panels: size #5.
  - .3 Equipment elsewhere: sizes as appropriate.

## **2.3 PIPING SYSTEMS GOVERNED BY CODES**

- .1 Identification:
  - .1 Natural gas: to CSA/CGA B149.1.
  - .2 Sprinklers: to NFPA 13.

## **2.4 IDENTIFICATION OF PIPING SYSTEMS**

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
  - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:



- .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
- .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
- .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Departmental Representative.
  - .2 Colours for legends, arrows: to following table:
 

<u>Background colour:</u>	<u>Legend, arrows:</u>
Yellow	BLACK
Green	WHITE
<u>Red</u>	<u>WHITE</u>
  - .3 Background colour marking and legends for piping systems:
 

<u>Contents</u>	<u>Background colour marking</u>	<u>Legend</u>
City water	Green	CITY WATER
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Natural gas	to Codes	
Compressed air (<700kPa)	Green	COMP. AIR

## 2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

## 2.6 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.

- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

## **2.7 CONTROLS COMPONENTS IDENTIFICATION**

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

## **2.8 LANGUAGE**

- .1 Identification in English.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 TIMING**

- .1 Provide identification only after painting specified Section 09 91 23 - Painting has been completed.

### **3.3 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC or CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

### **3.4 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
  - .2 Standoffs:
    - .1 Provide for nameplates on hot and/or insulated surfaces.
  - .3 Protection:
    - .1 Do not paint, insulate or cover.

### **3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### **3.6 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

### **3.7 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 for Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

**1.2 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
  - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
  - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

**1.3 PURPOSE OF TAB**

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

**1.4 EXCEPTIONS**

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

**1.5 CO-ORDINATION**

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

**1.6 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

**1.7 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

**1.8 OPERATION OF SYSTEMS DURING TAB**

- .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

**1.9 START OF TAB**

- .1 Notify Departmental Representative 7 days prior to start of TAB.

- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire, smoke, volume control dampers installed and open.
    - .6 Coil fins combed, clean.
    - .7 Access doors, installed, closed.
    - .8 Outlets installed, volume control dampers open.
  - .3 Liquid systems:
    - .1 Flushed, filled, vented.
    - .2 Correct pump rotation.
    - .3 Strainers in place, baskets clean.
    - .4 Isolating and balancing valves installed, open.
    - .5 Calibrated balancing valves installed, at factory settings.
    - .6 Chemical treatment systems complete, operational.

#### **1.10 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus 5%, minus 5%.
  - .2 Hydronic systems: plus or minus 10%.

#### **1.11 ACCURACY TOLERANCES**

- .1 Measured values accurate to within plus or minus 2% of actual values.

#### **1.12 INSTRUMENTS**

- .1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

### **1.13 SUBMITTALS**

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

### **1.14 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .2 Details of TAB procedures employed.
  - .3 Calculations procedures.
  - .4 Summaries.

### **1.15 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

### **1.16 VERIFICATION**

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

### **1.17 SETTINGS**

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

**1.18 COMPLETION OF TAB**

- .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

**1.19 AIR SYSTEMS**

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA, and ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:
  - .1 Air handling units
  - .2 Heat recovery ventilators
  - .3 Furnaces
  - .4 Fans
  - .5 VAV boxes
  - .6 Air outlets
- .3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB, qualified to standards of AABC or NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by to standards of AABC or NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

**1.20 OTHER TAB REQUIREMENTS**

- .1 General requirements applicable to work specified this paragraph:
  - .1 Qualifications of TAB personnel: as for air systems specified this section.
  - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions during winter, summer, design conditions at all times.
  - .2 TAB procedures:
    - .1 For smudging ventilation interlock.



- .3 Zone pressure differences:
  - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.
  - .2 TAB procedures:
    - .1 For smudging ventilation interlock.
- .4 Smoke management systems:
  - .1 Test for proper operation of all smoke and fire dampers, sensors, detectors, installed as component parts of air systems specified Division 23.
  - .2 Emergency evacuation: see post-occupancy TAB activities specified below.

**1.21 POST-OCCUPANCY TAB**

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone of following areas:
- .2 Emergency evacuation: participate in full scale emergency evacuation exercises. Repeat smoke management tests at this time.
- .3 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

**Part 2 Products****2.1 NOT USED**

- .1 Not used.

**Part 3 Execution****3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

.1            Definitions:

.1            For purposes of this section:

- .1            "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
- .2            "EXPOSED" - means "not concealed" as previously defined.
- .3            Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2            TIAC Codes:

- .1            CRD: Code Round Ductwork,
- .2            CRF: Code Rectangular Finish.

.2            Reference Standards:

.1            American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .1            ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2            ASTM International Inc.

- .1            ASTM C335-05a1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
- .2            ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .3            ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .4            ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
- .5            ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .6            ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3            Canadian General Standards Board (CGSB)

- .1            CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4            Green Seal Environmental Standards (GSES)

- .1            Standard GS-36-00, Commercial Adhesives.

.5            South Coast Air Quality Management District (SCAQMD), California State

- .1            SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6            Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.7            Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

## **1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 - General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
    - .2 Details of operation, servicing and maintenance.
    - .3 Recommended spare parts list.
- .3 Shop Drawings:
  - .1 Provide shop drawings.
- .4 Samples:
  - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
  - .2 Mount sample on 12 mm plywood board.
  - .3 Affix typewritten label beneath sample indicating service.
- .5 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

## **1.3 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards, member of TIAC.

## **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for reuse and return of pallets and packaging materials in accordance with Section 01 01 50 - General Instructions.

**Part 2 Products**

**2.1 FIRE AND SMOKE RATING**

- .1 To CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

**2.2 INSULATION**

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C553.

**2.3 ACCESSORIES**

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
    - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.
- .5 Contact adhesive: quick-setting
  - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 PRE-INSTALLATION REQUIREMENTS**

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

### **3.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

### **3.4 DUCTWORK INSULATION SCHEDULE**

- .1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	25
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts	none		

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

- .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

- .1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

### **3.5 CLEANING**

- .1 Clean in accordance with Section 01 01 50 - General Instructions.
- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

**END OF SECTION**

**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1       Divisions 22 and 23

**1.2            REFERENCES**

- .1       American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1       ANSI/ASHRAE 90.1-04-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2       ASTM International Inc.
  - .1       ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .2       ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .3       ASTM C533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - .4       ASTM C547-07, Standard Specification for Mineral Fiber Pipe Insulation.
  - .5       ASTM C553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .6       ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .7       ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .8       ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3       Canadian General Standards Board (CGSB)
  - .1       CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2       CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4       Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1       Material Safety Data Sheets (MSDS).
- .5       South Coast Air Quality Management District (SCAQMD), California State
  - .1       SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6       Thermal Insulation Association of Canada (TIAC)
  - .1       National Insulation Standards 2005.
- .7       Underwriters Laboratories of Canada (ULC)
  - .1       CAN/ULC-S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 01 50 General Instructions.
- .3 Samples:
  - .1 Provide for approval review: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
    - .1 Mount sample on 12 mm plywood board.
    - .2 Affix typewritten label beneath sample indicating service.
- .4 Manufacturer's Instructions:
  - .1 Include procedures to be used and installation standards to be achieved.
- .5 Qualifications:
  - .1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates, padding and packaging materials in accordance with Section 01 01 50 General Instructions.

**Part 2 Products**

**2.1 FIRE AND SMOKE RATING**

- .1 Fire and smoke ratings to CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

**2.2 INSULATION**

- .1 Mineral fibre: includes glass fibre, rock wool, slag wool.



- .1 Recycled content: (Post-Consumer + 1/2 Post-Industrial) in accordance with Section 01 01 50 General Instructions.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C547.
  - .2 Maximum "k" factor: ASTM C547.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C547.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C547.
- .5 TIAC Code C-1: rigid mineral fibre board, unfaced.
  - .1 Mineral fibre: ASTM C612.
  - .2 Maximum "k" factor: ASTM C612.
- .6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C612.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C612.
- .7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C553.
- .8 TIAC Code A.6: flexible unicellular tubular elastomer.
  - .1 Insulation: with vapour retarder jacket.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor.
  - .4 Certified by manufacturer free of potential stress corrosion cracking corrodents.
- .9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
  - .1 Insulation: ASTM C533.
  - .2 Maximum "k" factor: ASTM C533.
  - .3 Design to permit periodic removal and re-installation.

## **2.3 CEMENT**

- .1 Thermal insulating and finish

- .1 To: ASTM C449/C449M.
- .2 Hydraulic setting or Air drying on mineral wool, to ASTM C449.

## **2.4 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.
  - .2 Colours: to match adjacent finish paint selected by Departmental Representative.
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 65 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: mm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks.
    - .3 Pressure sensitive vinyl tape of matching colour.
  - .8 Special requirements:
    - .1 Indoor:
    - .2 Outdoor: UV rated material at least 0.5mm thick.
  - .9 Covering adhesive: compatible with insulation.
    - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168, GSES GS-36.
- .2 Canvas:
  - .1 220 and 120 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: compatible with insulation.
    - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168 GSES GS-36.
- .3 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: 0.50 mm sheet.
  - .3 Finish: smooth stucco embossed corrugated.
  - .4 Joining: longitudinal and circumferential slip joints with 50mm laps.
  - .5 Fittings: 0.5mm thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19mm wide, 0.5 mm thick at 300mm spacing.

## **2.5 INSULATION SECUREMENTS**

- .1 Tape: self-adhesive, aluminum, plain, reinforced, 50mm wide minimum.
- .2 Contact adhesive: quick setting.
  - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168 GSES GS-36.

- .3 Canvas adhesive: washable.
    - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168 GSES GS-36.
  - .4 Tie wire: 1.5mm diameter stainless steel.
  - .5 Bands: Stainless steel, 19mm wide, 0.5mm thick.
  - .6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation with expanded metal lath on other face.
  - .7 Fasteners: 2 mm diameter pins with 35mm diameter square clips. Length of pin to suit thickness of insulation.
- 2.6 VAPOUR RETARDER LAP ADHESIVE**
- .1 Water based, fire retardant type, compatible with insulation.
    - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168 GSES GS-36.
- 2.7 INDOOR VAPOUR RETARDER FINISH**
- .1 Vinyl emulsion type acrylic, compatible with insulation.
- 2.8 OUTDOOR VAPOUR RETARDER MASTIC**
- .1 Vinyl emulsion type acrylic, compatible with insulation.
  - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>.
- Part 3 Execution**
- 3.1 APPLICATION**
- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- 3.2 PRE- INSTALLATION REQUIREMENTS**
- .1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.
  - .2 Surfaces clean, dry, free from foreign material.
- 3.3 INSTALLATION**
- .1 Install in accordance with TIAC National Standards
    - .1 Hot equipment: To TIAC code 1503-H.
    - .2 Cold equipment: to TIAC code 1503-C.
  - .2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

- .3 Provide vapour retarder as recommended by manufacturer.
- .4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports outside vapour retarder jacket.
- .7 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### **3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Application: At expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

### **3.5 EQUIPMENT INSULATION SCHEDULES**

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Hot Equipment:
  - .1 TIAC code A-1 or C-1 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
  - .2 TIAC code C-2 unfaced with wire or bands and 13 mm cement preceded by one layer of reinforcing mesh.
  - .3 Thicknesses:  
Domestic hot water storage tanks 25 mm  
Heat exchangers 50 mm
- .3 Breechings:
  - .1 TIAC code A-2 with 25 mm air gap, mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
- .4 Cold equipment:
  - .1 TIAC A-3 or C-4 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
  - .2 TIAC C-2 faced with vapour retardant jacket and with wire or bands and 13 mm cement preceded by one layer of reinforcing mesh.
  - .3 TIAC A-6 or C-4 with mechanical fastenings or wire or bands.
  - .4 Thicknesses: 50mm.
- .5 Finishes:

- .1 Equipment in mechanical rooms: TIAC code CEF/1 with jacket.
- .2 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

**3.6 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

.1            Section Includes:

- .1            Thermal insulation for piping and piping accessories in commercial type applications.

**1.2            REFERENCES**

- .1            American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1            ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2            American Society for Testing and Materials International (ASTM)
  - .1            ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
  - .2            ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .3            ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .4            ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .5            ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
  - .6            ASTM C547-2003, Mineral Fiber Pipe Insulation.
  - .7            ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .8            ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3            Canadian General Standards Board (CGSB)
  - .1            CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2            CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4            Department of Justice Canada (Jus)
  - .1            Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2            Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  - .3            Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5            Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1            Material Safety Data Sheets (MSDS).
- .6            Manufacturer's Trade Associations

- .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .7 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
  - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

### **1.3 DEFINITIONS**

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
  - .1 CRF: Code Rectangular Finish.
  - .2 CPF: Code Piping Finish.

### **1.4 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.
- .3 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
    - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
- .4 Samples:
  - .1 Submit samples in accordance with Section 01 01 50 General Instructions.
  - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .2 Instructions: submit manufacturer's installation instructions.
- .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

## **1.5 QUALITY ASSURANCE**

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.
- .3 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.

## **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
  - .1 Protect from weather, construction traffic.
  - .2 Protect against damage.
  - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.
  - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
  - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
  - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

## **Part 2 Products**

### **2.1 FIRE AND SMOKE RATING**

- .1 In accordance with CAN/ULC-S102.
  - .1 Maximum flame spread rating: 25
  - .2 Maximum smoke developed rating: 50.



## **2.2 INSULATION**

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702 ASTM C547.
  - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702 ASTM C547.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702 ASTM C547.
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to CAN/ULC-S702 ASTM C547.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702 ASTM C547.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
  - .1 Insulation: with vapour retarder jacket.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor:
  - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
  - .1 Insulation: to ASTM C533.
  - .2 Maximum "k" factor: to
  - .3 Design to permit periodic removal and re-installation.

## **2.3 INSULATION SECUREMENT**

- .1 Tape: self-adhesive, aluminum, plain reinforced, 50mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5mm diameter stainless steel.
- .5 Bands: stainless steel, 19mm wide, 0.5mm thick.

## **2.4 CEMENT**

- .1 Thermal insulating and finishing cement:

- .1 Hydraulic setting or Air drying on mineral wool, to ASTM C449/C449M.

## **2.5 VAPOUR RETARDER LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.

## **2.6 INDOOR VAPOUR RETARDER FINISH**

- .1 Vinyl emulsion type acrylic, compatible with insulation.

## **2.7 OUTDOOR VAPOUR RETARDER FINISH**

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m<sup>2</sup>.

## **2.8 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .2 Colours: to match adjacent finish paint by Departmental Representative.
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 65 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: mm.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks.
    - .3 Pressure sensitive vinyl tape of matching colour.
  - .8 Special requirements:
    - .1 Indoor:.
    - .2 Outdoor: UV rated material at least 0.5mm thick.
- .2 Canvas:
  - .1 220 and 120 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: 0.50mm sheet.
  - .3 Finish: smooth.
  - .4 Joining: longitudinal and circumferential slip joints with 50mm laps.
  - .5 Fittings: 0.5mm thick die-shaped fitting covers with factory-attached protective liner.

- .6 Metal jacket banding and mechanical seals: stainless steel, 19mm wide, 0.5mm thick at 300mm spacing.

## **2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS**

- .1 Caulking to: Section 01 01 50 General Instructions.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 PRE-INSTALLATION REQUIREMENT**

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

### **3.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### **3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: aluminum or PVC.

### 3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

### 3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1
  - .1 Securements: SS wire, bands, tap at 300mm on centre.
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
  - .1 Securements: SS, wire, bands, tape at 300mm on centre.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
  - .1 Insulation securements:
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code:
- .5 TIAC Code: C-2 [with] [without] vapour retarder jacket.
  - .1 Insulation securements:
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code: 1501-C
- .6 TIAC Code: A-2
  - .1 Insulation securements:
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code: 1501-H.
- .7 Thickness of insulation as listed in following table.
  - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
  - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Applica- tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38
Hot	up to 59	A-1	25	25	25	25	38	38

Applica- tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Water Heating Glycol	60 - 94	A-1	25	38	38	38	38	38
Heating Glycol	up to 59	A-1	25	25	25	25	38	38
Heating Domesti c HWS		A-1	25	25	25	38	38	38
Refrigerated Drinking Water		A-3	25	25	25	25	25	25
Domesti c CWS		A-3	25	25	25	25	25	25
Domesti c CWS with vapour retarder		C-2	25	25	25	25	25	25
Refrigerant hot gas liquid,suction	4 - 13	A-6	25	25	25	25	25	25
Refrigerant hot gas liquid,suction	below 4	A-6	25	25	38	38	38	38
RWL and RWP		C-2	25	25	25	25	25	25

.8

Finishes:

- .1 Exposed indoors: canvas, aluminum, SS, PVC, jacket.
- .2 Exposed in mechanical rooms: PVC jacket.
- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .5 Outdoors: water-proof aluminum jacket.
- .6 Finish attachments: SS screws, bands, at 150mm on centre. Seals: wing, closed.
- .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

**3.7 FIELD QUALITY CONTROL**

- .1 Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Certified wood.
  - .8 Low-emitting materials.

**3.8 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY****.1 Related Sections:**

.1 Divisions 21, 22 and 23

**1.2 REFERENCES****.1 American Society for Testing and Materials International (ASTM)**

.1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

**1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS**

.1 In accordance with Section 01 01 50 General Instructions..

**1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)**

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Pump operation.

.2 Boiler and/or cooling equipment operation.

.3 Pressure bypass open/closed.

.4 Control pressure failure.

.5 Maximum heating demand.

.6 Maximum cooling demand.

.7 Boiler and/or cooling equipment failure.

.8 Condensing unit fan failure.

.9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

**1.5 HYDRONIC SYSTEM CAPACITY TEST**

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

- .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
  - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
    - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
    - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
  - .2 Test procedures:
    - .1 Open fully heat exchanger, heating coil and radiation control valves.
    - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
    - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

## **1.6 GLYCOL SYSTEMS**

- .1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

## **1.7 GASEOUS FUEL SYSTEMS**

- .1 Operation tests:
  - .1 Measure gas pressure at gas meter outlet and at burner manifold.
  - .2 Verify details of temperature and pressure compensation at meter.
  - .3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.
  - .4 Check terminals of vents for gas pressure regulators.

## **1.8 POTABLE WATER SYSTEMS**

- .1 When cleaning is completed and system filled:
  - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.



- .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
- .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

#### **1.9 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS**

- .1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- .2 Verification of controls, detection devices, alarm devices is specified Division 26.
- .3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.
- .4 Verify operation of interlocks between HVAC systems and fire alarm systems.

#### **1.10 SANITARY AND STORM DRAINAGE SYSTEMS**

- .1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.
- .2 Ensure that traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system.
- .4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.
- .5 Cleanouts: refer to Section 22 42 01.
- .6 Roof drains:
  - .1 Refer to Section 22 42 01.
  - .2 Remove caps as required.

#### **1.11 REPORTS**

- .1 In accordance with Section 01 91 00 and 23 08 02.

#### **1.12 TRAINING**

- .1 In accordance with Section 01 91 00 and 23 08 02.

### **Part 2 Products**

#### **2.1 NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

## **PART 1        GENERAL**

### **1.1            General Commissioning Concept and Commissioning Plan**

- .1     The Commissioning as applied to buildings is the process of bringing a building into use concluding all activities directed to that end, and including equipment as well as staffing involved in the subject facility. This section is included in the contract scope and price, and part of Section 01 91 00.
- .2     Verification, as related to the Mechanical, Electrical and Specialty systems installed in the building, represents the process of proving the performance of the equipment as defined in the technical specifications.
- .3     Contractor shall retain and pay for a Commissioning Agent.
- .4     The Commissioning Plan (provided by the Commissioning Agent):
  - .1       Identifies the role of each participant in the Commissioning Process and maps out both overall and phase-specific strategies for the project.
  - .2       Describes the procedures for verification of each system.
- .5     The Commissioning Process covers the full life cycle of the project from the initial planning activities through to the point where that facility is in full operation and in full compliance with predefined user, operator, design and contract requirements.
- .6     The Commissioning Process includes the following five major components:
  - .1       Thorough documentation and monitoring of all facets of construction.
  - .2       Extensive tests of all subsystems, their components and controls.
  - .3       Testing of whole systems that include a multiple of subsystems.
  - .4       Specific and detailed training on all major equipment for operational personnel.
  - .5       Ongoing monitoring and checking during the warranty period.

### **1.2            Objectives**

- .1     Support quality management through monitoring and checking of the installation.
- .2     Verify systems performance through inspection and performance testing of the completed installation.
- .3     Move the completed facility from the "static completion" state to the optimal "dynamic" operating state.
- .4     Optimize operating and maintenance through delivery of comprehensive quality training and instruction to the Owner's operating personnel.
- .5     System debugging and optimization.
- .6     Completion of training and instruction for the operating and maintenance personnel.

- .7 Assure provision of accurate and useful historical records, such as "as-built drawings", test certificates etc. Such records provide important data for operating and maintaining the systems as well as for future system testing, maintenance or renovations.
- .8 Completion of testing and verification through seasonal review.
- .9 Specifically, the Commissioning Process shall deliver to the owner:
  - .1 A complete set of documentation on the design intent and maintenance requirements of each system involved in the commissioning process.
  - .2 A system that functions in accordance with the design intent.
  - .3 Operators who fully understand the design intent and the operation and maintenance requirements of the equipment.

### **1.3 Contractor's Responsibilities**

- .1 Start-up Phase
  - .1 Ensures that start-up program is implemented in accordance with the facility start-up requirements within the contract documents.
  - .2 Following start-up, which may be observed by the Departmental Representatives /Commissioning Agent, and must therefore be pre-scheduled, begins Performance Testing under conditions which simulate varying load and all operating modes, including emergency modes of operation.
  - .3 Following contractor's thorough testing, schedules, and performs verification-related tasks in the presence of the Commissioning Agent.
- .2 Post-Construction Phase
  - .1 Post construction commissioning is the continued adjustment, optimization and modification of the systems to meet specified requirements. It includes updating documentation to reflect minor set point adjustments, system maintenance and calibration, major system modifications and provision of ongoing training of operation and maintenance personnel.
  - .2 The objective of post construction phase commissioning is to maintain the performance of the systems throughout the useful life of the facility in accordance with the current design intent.
  - .3 Optimizes operation according to occupant's needs, using the Systems Operations Manual prepared by the Commissioning Agent for reference.
  - .4 Complete all commissioning procedures, activities, and performance verification, which were delayed or not executed during the construction phase.
  - .5 Executes system checks with the Owner/Commissioning Agent:
    - .1 Once during the first month of building operation.
    - .2 Once during the third month of building operation.
    - .3 Once between the fourth and tenth months in a season opposite to the first or third month visit.
  - .6 Completes rectification of all deficiencies revealed by the above checks.
  - .7 Revises all as-builts and operating and maintenance documents to reflect all changes, modifications, revisions and adjustments upon completion of commissioning.
  - .8 Re-verifies equipment and systems during change of season.

## **PART 2 PRODUCTS**

### **2.1 Commissioning Involvement**

- .1 The Commissioning Agent shall direct, witness and verify equipment performance testing. Accordingly, the Contractor and/or his suppliers and/or his retained Independent Third Party Agents shall perform the following:
  - .1 Check and ensure the installation of the systems and equipment to ensure that the installation is complete, is in a proper and safe state, has been pre-tested to ensure all complete and proper operation, and is ready for verification.
  - .2 Run and test the systems and equipment through their design parameters to verify their capabilities in performance, sequencing, safety protection and alarms annunciation.

### **2.2 Systems to be Commissioned**

- .1 Mechanical systems shall include, but are not limited to, the following:
  - .1 Fire protection systems; sprinkler
  - .2 Hydronic heating systems
  - .3 Air distribution systems
  - .4 Control systems
  - .5 Plumbing systems

### **2.3 Testing Equipment**

- .1 The Contractor shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. The Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Agent and Departmental Representatives for approval.

### **2.4 Documentation**

- .1 Contractor shall record all test results and procedures on approved record forms, and submit the forms together with copies of test certificates to consultant and Commissioning Agent for review and approval.
- .2 When the results are verified, the Commissioning Agent shall incorporate those records in his Systems Operations Manual. He shall also make entry of those test results into appropriate sections of the Operating and Maintenance Manual for reference.

## **PART 3 EXECUTION**

### **3.1 Commissioning Process**

- .1 Perform and complete all works as specified in the Mechanical specifications. In general, it shall include complete activation of all systems; calibration; testing; verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequences of operation, recording of test results for submission; demonstration, instruction and training of Departmental

Representative's operating and maintenance personnel; and follow-up during the first year of operation for fine tuning and monitoring purposes.

- .2 Advise the Departmental Representatives at least 3 days in advance of any test.
- .3 Complete the testing form provided by the commissioning agent for each test, and submit copies to the Departmental Representatives.

### **3.2 Testing of Mechanical Systems – Additional Requirements**

- .1 Plumbing and Drainage System Testing
  - .1 The plumbing and drainage system shall be tested in accordance with the Plumbing Code under the BC Water Resources Act.
  - .2 The Contractor shall notify the Departmental Representatives and Fire Commissioner when systems are available for testing. The Contractor shall document all tests performed and shall arrange for the Departmental Representatives to sign for tests completed. The forms shall be forwarded to the Departmental Representatives and Commissioning Agent for review.
  - .3 Perform hydrostatic pressure test and system disinfection for domestic hot and cold water systems as per the requirements of this specification and CSA-Z317.1-98. Inform Commissioning Agent of dates.
  - .4 Perform pressure tests to the gas piping and gas site services to gas code requirements.
- .2 Water Treatment/Flushing of New Piping
  - .1 The Specialist shall complete the Manufacturers' testing forms and submit a report to the Departmental Representatives and Commissioning Agent.
  - .2 The Specialist shall assist the Contractor in cleaning all new piping systems. The Specialist shall take samples and repeat the cleaning process if the specification requirements are not met.
  - .3 The specialist shall provide:
    - .1 Initial water analysis and treatment recommendations
    - .2 Start-up assistance
    - .3 All necessary laboratory services and technical assistance required
  - .4 During circulation of cleaning solutions, periodically examine and clean filters and screens and measure and monitor changes in pressure drop across equipment.
  - .5 The specialist shall revisit the site after one month of operation of each system and re-test the systems, and provide a report to the Departmental Representatives and Commissioning Agent.
  - .6 Where multiple cut-ins are required into an existing system, the Specialist shall repeat the above steps, and report after the completion of each cut-in.
- .3 Fire Protection
  - .1 The Contractor shall hydrostatically test the systems as per the specification and NFPA requirements to meet all certifications. The test shall be witnessed by the Consultant and/or the Commissioning Agent. Provide a copy of the report in NFPA 13 and 14 reporting format for all such tests to the Commissioning Agent.

- .2 The Contractor shall obtain approval certificates from the Authorities having Jurisdiction and submit copies of the certificates to the Commissioning Agent and the Owner's third party verification agency for review.
- .4 Piping Systems (Hydronic Circulation)
  - .1 Before testing, ensure that all installed valves and equipment are accessible for servicing and replacement, as per manufacturer's recommendations.
  - .2 Test all piping systems in accordance with all applicable Plumbing Codes.
  - .3 All other systems not covered by Codes noted above shall be tested and proven tight over a period of twenty-four (24) hours by a hydrostatic test. Remove fixtures, appliances, devices, vents and gauges and temporarily plug connections, as required. Provide temporary bypass when required.
  - .4 Test pressure for water systems (heating) shall be:
    - .1 1½ times the system working pressure but not less than 125 psi for a minimum of two (2) hours.
    - .2 limited to the maximum working pressure of expansion joints and vibration isolators
  - .5 Repair any leaks or defects and repeat the tests to the satisfaction of the Consultant.
  - .6 All tests for the systems shall be witnessed by the Departmental Representatives /Commissioning Agent. Complete the testing forms and forward copies of the test reports to the Departmental Representatives and Commissioning Agent.
  - .7 After testing, TAB contractor shall measure the water flow at each existing reheat coil via the existing circuit setters. Submit report to the Departmental Representatives and Commissioning Agent for review.
  - .8 All tests be witnessed by the Departmental Representatives/Commissioning Agent.
  - .9 The Contractor shall co-ordinate with the TAB Contractor and provide assistance during the balancing process. Review the complete installation with the balancing contractor, and provide a report stating that all systems can be balanced by the balancing contractor as per the design. Any concerns or discrepancies must be highlighted to the Departmental Representatives and Commissioning Agent prior to installation. Notify the Departmental Representatives and Commissioning Agent in writing that this coordination has taken place before installation begins. Additional costs related to the lack of proper type or location of balancing devices will be borne by the Contractor.
  - .10 Submit a TAB procedure for review and acceptance.
  - .11 .11 Balancing shall not begin until all point to point and EMCS component testing has been satisfactory completed.
- .5 Testing, Adjusting and Balancing – General
  - .1 The testing equipment shall be itemized in the test reports and shall be pre-approved by the Departmental Representatives and Commissioning Agent before any measurements are taken. Calibration of the test equipment must be confirmed and approved by the Departmental Representatives before balancing begins.
  - .2 The TAB Contractor shall co-ordinate with the Contractor to ensure that all necessary devices and valves for control and balancing are installed in all necessary locations. Notify the Departmental Representatives and Commissioning

- Agent, in writing, that this co-ordination has taken place. Include in this letter any recommendations made regarding valves, locations, installation, etc.
- .3 If the TAB Contractor fails to co-ordinate with the Contractor, and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be at no cost to the Departmental Representatives.
  - .4 The TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met. TAB to be performed using as-built drawings.
  - .5 The TAB contractor shall trim impellers, change sheaves, etc... to provide the required conditions.
  - .6 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.
  - .7 The TAB contractor shall not disconnect any DDC device after it has calibrated.
  - .8 At the time of final inspection, recheck, in the presence of the Departmental Representatives and Commissioning Agent, random selections of data recorded in the certified report.
  - .9 Points or areas of recheck shall be selected by the Departmental Representatives /Commissioning Agent and shall be as specified.
  - .10 In the event the report is rejected, rebalance all systems, submit new certified reports and perform a re-inspection at all no additional cost to the Owner. In addition, pay for additional costs borne by the Departmental Representatives and/or Commissioning Agent.
  - .11 Following final acceptance of the certified reports by the Departmental Representatives and Commissioning Agent, permanently mark the settings of all valves and other adjustable devices so that balance set position can be restored if disturbed at any time. For circuit balancing valves, record the valve position by the number of turns registered on the valve and lock the valve in that position.
  - .12 Record all settings and accurate device locations on the as built drawings.
  - .13 Submit six (6) copies of the final testing and balancing reports to the Departmental Representatives. Reports shall be complete with index pages and index tabs and certified by the TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system acceptable to the Departmental Representatives.
  - .14 Submit a copy of the report to the Commissioning Agent for review.
    - .1 Include in the water balancing report: types, serial numbers and dates and calibration of all instruments used in balancing report.
    - .2 Include in the air balancing report: equipment data, Manufacturer and model size, arrangement discharge and class, motor type, horsepower, voltage, phase, cycles and full load amps., location and local identification data; fan design data, total volume flow rate, static pressure, motor type, RPM, volts, full load amps and outside air flow rate etc.; a complete system schematic with design and actual flow rates at each outlet or inlet; Manufacturer's catalogue identification and type, of air inlets and outlets application factors, designed area, design and recorded velocities, design and recorded air flow rates, deflector vane of diffusion cone settings.
    - .3 Confirm correct room numbers and show numbers and floors. Duct air quantities: for mains, branches and maximum and minimum for outside



air and exhausts, duct size, pressure readings, average velocity, duct recorded flow rates, duct design flow rates. Air inlet and outlets, supply or exhaust outlet identification. Location and number designation of Air Handling units and static pressure shall be included.

- .15 All duct pressure tests shall be performed in the presence of the Departmental Representatives/Commissioning Agent. Complete the testing forms and forward to the Consultant and Commissioning Agent.

.6 Testing, Adjusting and Balancing-Hydrionic Systems

- .1 The TAB Contractor shall balance the entire water system to ensure all equipment and systems are operating to design conditions. Adjust the circuits by means of the balancing valves and record the balance positions.
- .2 Each pump shall be checked for design, working and shut-off head conditions. Flow through all heat exchangers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within five percent ( $\pm 5\%$ ) of the Manufacturer's design conditions. Initial balancing of coils shall be used to ensure that the actual flows are within  $\pm 10\%$  of the Manufacturer's design conditions. When both the air and water systems are fully operational, entering air and water systems are fully operational, leaving air and water readings shall be taken as close as possible to the peak design conditions. Coil water working conditions shall only be taken with the airflow working conditions for the coil.
- .3 A measured deviation of more than ten percent ( $\pm 10\%$ ) between the verification reading and the reported data will be considered as failing the verification procedure, and the rejection of the report.

.7 Testing, Adjusting and Balancing – Air Systems

- .1 The Contractor shall test for air leakage in accordance with SMACNA Manuals and Standards, all ductwork with the exception of ductwork downstream of variable air volume boxes or other pressure reducing devices. Test methods and results shall be in compliance with HVAC air duct leakage test manuals of SMACNA. In addition, seal any leaks. Test system as a whole or in parts, provided all ductwork is accessible for inspection at the time of test. Refer to specification section related to Ductwork and Specialties for pressure ratings of ductwork and systems.
- .2 The entire system shall be tested for noise, tightness of joints and proper functioning of the system. Noise tests shall be made under minimum system pressure drop conditions (highest air velocities and clean filter conditions). This section shall make all necessary alterations and repeat the tests until satisfactory operation is achieved.
- .3 In conjunction with the EMCS Contractor, determine the signal level that corresponds to the specified amount of minimum outside air. Adjust air damper linkages to provide this amount, and record the corresponding signal level for both maximum and minimum fresh air modes.
- .4 Ensure access is provided to all fire dampers and equipment that require servicing.
- .5 The TAB Contractor shall balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).
- .6 The TAB Contractor shall take air measurements, make final adjustments and report upon the air volume at each variable volume box, diffuser, register and

- grille. Measure the static pressure upstream of the fan, the fan speed and the motor current.
- .7 Measure the return and supply air flow when mixing dampers are set for full outside air and minimum outside air position.
- .8 The Contractor shall provide new filters after balancing has been completed and verified.
- .9 Duct traverse readings shall be taken through access ports. The access ports shall be air tight.
- .10 The insulation or vapour barrier shall be repaired in an approved manner, if damaged.
- .11 Ensure that all thermostats and controls are set to give the specified conditions and include settings in the report.
- .12 Adjust each supply outlet to provide proper throw and distribution in accordance with architectural requirements. Provide blank off sections to avoid drafts.
- .13 Fans on all systems shall be set-up to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.
- .14 At the time of verification, measure space temperature and relative humidity in a representative number of rooms to verify performance. Tabulate these results and include in certified report as an appendix.
- .15 Air volumes measured by the TAB Contractor shall be within  $\pm 5\%$  of those shown on drawings for diffusers, grilles, registers, variable air volume boxes and fans, at both maximum and minimum volumes shown.
- .16 A measured deviation of more than five percent ( $\pm 5\%$ ) between the verification reading and the reported data will be considered as failing the verification procedure, and the rejection of the report.
- .8 Equipment Testing-General
  - .1 A report shall be issued to the Departmental Representatives and Commissioning Agent after each site visit.
- .9 Energy Monitoring and Controls Systems
  - .1 Commissioning comprises a full range of checks and tests to determine that all components, equipment, systems and interfaces between systems operate in accordance with the contract documents. This includes all operating modes, all interlocks, all control responses and all specified responses to emergency conditions. Verification of the proper operation of the control system also includes verifying the interface of the control system with the TAB criteria and the response of monitoring and control system controllers and sensors. Verification of control systems validates the TAB report.
  - .2 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.
  - .3 The EMCS Contractor shall make all necessary adjustments through the control system as requested by the TAB Contractor. The TAB Contractor shall co-ordinate with the EMCS Contractor and receive instruction regarding set-up, calibration and operation of the EMCS as it applies to the TAB Contractor's work.
  - .4 The EMCS Contractor may provide the TAB Contractor with a portable operator's terminal for this work.

- .5 The EMCS Contractor shall make all necessary adjustments through the control system as requested by the TAB Contractor. The TAB Contractor shall co-ordinate with the EMCS Contractor and receive instructions regarding set-up, calibration and operation of the EMCS as it applies to the TAB Contractor's work.
- .6 The EMCS Contractor may provide the TAB Contractor with a portable operator's terminal for this work.
- .7 The EMCS Contractor shall provide a printout of general and critical alarm lists and all points connected to the Building Automation and Controls Systems. The all point log shall be sub-divided into points per system. One (1) report shall be taken prior to the acceptance test.
- .8 The EMCS Contractor shall either provide an operating terminal and sufficient training and instruction to the TAB Contractor, which will allow them to set-up and balance the water and air systems, or provide on-site assistance as needed.
- .9 The EMCS contractor shall provide a printout of all proposed graphical layouts to the commissioning agent for review and comment. Changes requested by the commissioning agent or owner shall be at no extra cost to the owner.
- .10 Provide the calibration procedure for each analog sensor. In conjunction with the TAB contractor, physically check the calibration of each analog sensor type using a calibrated instrument prior to testing. The TAB contractor shall provide all required field measurement instrumentation.
- .11 Point to point testing shall be executed, and thoroughly documented in detail by the EMCS contractor. This testing shall include, but is not limited to:
  - .1 Ensuring that wiring is accurately connected to appropriate terminals
  - .2 Checking the function of each control and controlled device (such as the beginning, end and extent of actuator travel
  - .3 Connection integrity between actuator and device
  - .4 Calibration of sensors
  - .5 Output from sensors
  - .6 Operation of relays
  - .7 Data/information integrity at console
  - .8 Remove reset integrity from console to field device
  - .9 Interfacing with other systems such as life safety monitoring system
  - .10 Creating simulated design load conditions for control verification tests
  - .11 Loop tuning
  - .12 Checking and verifying that each input point is reporting to the Building Automation and Controls Systems panels and workstations in the normal state and change of state
  - .13 Creating false alarms at each point and providing a print-out of the test
  - .14 Commanding each output point, via the work station and verifying the action at the device
  - .15 Verifying that each time of day and optimum start program is operational in software and at the device
  - .16 Verifying that each program is operational in software and at the device(s)
  - .17 Verifying that each system graphic is dynamically updating
  - .18 Testing each DDC loop and verifying that it is controlling in a stable manner

- .19 Creating set point changes on output points, imposing false loads, and observing and adjusting the control loops' response. Documentation shall include the programming of trend logs at the Building Automation and Controls Systems for a minimum of thirty (30) minutes per control loop with a sampling time of thirty (30) seconds, and providing a printout of the results.
- .20 Tuning of each DDC loop. Re-check each loop again, once during the heating and once during the cooling season and re-tuning where necessary
- .21 Verifying that each report type is functional
- .22 Verifying that each global program that controls more than one (1) system is operating
- .23 Verifying that all safeties are operating (i.e. fire stats)
- .24 Verifying valve and damper actuation
- .25 Verifying the calibration of each analog input point, particularly non-temperature points
- .12 Any sensor disconnected from the input terminal after completion of the performance test shall be retested.
- .13 The EMCS Contractor shall provide a "signed-off" copy of the results of all tests to the Departmental Representatives and the Commissioning Agent. The verification stage will not begin until the documentation of the above testing has been reviewed and accepted.
- .14 Following acceptance of the above documentation, the Commissioning Agent shall direct and witness verification testing. Generally, this verification stage will include:
  - .1 All graphics;
  - .2 All specified software features;
  - .3 All specified sequences of operation;
  - .4 All specified alarm functions;
  - .5 Spare point capacity;
  - .6 Approximately a 50% sampling of all control loop tuning;
  - .7 Approximately 30% sampling of all field control devices;
  - .8 Ancillary equipment
  - .9 The system shall not be accepted or considered substantially complete until all tests are completed and approved.
  - .10 The EMCS Contractor shall provide a minimum of two (2) weeks notice to the Departmental Representatives and Commissioning Agent prior to all testing dates and/or reviews.
  - .11 The EMCS Contractor shall revisit the site during the first year of operation to review the performance of the Building Automation and Controls Systems.
  - .12 The EMCS Contractor, in conjunction with the fire alarm independent testing agent, shall test and verify the smoke control and fire alarm interlock and/or interfacing systems.

**3.3 Commissioning Meetings and Reporting**

- .1 The Contractor shall include all responsibilities noted in the commissioning specifications, including all tests, within his construction schedule.
- .2 The commissioning meetings, as required by the commissioning agent, shall follow the regular construction meetings. The testing schedules and results of all tests shall be reviewed.
- .3 All testing forms and reports associated with the mechanical systems shall be directed to the Commissioning Agent with copies to the Architect, the Departmental Representatives.
- .4 The forms and reports to be issued shall include:
  - .1 Reviewed shop drawings
  - .2 Equipment verification/data forms
  - .3 Testing forms
  - .4 Reports resulting from tests
  - .5 Testing schedule

**3.4 Operating and Maintenance Manual**

- .1 The Contractor shall prepare and submit the Operating and Maintenance Manual as detailed in the specification to the Consultant six (6) weeks prior to the beginning of training.
- .2 The Contractor shall re-submit the manual should the Departmental Representatives find deficiencies. Training shall not begin until the manual has been accepted by the Departmental Representatives.
- .3 One (1) copy of the manual shall be forwarded to the Commissioning Agent in good quality, vinyl covered binders at the time of submission to the Consultant. Three (3) copies of the manuals (after incorporating the Departmental Representatives/Commissioning Agents comments) shall be submitted to the Commissioning Agent in 75mm (3") D-ring white vinyl covered binders with transparent sleeve. No binder shall have more than 50mm (2") of material in a 75mm (3") binder.
- .4 Each mechanical manual shall be organized as follows, but not limited to the following:
  - .1 Project Directory
  - .2 Plumbing
  - .3 Fire Protection
  - .4 Heating
  - .5 Ventilation
  - .6 Energy Monitoring and Controls System
- .5 The project directory shall contain the names, addresses, fax numbers and telephone numbers of Contractors, Sub-Contractors, Manufacturers and Manufacturers representatives.
- .6 Sections 3.4.4.2 to 3.4.4.6 noted above shall be divided into the following sub-sections.
  - .1 Shop drawings (reduced to 8½" x 11")

- .2 As-built drawings (reduced to 8½" x 11")
- .3 As-built riser diagrams (reduced to 8½" x 11")
- .4 Systems description
- .5 Operating procedures
- .6 Maintenance procedures
- .7 Spare parts list
- .8 Trouble shooting guide;
- .9 Valve chart (where applicable)
- .10 Filter size chart (where applicable)
- .11 Equipment lists
- .12 Testing and verification forms
- .13 Certification forms
- .7 Section 3.4.4.7 noted above shall be sub-divided into the following sub-sections.
  - .1 Shop drawings
  - .2 As-built control sequences
  - .3 As-built panel layout and points list
  - .4 Maintenance procedures for all equipment
  - .5 Spare parts list
  - .6 Software licensing agreements (as required)
  - .7 Software manuals (as required)
  - .8 Software disks (as required)
  - .9 Point data and program disks
  - .10 Testing and verification forms
- .8 Systems description shall be a detailed description of each major component, describing the intent (as per the Consultant's design brief), function, operational modes, and any information that may be pertinent to day-to-day operation.
- .9 The operating procedures, maintenance procedures, spare parts list, and troubleshooting guide shall be as recommended by the Manufacturer.
- .10 The equipment list shall include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes.

### **3.5 Systems Operations Manual**

- .1 The Systems Operations Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.
- .2 The Systems Operations Manual shall be prepared by the Commissioning Agent using data collected by the Contractor and provided in the O&M manual, as well as test results.
- .3 The Systems Operations Manual shall be sub-divided into the following systems.
  - .1 Heating, cooling and ventilation
  - .2 Other operating systems
  - .3 Water treatment

- .4 Fire protection
- .5 Energy monitoring and controls systems
- .6 Miscellaneous systems
- .7 Plumbing
- .4 Each section describing a system will contain as a minimum.
  - .1 A basic description of the system
  - .2 System location and areas it serves
  - .3 A basic description of operations
  - .4 Electrical services and locations
  - .5 EMCS points alarm limits and set points
  - .6 Time of day schedules
  - .7 A schematic of the system
- .5 The Commissioning Agent shall provide three (3) copies of the systems operations manual to the Departmental Representatives.

### **3.6 Owner Demonstration and Operator Training**

- .1 Systems' demonstration shall be conducted by the Contractor. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.
- .2 Owner demonstration shall include a walk-through of the building by the Contractor. During the walk-through, the Contractor shall:
  - .1 Identify equipment
  - .2 Identify starters associated with equipment
  - .3 Identify valves and balancing dampers
  - .4 Identify access doors
  - .5 Review general maintenance of equipment
  - .6 Review drain points in pipe work systems
  - .7 Identify maintenance items
- .3 The Contractor and equipment Manufacturer shall provide operator training for each mechanical system and item of equipment.
- .4 Training and instruction shall be provided by qualified Technicians and shall be conducted in a classroom setting and at the equipment or system.
- .5 Training and instruction will begin after the Operating and Maintenance manual has been approved and delivered to the Departmental Representatives.
- .6 Each session shall be structural to cover.
  - .1 The operating and maintenance manual
  - .2 System description
  - .3 Operating procedures

- .4 Maintenance procedures
- .5 Trouble shooting procedures
- .6 The Manufacturer's or Service Representative's name, address and telephone number
- .7 Provide course documentation for up to six (6) people.
- .8 The sessions will be co-ordinated with the contractor and videotaped by the Commissioning Agent.
- .9 Training and instruction shall be provided for the following systems wherever applicable:
  - .1 Life Safety & Fire Protection Systems
  - .2 Heating, Cooling and Ventilation Systems
  - .3 Building Automation & Controls Systems
  - .4 Mechanical Systems
  - .5 Ventilation Systems
- .10 The minimum training and instruction for the Energy Monitoring and Controls Systems will be as directed by the Commissioning Agent.

### **3.7 System Turnover**

- .1 Turnover to the Owner shall occur when:
  - .1 The installation is complete
  - .2 The acceptance test conducted by the Consultant has been successfully completed
  - .3 The Commissioning Agent system verification has been successfully completed
  - .4 Training and instruction has been completed
  - .5 Operating and maintenance manuals have been accepted
  - .6 The system description manuals have been accepted
  - .7 Shop drawings have been updated
  - .8 As-built drawings have been completed and reviewed

### **3.8 Testing Forms**

- .1 The Contractor and Manufacturer shall fill out the forms listed in this section and any other additional data sheets not included in this specification, but required for the mechanical and electrical systems of this project. All forms to be provided by the Commissioning Agent at the start of construction.
- .2 Mechanical testing and verification forms shall include, but are not limited to, the following:
  - .1 Equipment test form
  - .2 Piping pressure test form
  - .3 Test identification form
  - .4 Chemical treatment data sheet
  - .5 Heating and cooling coil data sheet
  - .6 Fan data sheet
  - .7 Variable constant volume units
  - .8 Radiant panel data sheets



.9 Plumbing fixtures and equipment data sheets

END OF SECTION

**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

**1.2 REFERENCES****.1 American Society for Testing and Materials International (ASTM)**

- .1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

**.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)**

- .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS****.1 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.

**.2 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.**

- .1 Instructions: submit manufacturer's installation instructions.

- .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.4 QUALITY ASSURANCE****.1 Health and Safety:**

- .1 Do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.

**1.5 DELIVERY, STORAGE, AND HANDLING****.1 Packing, shipping, handling and unloading:**

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.

**.2 Waste Management and Disposal:**

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**Part 2 Products****2.1 CLEANING SOLUTIONS**

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2 CLEANING HYDRONIC SYSTEMS**

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
  - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
  - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
    - .1 Cleaning procedures, flow rates, elapsed time.
    - .2 Chemicals and concentrations used.
    - .3 Inhibitors and concentrations.
    - .4 Specific requirements for completion of work.
    - .5 Special precautions for protecting piping system materials and components.
    - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
  - .1 Systems: free from construction debris, dirt and other foreign material.
  - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
  - .3 Strainers: clean prior to initial fill.
  - .4 Install temporary filters on pumps not equipped with permanent filters.
  - .5 Install pressure gauges on strainers to detect plugging.

- .6 Report on Completion of Cleaning:
  - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
  - .1 Fill system with water, ensure air is vented from system.
  - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
  - .3 Use water metre to record volume of water in system to +/- 0.5%.
  - .4 Add chemicals under direct supervision of chemical treatment supplier.
  - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
  - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
  - .7 Add chemical solution to system.
  - .8 Establish circulation, raise temperature slowly to maximum design 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol Systems:
  - .1 In addition to procedures specified above perform specified procedures.
  - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

### **3.3 START-UP OF HYDRONIC SYSTEMS**

- .1 After cleaning is completed and system is filled:
  - .1 Establish circulation and expansion tank level, set pressure controls.
  - .2 Ensure air is removed.
  - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
  - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
  - .5 Clean out strainers repeatedly until system is clean.
  - .6 Commission water treatment systems as specified in Section 23 08 02. Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
  - .7 Repeat with water at design temperature.
  - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
  - .9 Bring system up to design temperature and pressure slowly over a 48 hour period.

- .10 Perform TAB as specified in Section 23 05 93.
- .11 Adjust pipe supports, hangers, springs as necessary.
- .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .15 Check operation of drain valves.
- .16 Adjust valve stem packings as systems settle down.
- .17 Fully open balancing valves (except those that are factory-set).
- .18 Check operation of over-temperature protection devices on circulating pumps.
- .19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

### 3.4 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Certified wood.
  - .8 Low-emitting materials.

### 3.5 CLEANING

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1       Materials and installation for piping, valves and fittings for gas fired equipment.
- .2    Related Sections:
  - .1       Section 23 05 01 - Installation of Pipework.
  - .2       Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
  - .3       Section 23 08 03 - Cleaning and Start-Up of Mechanical Piping Systems.

**1.2            REFERENCES**

- .1    American Society of Mechanical Engineers (ASME)
  - .1       ASME B16.5-03, Pipe Flanges and Flanged Fittings.
  - .2       ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3       ASME B16.22-01, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - .4       ASME B18.2.1-96, Square and Hex Bolts and Screws Inch Series.
- .2    American Society for Testing and Materials International (ASTM)
  - .1       ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
  - .2       ASTM A53/A53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3       ASTM B75M-99, Standard Specification for Seamless Copper Tube.
  - .4       ASTM B837-01, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3    Canadian Standards Association (CSA International)
  - .1       CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.
  - .2       CSA C22.2 No 213-M1987, First Edition: Non-incendive Electrical Equipment for Use in Class I, Div.2 Hazardous Locations.
- .4    Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
  - .1       CAN/CSA B149.1HB-00, Natural Gas and Propane Installation Code Handbook.
  - .2       CAN/CSA B149.2-00, Propane Storage and Handling Code.
- .5    Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1       Material Safety Data Sheets (MSDS).
- .6    Underwriters Laboratory (UL)
  - .1       UL 1604, Third Edition, Rev. 2/3/04: Electrical Equipment for Use in Class I and Class II, Div.2, and Class III Hazardous Classified Locations.

### **1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50 - General Instructions.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
  - .2 Indicate on manufacturers catalogue literature following: valves.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 01 50 for Closeout Submittals.

### **1.4 QUALITY ASSURANCE**

- .1 Pre-Installation Meeting:
  - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
    - .1 Verify project requirements.
    - .2 Review installation and substrate conditions.
    - .3 Co-ordination with other building subtrades.
    - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## **Part 2 Products**

### **2.1 PIPE**

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

- .1 NPS 1/2 to 2, screwed.
- .2 NPS 2 1/2 and over, plain end, welded.
- .2 Copper tube: to ASTM B837.

## **2.2 JOINTING MATERIAL**

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Brazing: to ASTM B837.

## **2.3 FITTINGS**

- .1 Steel pipe fittings, screwed, flanged or welded:
  - .1 Malleable iron: screwed, banded, Class 150.
  - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
  - .3 Welding: butt-welding fittings.
  - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
  - .5 Bolts and nuts: to ASME B18.2.1.
  - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:
  - .1 Cast copper fittings: to ASME B16.18.
  - .2 Wrought copper fittings: to ASME B16.22.

## **2.4 VALVES**

- .1 Provincial Code approved, lubricated ball type.

## **2.5 GAS METER**

- .1 Meter type: single path ultrasonic.
- .2 Configuration: top in, top out, 150 mm center.
- .3 Maximum allowable operating Pressure: 20 psig.
- .4 Temperature range: -30 deg.F to +150 deg.F ambient.
- .5 Capacities:
  - .1 Pressure drop of 2.0'' w.c: 1800 CFH.
- .6 Temperature compensation: internal thermistor.
- .7 Pressure compensation: programmable fixed factor.
- .8 Data logging: Hourly for 60 days.



- .9 Provide all provisions and features for EMCS (DDC) to monitor and trend log the gas consumption.
- .10 Case: 383 aluminum alloy
  - .1 Communications:
    - .1 Collect pulse data from up to two inputs and store data as a function of time.
    - .2 Data can be retrieved through RS-232 protocols.
- .11 Acceptable material: Sensus Sonix 880.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2 PIPING**

- .1 Install in accordance with Section 23 05 01 - Installation of Pipework, applicable Provincial/Territorial Codes, CAN/CSA B149.1, supplemented as specified.
- .2 Provide new underground gas pipes (with 5 psi gas pressure) on site with approved jackets to meet code requirements. Coordinate with Civil Drawings and Specification (civil work trade) for routing, elevation, excavation, trenching, cutting, backfill and make good site surfaces for new pipe installation. New gas pipes shall be approximately similar buried depth as existing main gas service lines.
- .3 Provide gas pipes to all new gas-fired equipment with shut-off valves and gas pressure regulators.
- .4 Install drip points:
  - .1 At low points in piping system.
  - .2 At connections to equipment.

**3.3 VALVES**

- .1 Install valves with stems upright or horizontal unless otherwise approved by Departmental Representative.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

**3.4 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.

- .2 Performance Verification:
  - .1 Refer to Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

- .3 PV procedures:
  - .1 Test performance of components.

### **3.5 ADJUSTING**

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
- .2 Pre-Start-Up Inspections:
  - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
  - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

### **3.6 CLEANING**

- .1 Cleaning: in accordance with CAN/CSA B149.1.
- .2 Perform cleaning operations in accordance with manufacturer's recommendations.
- .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Copper piping valves and fittings for hydronic systems.

**1.2 REFERENCES**

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)

- .1 ANSI/AWS A5.8/A5.8M-04, Specification Filler Metals for Brazing and Bronze Welding.

.2 American Society of Mechanical Engineers (ASME)

- .1 ANSI/ASME B16.4-98, Gray-Iron Threaded Fittings.
- .2 ANSI/ASME B16.15-1985(2004), Cast Bronze Threaded Fittings.
- .3 ANSI B16.18-2001, Cast Copper Alloy, Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.22-2001, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

.3 American Society for Testing and Materials International (ASTM)

- .1 ASTM B32-04, Standard Specification for Solder Metal.
- .2 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
- .3 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .4 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube Metric.
- .5 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

.5 Manufacturers Standardization Society (MSS)

- .1 MSS SP67-2002a, Butterfly Valves.
- .2 MSS SP70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
- .3 MSS SP71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
- .4 MSS SP80-2003, Bronze Gate, Globe, Angle and Check Valves.
- .5 MSS SP85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

**1.3 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.
  - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
    - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Indicate on manufacturers catalogue literature the following: VALVES.
- .3 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.

#### **1.4 QUALITY ASSURANCE**

- .1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33.

#### **1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Furnish following spare parts:
    - .1 Valve seats: one for every ten valves, each size. Minimum one.
    - .2 Discs: one for every ten valves, each size. Minimum one.
    - .3 Stem packing: one for every ten valves, each size. Minimum one.
    - .4 Valve handles: two of each size.
    - .5 Gaskets for flanges: one for every ten flanges.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

## **Part 2 Products**

### **2.1 TUBING**

- .1 Type L hard drawn copper tubing: to ASTM B88M.

### **2.2 FITTINGS**

- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

### **2.3 FLANGES**

- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

### **2.4 JOINTS**

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.

### **2.5 VALVES**

- .1 Connections:
  - .1 NPS 2 and smaller: ends for soldering.
  - .2 NPS 2 1/2 and larger: flanged ends.
- .2 Gate Valves Application: isolating equipment, control valves, pipelines:
  - .1 NPS 2 and under:
    - .1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 23.01 Valve Bronze.

- .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 Valve Bronze.
- .2 NPS 2 1/2 and over:
  - .1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 23 05 23.02 Valve Cast Iron.
  - .2 Elsewhere: Non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 Valve Cast Iron.
- .3 Butterfly valves: application: isolating each cell or section of multiple component equipment (eg. multi-section coils):
  - .1 NPS 2 1/2 and over: lug type: as specified Section 23 05 23.02 Valve Cast Iron.
- .4 Globe valves: application: throttling, flow control, emergency bypass:
  - .1 NPS 2 and under:
    - .1 Mechanical Rooms: with PFTE disc, as specified Section 23 05 23.01 Valve Bronze.
    - .2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 Valve Bronze.
  - .2 NPS 2 1/2 and over:
    - .1 With composition bronze disc, bronze trim, as specified Section 23 05 23.02 Valve Cast Iron.
- .5 Balancing, for TAB:
  - .1 Sizes: calibrated balancing valves, as specified.
  - .2 NPS 2 and under:
    - .1 Mechanical Rooms : globe, with plug disc as specified Section 23 05 23.01 Valve Bronze.
    - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 Valve Bronze.
- .6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 0523.01 Valve Bronze.
- .7 Bypass valves on gate and globe valves NPS 8 and larger: NPS 3/4, globe, with PFTE disc as specified Section 23 05 23.01 Valve Bronze.
- .8 Swing check valves:
  - .1 NPS 2 and under:
    - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 Valve Bronze.
    - .2 NPS 2 1/2 and over:
      - .1 Flanged ends: as specified Section 23 05 23.02 Valve Cast Iron.
- .9 Silent check valves:
  - .1 NPS 2 and under:
    - .1 As specified Section 23 05 23.01 Valve Bronze.
  - .2 NPS 2 1/2 and over:

- .1 Flanged ends: as specified Section 23 05 23.02 Valve Cast Iron.
- .10 Ball valves:
  - .1 NPS 2 and under: as specified Section 23 05 23.01 Valve Bronze.
- .11 Lubricated Plug Valves:
  - .1 NPS 2 and under: as specified in Section 23 05 23.01 Valve Bronze.
  - .2 NPS 2 1/2 and over: as specified Section 23 05 23.02 Valve Cast Iron.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

#### **3.2 PIPING INSTALLATION**

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Assemble piping using fittings manufactured to ANSI standards.

#### **3.3 VALVE INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install butterfly valves on chilled water and condenser water lines only.
- .3 Install ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install globe valves for balancing and in by-pass around control valves as indicated.
- .5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- .6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

- .7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

- .8 Install ball valves for glycol service.

### **3.4 CIRCUIT BALANCING VALVES**

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

### **3.5 FLUSHING AND CLEANING**

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test for a minimum of 4h.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.
- .4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.
- .5 Refill system with clean water. Circulate for at least 2h. Clean out strainer screens/baskets regularly. Then drain.
- .6 Drainage to include drain valves, dirt pockets, strainers, low points in system.
- .7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

### **3.6 FILLING OF SYSTEM**

- .1 Refill system with clean water adding water treatment as specified glycol.

### **3.7 FIELD QUALITY CONTROL**

- .1 Testing:
  - .1 Test system in accordance with Section 21 05 01.
  - .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.
- .2 Balancing:
  - .1 Balance water systems to within plus or minus 5 % of design output.
  - .2 Refer to Section for applicable procedures.
- .3 Glycol Charging:
  - .1 Provide mixing tank and positive displacement pump for glycol charging.
  - .2 Retest for concentration to ASTM E202 after cleaning.



- .3 Provide report to Departmental Representative.
- .4 Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Low-emitting materials.

**3.8 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes.
  - .1       Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
  - .2       Sustainable requirements for construction and verification.
    - .1
- .2    Related Sections.
  - .1       Section 01 35 29.06 - Health and Safety Requirements.
  - .2       Section 21 05 01 - Common Work Results for Mechanical.
  - .3       Section 23 05 17 - Pipe Welding.
  - .4       Section 23 08 03 - Cleaning and Start-up of Mechanical Piping Systems.
  - .5       Section 23 05 01 - Installation of Pipework.
  - .6       Section 23 05 23.01 - Valves - Bronze.
  - .7       Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .8       Section 23 08 01 - Performance Verification of Mechanical Piping.

**1.2            REFERENCES**

- .1    American Society of Mechanical Engineers (ASME).
  - .1       ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
  - .2       ASME B16.3-98, Malleable Iron Threaded Fittings.
  - .3       ASME B16.5-03, Pipe Flanges and Flanged Fittings.
  - .4       ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.
  - .5       ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
  - .6       ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
- .2    American Society for Testing and Materials International, (ASTM).
  - .1       ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
  - .2       ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
  - .3       ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
  - .4       ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
  - .5       ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .6       ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3    American Water Works Association (AWWA).
  - .1       AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

- .4 Canadian Standards Association (CSA International).
  - .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
  - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
  - .1 MSS-SP-67-025, Butterfly Valves.
  - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
  - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
  - .5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

### **1.3 SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
- .2 Closeout Submittals.
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions and include following:
    - .1 Special servicing requirements.

### **1.4 QUALITY ASSURANCE**

- .1 Health and Safety.
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33.

### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal.
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
  - .4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

### **1.6 MAINTENANCE**

- .1 Extra Materials.
  - .1 Provide following spare parts:
    - .1 Valve seats: one for every ten valves, each size. Minimum one.
    - .2 Discs: one for every ten valves, each size. Minimum one.
    - .3 Stem packing: one for every ten valves, each size. Minimum one.

- .4 Valve handles: two of each size.
- .5 Gaskets for flanges: one for every ten flanges.

## **Part 2 Products**

### **2.1 PIPE**

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
  - .1 To NPS6.

### **2.2 PIPE JOINTS**

- .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.
- .3 Roll grooved: standard coupling to CSA B242.
- .4 Flanges: plain or raised face, weld neck to AWWA C111
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: to AWWA C111.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM.

### **2.3 FITTINGS**

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
  - .1 Cast iron: to ASME B16.1, Class 125.
  - .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.
- .5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M ductile iron to ASTM A536.

### **2.4 VALVES**

- .1 Connections:
  - .1 NPS2 and smaller: screwed ends.
  - .2 NPS2.1/2 and larger: Flanged ends.

- .2 Gate valves: to MSS-SP-70 to MSS-SP-80 Application: Isolating equipment, control valves, pipelines:
  - .1 NPS2 and under:
    - .1 Mechanical Rooms : Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 – Valves- Bronze: Gate, Globe, Check.
    - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
  - .2 NPS21/2 and over:
    - .1 Mechanical Rooms: risingstem, split wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
    - .2 Elsewhere: Non- rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (eg. multi-section coils:
  - .1 NPS21/2 and over: Lug type: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .4 Globe valves: to MSS-SP-80 Application: Throttling, flow control, emergency bypass:
  - .1 NPS2 and under:
    - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
    - .2 Elsewhere: Globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check instructions
  - .2 NPS21/2 and over:
    - .1 With composition lead free bronze disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
    - .2 Operators:
- .5 Balancing, for TAB:
  - .1 Sizes: Calibrated balancing valves, as specified this section.
  - .2 NPS2 and under:
    - .1 Mechanical Rooms: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
    - .2 Elsewhere: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
- .7 Bypass valves on gate globe valves NPS8 and larger: NPS3/4, Globe, with PTFE disc as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .8 Swing check valves: to MSS-SP-71.
  - .1 NPS2 and under:
    - .1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.

- .2 NPS21/2 and over:
  - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .9 Silent check valves:
  - .1 NPS2 and under:
    - .1 As specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
  - .2 NPS21/2 and over:
    - .1 Flanged ends: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- .10 Ball valves:
  - .1 NPS2 and under: as specified Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
- .11 Lubricated Plug Valves
  - .1 NPS2 and under: Section 23 05 23.01 - Valves - Bronze: Gate, Globe, Check.
  - .2 NPS21/2 and over:
    - .1 As specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

### **Part 3 Execution**

#### **3.1 PIPING INSTALLATION**

- .1 Install pipework in accordance with Section 23 05 17.

#### **3.2 CIRCUIT BALANCING VALVES**

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

#### **3.3 CLEANING, FLUSHING AND START-UP**

- .1 In accordance with Section 01 08 03 and 23 25 00.

#### **3.4 TESTING**

- .1 Test system in accordance with Section 23 05 93.
- .2 For glycol systems, retest with ethylene propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

#### **3.5 BALANCING**

- .1 Balance water systems to within plus or minus 5 % of design output.

- .2 Refer to Section 23 05 93 for applicable procedures.

### **3.6 GLYCOL CHARGING**

- .1 Provide mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.

### **3.7 PERFORMANCE VERIFICATION**

- .1 In accordance with Section 23 08 01 and 23 08 02.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME-04(2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
  - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01(2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-84(2004), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
  - .1 CSA B51-03(R2003), Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA B51-03(R2005), Boiler, Pressure Vessel, and Pressure Piping Code, Supplement #1.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance and operation data in accordance with Section 01 01 50 General Instructions.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.



- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, paddling and packaging materials in accordance with Section 01 01 50 General Instructions.

## **Part 2 Products**

### **2.1 CLOSED EXPANSION TANK**

- .1 Horizontal expansion tank with threaded pipe connections.
- .2 Capacity: 50 L.
- .3 Size: 750 mm long x 600 mm diameter.
- .4 Construction:
  - .1 ASME code rated welded tank to 860 kPa test pressure of ASTM A516/A516M, pressure vessel carbon steel plate with dished heads galvanized after manufacture.
  - .2 Conform to: ANSI/ASME BPVC, Section VIII and CSA B51, and provincial regulations.
  - .3 Submit certificate of registration as required by provincial authorities .
- .5 Accessories:
  - .1 Expansion pipe connection at bottom.
  - .2 Circulating pipe connection at bottom .
  - .3 NPS 1 drain connection at bottom with drain valve.
  - .4 Vent connection, NPS, at top.
  - .5 Relief valve and connection at top, to manufacturer's recommendations.
  - .6 Service hole - 275 x 375 mm on end.
  - .7 12 mm sight glass connections at 1/8 and 7/8 points of height, complete with sight glass, shut-off valves with blowdown and protective guards.
  - .8 Two - 62 mm inspection tappings on centre line of sides, one near each end.
- .6 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems .

### **2.2 DIAPHRAGM TYPE EXPANSION TANK**

- .1 Horizontal, Vertical, galvanized steel, steel pressurized diaphragm type expansion tank.
- .2 Capacity: 50 L.
- .3 Size: 750 mm long x 600 mm diameter.
- .4 Diaphragm sealed in elastomer, EPDM, suitable for 115 degrees C operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification 520 kPa.
- .6 Air precharged to 84 kPa (initial fill pressure of system).

- .7 Saddles for horizontal installation. Base mount for vertical installation.
- .8 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .9 Renewable diaphragm.

### **2.3 AUTOMATIC AIR VENT**

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 620 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .3 Float: solid material suitable for 115 degrees C working temperature.

### **2.4 AIR SEPARATOR - BOILER MOUNTED**

- .1 Complete with dip tube.
- .2 Working pressure: 860 kPa.

### **2.5 AIR SEPARATOR - EXPANSION TANK FITTING**

- .1 Complete with adjustable vent tube and built-in manual vent valve.
- .2 Working pressure: 860 kPa.

### **2.6 AIR SEPARATOR - IN-LINE**

- .1 Working pressure: 860 kPa.
- .2 Size: NPS 1 1/2.

### **2.7 COMBINATION SEPARATORS/STRAINERS**

- .1 Steel, tested and stamped in accordance with ANSI/ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

### **2.8 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE**

- .1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.

### **2.9 PIPE LINE STRAINER**

- .1 NPS 1/2 to 2: bronze body to ASTM B62, solder end screwed connections, Y pattern.

- .2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, cast iron body to ASTM A278/A278M, Class 30 flanged connections.
- .3 NPS 2 to 12: T type with ductile iron body to ASTM A536 malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.
- .5 Screen: stainless steel brass with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

## **2.10 SUCTION DIFFUSER**

- .1 Body: cast iron with flanged screwed connections.
- .2 Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.
- .3 Permanent magnet particle trap.
- .4 Full length straightening vanes.
- .5 Pressure gauge tapings.
- .6 Adjustable support leg.

## **Part 3 Execution**

### **3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 GENERAL**

- .1 Run drain lines and blow off connections to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tapings for ancillaries and for equipment operating weights.

### **3.3 STRAINERS**

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.

- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and radiation except at radiation and as indicated.

### **3.4 AIR VENTS**

- .1 Install at high points of systems.
- .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink.

### **3.5 EXPANSION TANKS**

- .1 Adjust expansion tank pressure as indicated to suit design criteria.
- .2 Install lock shield type valve at inlet of tank.

### **3.6 PRESSURE SAFETY RELIEF VALVES**

- .1 Run discharge pipe to terminate above nearest drain.

### **3.7 SUCTION DIFFUSERS**

- .1 Install on inlet to pumps having suction size greater than 50.

### **3.8 PERFORMANCE VERIFICATION**

- .1 Operational requirements in accordance with Section 23 08 01 and 23 08 02, include:
  - .1 Repair and maintenance materials and instructions.

### **3.9 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA International)
  - .1 CSA-B214-07, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2006, Motors and Generators.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Provinces of BC, Canada.
- .4 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance and operation data for incorporation into manual specified in Section 01 01 50 General Instructions

**1.4 MAINTENANCE**

- .1 Provide maintenance materials in accordance with Section 01 01 50 General Instructions.
- .2 Supply spare parts as follows:

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.

- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates paddling and packaging materials in accordance with Section 01 01 50 General Instructions.

## **Part 2 Products**

### **2.1 EQUIPMENT**

- .1 Size and select components to: CSA-B214.

### **2.2 IN-LINE CIRCULATORS**

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: alloy steel cast bronze cast iron stainless steel.
- .3 Shaft: alloy steel stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, TEFC, explosion proof, sleeve bearing, r/min, minimum efficiency %, kW HP.
- .7 Capacity: as section 23 90 00.
- .8 Design pressure: 860 kPa..

### **2.3 VERTICAL IN-LINE CIRCULATORS**

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: corrosion resistant steel brass or bronze cast iron.
- .3 Shaft: alloy steel stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing, 1750 r/min, kW HP.
- .7 Capacity: as section 23 90 00.
- .8 Design pressure: 1200 kPa.

## **2.4 SINGLE SUCTION CENTRIFUGAL PUMP**

- .1 General: bronze fitted all iron cast steel all bronze all stainless steel pump complete with motor.
- .2 Base: common cast iron fabricated steel with drip rim and tapping for drain connection.
- .3 Volute: cast iron bronze stainless steel radially split, end suction, screwed flanged suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tappings.
- .4 Impeller: bronze cast iron stainless steel enclosed open type, keyed drive with locking nut or screw.
- .5 Shaft: alloy steel stainless steel with two point support, machined shoulders for ball bearing mounting sleeve bearings hardened wear rings at packing gland .
- .6 Seal assembly: mechanical packing gland with drip pocket under gland and piped to base gutter seal, oil grease lubricated.
- .7 Coupling: flexible self-aligning.
- .8 Motor: EEMAC Class B NEMA MG 1 , squirrel cage induction, 1,725 r/min. kW HP, continuous duty, drip proof, ball bearing, maximum temperature rise 50 degrees C.
- .9 Capacity: as per the associated pumps.
- .10 Design pressure: 1200 kPa.

## **Part 3 Execution**

### **3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

### **3.2 INSTALLATION**

- .1 Install hydronic pumps to: CSA-B214.
- .2 In line circulators: install as indicated by flow arrows.
  - .1 Support at inlet and outlet flanges or unions.
  - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
  - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
  - .2 Align coupling in accordance with manufacturer's recommended tolerance.
  - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment.

- .1 Provide stanchions or hangers for this purpose.
- .2 Refer to manufacturer's installation instructions for details.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

### **3.3 START-UP**

- .1 General:
  - .1 In accordance with Section 23 08 01, 01 08 02, and 23 08 03.
  - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
  - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
  - .2 After starting pump, check for proper, safe operation.
  - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
  - .4 Check base for free-floating, no obstructions under base.
  - .5 Run-in pumps for 12 continuous hours minimum.
  - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
  - .7 Eliminate air from scroll casing.
  - .8 Adjust water flow rate through water-cooled bearings.
  - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
  - .10 Adjust alignment of piping and conduit to ensure true flexibility.
  - .11 Eliminate cavitation, flashing and air entrainment.
  - .12 Adjust pump shaft seals, stuffing boxes, glands.
  - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
  - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
  - .15 Verify lubricating oil levels.

### **3.4 PERFORMANCE VERIFICATION (PV)**

- .1 General:
  - .1 Verify performance in accordance with Section 23 08 01.
- .2 Verify that manufacturer's performance curves are accurate.
- .3 Ensure valves on pump suction and discharge provide tight shut-off.



- .4 Net Positive Suction Head (NPSH):
  - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
  - .2 Measure using procedures prescribed in Section 23 08 01 and 23 08 02.
  - .3 Where procedures do not exist, discontinue PV, report to Departmental Representative and await instructions.
- .5 Multiple Pump Installations - Series and Parallel:
  - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .7 Commissioning Reports: in accordance with Section 23 08 02. Reports to include:
  - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
  - .2 Use Report Forms specified in Section 23 08 02.
  - .3 Pump performance curves (family of curves).

### **3.5 OPERATION REQUIREMENTS**

- .1 Operational requirements in accordance with Section 23 08 02, include:
  - .1 Repair and maintenance materials and instructions.

### **3.6 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

**.1 Section Includes:**

- .1 Materials and installation for copper tubing and fittings for refrigerant.

**.2 Related Sections:**

- .1 Section 01 35 33 - Health and Safety Requirements.
- .2 Section 23 05 01 - Installation of Pipework.

**1.2 REFERENCES**

**.1 American Society of Mechanical Engineers (ASME)**

- .1 ASME B16.22-01, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
- .2 ASME B16.24-02, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
- .3 ASME B16.26-88, Cast Copper Alloy Fittings for Flared Copper Tubes.
- .4 ASME B31.5-01, Refrigeration Piping and Heat Transfer Components.

**.2 American Society for Testing and Materials International (ASTM)**

- .1 ASTM A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B280-03, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

**.3 Canadian Standards Association (CSA International)**

- .1 CSA B52-99, Mechanical Refrigeration Code.

**.4 Environment Canada (EC)**

- .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

**.5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)**

- .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

**.1 Submittals in accordance with Section 01 01 50 General Instructions.**

**.2 Co-ordinate submittal requirements and provide submittals required by Section 01 01 50 General Instructions.**

**.3 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.

- .2 Submit WHMIS MSDS in accordance with Section 01 01 50 General Instructions. Indicate VOC's for adhesive and solvents during application and curing.
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Instructions: submit manufacturer's installation instructions.
- .7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 01 50 General Instructions.

#### **1.4 QUALITY ASSURANCE**

- .1 Pre-Installation Meeting:
  - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations in accordance with Section 01 01 50 General Instructions .
    - .1 Verify project requirements.
    - .2 Review installation and substrate conditions.
    - .3 Co-ordination with other building subtrades.
    - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33.
- .3 Construction requirements: in accordance with Section 01 01 50 General Instructions .
- .4 Verification: contractor's verification in accordance with Section 23 08 01.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
  - .4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan (WMP).
  - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative Engineer.

**Part 2 Products**

**2.1 TUBING**

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
  - .1 Hard copper: to ASTM B280, type ACR B.
  - .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

**2.2 FITTINGS**

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
  - .1 Fittings: wrought copper to ASME B16.22.
  - .2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
  - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
  - .2 Gaskets: suitable for service.
  - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
  - .1 Bronze or brass, for refrigeration, to ASME B16.26.

**2.3 PIPE SLEEVES**

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

**2.4 VALVES**

- .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
- .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 GENERAL**

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.

### **3.3 BRAZING PROCEDURES**

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

### **3.4 PIPING INSTALLATION**

- .1 General:
  - .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
  - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
  - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
  - .3 Provide inverted deep trap at top of risers.
  - .4 Provide double risers for compressors having capacity modulation.
    - .1 Large riser: install traps as specified.
    - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

### **3.5 PRESSURE AND LEAK TESTING**

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.
- .3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

### **3.6 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.

- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
  - .1 Twice to 14 Pa absolute and hold for 4 h.
  - .2 Break vacuum with refrigerant to 14 kPa.
  - .3 Final to 5 Pa absolute and hold for at least 12 h.
  - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
  - .5 Submit test results to Departmental Representative.
- .7 Charging:
  - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
  - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
  - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
  - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
  - .2 Record and report measurements to Departmental Representative.
- .9 Manufacturer's Field Services:
  - .1 Have manufacturer of products, supplied under this Section, review work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of work with contract.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review work, at stages listed:
    - .1 After delivery and storage of products, and when preparatory work, or other work, on which the work of this section depends, is complete but before installation begins.
    - .2 Twice during progress of Work at 25% and 60% complete.
    - .3 Upon completion of the Work, after cleaning is carried out.
  - .4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.
- .10 Verification requirements in accordance with Section 01 01 50 General Instructions, include:

- .1 Materials and resources.
- .2 Storage and collection of recyclables.
- .3 Construction waste management.
- .4 Resource reuse.
- .5 Recycled content.
- .6 Local/regional materials.
- .7 Certified Wood.
- .8 Low-emitting materials.

**3.7 DEMONSTRATION**

- .1 Instructions:
  - .1 Post instructions in frame with glass cover in accordance with Section 01 01 50 General Instructions and CSA B52.

**3.8 CLEANING**

- .1 Perform cleaning operations as specified in section and in accordance with manufacturer's recommendations.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

**.1 Section Includes:**

- .1 Materials, components, equipment and chemicals for installation of complete HVAC water treatment system.

**1.2 REFERENCES**

**.1 American Society of Mechanical Engineers (ASME)**

- .1 ASME Boiler and Pressure Vessel Code, Section VII-2004.

**.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)**

- .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

**.1 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.

**.2 Shop Drawings:**

- .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
  - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.

**.3 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.**

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**.4 Closeout Submittals:**

- .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions
- .2 Include following:
  - .1 Log sheets as recommended by manufacturer Departmental Representative.

**1.4 QUALITY ASSURANCE**

**.1 Health and Safety:**

- .1 Do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.



**1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**Part 2 Products**

**2.1 MANUFACTURER**

- .1 Equipment, chemicals, service provided by one supplier.

**2.2 POT FEEDER**

- .1 Welded steel, pressure rating kPa. Temperature rating: 90 degrees C.

**2.3 CHEMICAL FEED PIPING**

- .1 Resistant to chemicals employed. Pressure rating: 860 kPa.

**2.4 CHEMICAL FEED PUMPS**

- .1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.
- .2 Piston type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with stainless steel piston, pressure relief valve, double ball and check valves.

**2.5 CONDUCTIVITY CONTROLLER**

- .1 Fully transistorized, suitable for wall or flush panel mounting, linear over full measuring range of 0-5000 micromhs.
- .2 Insensitive to phase angle shifts, capable of operating on 95-130 Volts without affecting accuracy, power, bleedoff status lights.

**2.6 CONDUCTIVITY PROBES**

- .1 Dual carbon elements in PVC holder, quick disconnect, self-locking connection.

**2.7 WATER SOFTENER**

- .1 General: 1 sodium zeolite exchanger[s] with common brine tank with eductor and manifold.

- .2 Performance: to reduce effluent hardness to less than 1 ppm
- .3 Control:
  - .1 Automatic feature to prevent regeneration of both exchangers at same time
  - .2 Individual metres with solenoid operated diaphragm valves to regenerate unit whenever L have passed through softener
  - .3 Seven day clock permitting regeneration as required. Provide for adjustment of brine/rinse and backwash cycles
- .4 Water metre:
  - .1 Provide totalizing water metre and tie to building EMCS system.
  - .2 Capacity: L/s. kPa pressure drop.
  - .3 Refer to Section 22 42 01.

## **2.8 WATER TREATMENT FOR HYDRONIC SYSTEMS**

- .1 Hot water heating system: pot feeder, 25 L, operating pressure 860 kPa.
- .2 Glycol system: pot feeder, 25, operating pressure 860 kPa.
- .3 Micron filter for each pot feeder:
  - .1 Capacity 2% of pump recirculating rate at operating pressure.
  - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

## **2.9 CHEMICALS**

- .1 Provide 1 years supply.
- .2 Obtain chemicals information with same manufacturer from existing Central Heating Plant's facility manager.

## **2.10 TEST EQUIPMENT**

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 INSTALLATION**

- .1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

### **3.3 CHEMICAL FEED PIPING**

- .1 Install crosses at changes in direction. Install plugs in unused connections.

### **3.4 CLEANING OF MECHANICAL SYSTEM**

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
- .2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .5 Disposal of cleaning solutions approved by authority having jurisdiction.

### **3.5 WATER TREATMENT SERVICES**

- .1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
  - .1 Initial water analysis and treatment recommendations.
  - .2 System start-up assistance.
  - .3 Operating staff training.
  - .4 Visit plant every days during period of operation and as required until system stabilizes, and advise on treatment system performance.
  - .5 Provide necessary recording charts and log sheets for one year operation.
  - .6 Provide necessary laboratory and technical assistance.
  - .7 Provide clear, concise, written instructions and advice to operating staff.

### **3.6 WATER SOFTENER**

- .1 Install in accordance with manufacturer's instructions.
- .2 Install water metre in water softener inlet piping.

### **3.7 FIELD QUALITY CONTROL**

- .1 Start-up:
  - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
  - .1 Commissioning Agency: to be installing water treatment sub-contractor water treatment supplier holder of service contract.
  - .2 Timing:
    - .1 After start-up deficiencies rectified.
    - .2 After start-up and before TAB of connected systems.
  - .3 Pre-commissioning Inspections: verify:
    - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
    - .2 Suitability of log book.
    - .3 Currency and accuracy of raw initial water analysis.
    - .4 Required quality of treated water.
  - .4 Commissioning procedures - applicable to Water Treatment Systems:
    - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
    - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
    - .3 Establish test intervals, regeneration intervals.
    - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
    - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
    - .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
    - .7 Advise Departmental Representative in writing on matters regarding installed water treatment systems.
  - .5 Commissioning procedures - Water Softeners:
    - .1 Demonstrate compliance with specifications by chemical analyses of raw water and treated water.
    - .2 Determine, demonstrate actual softening capacity between regenerations.
    - .3 Establish regeneration intervals and procedures.
    - .4 Train O&M personnel in regeneration procedures.
  - .6 Commissioning procedures - Closed Circuit Hydronic Systems:
    - .1 Analyze water in system.
    - .2 Based upon an assumed rate of loss approved by Departmental Representative, establish rate of chemical feed.

- .3 Record types, quantities of chemicals applied.
  - .7 Training:
    - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.
    - .2 Train O&M personnel in softener regeneration procedures.
    - .3
  - .8 Certificates:
    - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
  - .9 Commissioning Reports:
    - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
  - .10 Demonstrations:
  - .11 Commissioning activities during Warranty Period:
    - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.
- .3 Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Low-emitting materials.

### **3.8 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

**.1 Section Includes:**

- .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

**1.2 REFERENCES**

**.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)**

**.2 American Society for Testing and Materials International, (ASTM).**

- .1 ASTM A 480/A 480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .2 ASTM A 635/A 635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
- .3 ASTM A 653/A 653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

**.3 Department of Justice Canada (Jus).**

- .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

**.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).**

- .1 Material Safety Data Sheets (MSDS).

**.5 National Fire Protection Association (NFPA).**

- .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
- .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

**.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).**

- .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
- .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
- .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

.7 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

.1 Submit shop drawings and product data in accordance with Section 01 01 50- General Instructions.

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 33 – Health and Safety Requirements for the following:

.1 Sealants.

.2 Tape.

.3 Proprietary Joints.

### **1.4 QUALITY ASSURANCE**

.1 Certification of Ratings:

.1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

.3 Indoor Air Quality (IAQ) Management Plan.

.1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

### **1.5 DELIVERY, STORAGE AND HANDLING**

.1 Protect on site stored or installed absorptive material from moisture damage.

.2 Waste Management and Disposal:

.3 Separate waste materials in accordance with Section 01 01 50 - General Instructions.

## **Part 2 Products**

### **2.1 SEAL CLASSIFICATION**

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed

.2 Classification as follows:

- .1 Class C: transverse joints and connections made air tight with gaskets, sealant, tape or combination thereof. Longitudinal seams unsealed.
- .2 Unsealed seams and joints.

## **2.2 SEALANT**

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

## **2.3 TAPE**

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

## **2.4 DUCT LEAKAGE**

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

## **2.5 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
  - .1 Rectangular: standard radius short radius with single thickness turning vanes  
Centreline radius: 1.5 times width of duct .
  - .2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single double thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
  - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30degrees maximum included angle.
- .6 Offsets:
  - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.



**2.6 FIRE STOPPING**

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.

**2.7 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A 653/A 653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

**2.8 HANGERS AND SUPPORTS**

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA.
  - .4 Upper hanger attachments:
    - .1 For concrete: manufactured concrete inserts.
    - .2 For steel joist: steel plate washer.
    - .3 For steel beams: manufactured beam clamps:

**Part 3 Execution**

**3.1 GENERAL**

- .1 Do work in accordance with, NFPA 90A, NFPA 90B, ASHRAE, SMACNA, as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with ASHRAE, SMACNA and as indicated.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining

### **3.2 HANGERS**

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with ASHRAE and SMACNA.

### **3.3 SEALING AND TAPING**

- .1 Apply sealant to outside of joint to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

### **3.4 LEAKAGE TESTS**

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Do not install additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .6 Complete test before performance insulation or concealment Work.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.
  - .2 Sustainable requirements for construction and verification.
- .2 Related Sections:
  - .1 Section 01 01 50 – General Instructions.

**1.2 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50 for Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
  - .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's Field Reports: manufacturer's field reports specified.
- .7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 01 50 - General Instructions.

**1.4 QUALITY ASSURANCE**

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50- General Instructions.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

**Part 2 Products**

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

**2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m<sup>2</sup>.

**2.3 ACCESS DOORS IN DUCTS**

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
  - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
  - .2 301 to 450 mm: four sash locks complete with safety chain.
  - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
  - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
  - .5 Hold open devices.
  - .6 300 x 300 mm glass viewing panels.

**2.4 TURNING VANES**

- .1 Factory or shop fabricated single thickness with trailing edge, to recommendations of SMACNA and as indicated.

**2.5 INSTRUMENT TEST**

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

**2.6 SPIN-IN COLLARS**

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

**3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
  - .1 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Reheat coils.
    - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:

- .1 General:
  - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 In mixed air applications in locations as approved by Departmental Representative.
      - .3 At inlet and outlet of coils.
      - .4 Downstream of junctions of two converging air streams of different temperatures.
      - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### **3.3 CLEANING**

- .1 Perform cleaning operations as specified in Section 21 05 01 and in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

**1.2 REFERENCES**

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 for Submittal Procedures. Include product characteristics, performance criteria, and limitations.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Quality assurance submittals: submit following in accordance with Section 01 01 50- General Instructions.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

- .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.4 QUALITY ASSURANCE**

.1 Health and Safety Requirements:

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.5 DELIVERY, STORAGE, AND HANDLING**

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.

.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 SPLITTER DAMPERS**

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Single thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

**2.3 SINGLE BLADE DAMPERS**

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm or as indicated.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

**2.4 MULTI-BLADED DAMPERS**

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm or as indicated.
- .4 Bearings: pin in bronze bushings.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.



**Part 3            Execution**

**3.1                MANUFACTURER'S INSTRUCTIONS**

- .1        Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2                INSTALLATION**

- .1        Install where indicated.
- .2        Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3        Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4        Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5        Dampers: vibration free.
- .6        Ensure damper operators are observable and accessible.
- .7        Corrections and adjustments conducted by Engineer.

**3.3                FIELD QUALITY CONTROL**

- .1        Tests:
  - .1        Tests to cover period of not less than 2 days and demonstrate that system is functioning as specified.

**3.4                CLEANING**

- .1        Proceed in accordance with Section 01 01 50 - General Instructions.
- .2        Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

**1.2 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 - General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 - General Instructions.
  - .2 Indicate the following:
    - .1 Performance data.
- .2 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .3 Closeout Submittals
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 - General Instructions.

**1.4 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.
- .2 Certificates:

- .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

## **Part 2 Products**

### **2.1 MULTI-LEAF DAMPERS**

- .1 Opposed or parallel blade type as indicated.
- .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Operator: to Section 25 30 02.
- .6 Performance:
  - .1 Leakage: in closed position less than 2% of rated air flow at 1000 Pa differential across damper.
  - .2 Pressure drop: at full open position less than 25 Pa differential across damper at 2.5 m/s.
- .7 Insulated aluminum dampers:
  - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
  - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

### **2.2 BACK DRAFT DAMPERS**

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, spring assisted or counterweighted.

### **2.3 RELIEF DAMPERS**

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 0.5 Pa static pressure, as indicated.

**Part 3            Execution**

**3.1                MANUFACTURER'S INSTRUCTIONS**

- .1        Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2                INSTALLATION**

- .1        Install where indicated.
- .2        Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3        Seal multiple damper modules with silicon sealant.
- .4        Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5        Ensure dampers are observable and accessible.

**3.3                CLEANING**

- .1        Proceed in accordance with Section 01 01 50 - General Instructions.
- .2        Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

**.1 Section Includes:**

- .1 Fire and smoke dampers, and fire stop flaps.

**1.2 REFERENCES**

**.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)**

- .1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.

**.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)**

- .1 Material Safety Data Sheets (MSDS).

**.3 Underwriters Laboratories of Canada (ULC)**

- .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
- .2 ULC-S505-1974, Fusible Links for Fire Protection Service.

**1.3 SUBMITTALS**

**.1 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 - General Instructions. Include product characteristics, performance criteria, and limitations.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 - General Instructions.

- .2 Indicate the following:

- .1 Fire dampers.
  - .2 Fusible links.
  - .3 Design details of break-away joints.

**.2 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.**

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .2 Instructions: submit manufacturer's installation instructions.

- .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**.3 Closeout Submittals:**

- .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 - General Instructions.

#### **1.4 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.
- .2 Certificates:
  - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

#### **1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 01 50 - General Instructions.
  - .2 Provide following:
    - .1 6 fusible links of each type.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 01 50- General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

### **Part 2 Products**

#### **2.1 FIRE DAMPERS**

- .1 Fire dampers: arrangement Type B, listed and bear label of ULC, meet requirements of provincial fire authority and Fire Commissioner of Canada (FCC) and ANSI/NFPA 90A, authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
  - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
  - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; sized to maintain full duct cross section.

- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

#### **3.2 INSTALLATION**

- .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Co-ordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

**3.3 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 - General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Materials and installation of flexible ductwork, joints and accessories.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  - .2 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
  - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 (Addendum No.1, November 1997).
  - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.
- .6 Underwriters' Laboratories Inc. (UL).
  - .1 UL 181-96, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC).
  - .1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.

**1.3 SUBMITTALS**

- .1 Make submittals in accordance with Section 01 01 50 - General Instructions.
- .2 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 01 50 - General Instructions.

**1.4 QUALITY ASSURANCE**

- .1 Certification of Ratings:

- .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## **1.6 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN**

- .1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

### **2.2 METALLIC - UNINSULATED**

- .1 Type 1: spiral wound flexible aluminum.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Thermal loss/gain:  $W/m^2$ . degrees C mean.

## **Part 3 Execution**

### **3.1 DUCT INSTALLATION**

- .1 Install in accordance with: CAN/ULC-S110, UL-181, NFPA 90A, NFPA 90B, SMACNA.

- .2 Provide flexible duct at a maximum length of 300 mm in concealed ceiling areas for final duct connection; and provide all solid ducts in exposed ceiling and areas.

**END OF SECTION**

**Part 1            General**

**1.1            SECTION INCLUDES**

- .1        Materials and installation for acoustic duct lining.

**1.2            RELATED SECTIONS**

- .1        Section 01 01 50 – General Instructions.
- .2        Section 01 35 33 - Health and Safety Requirements.

**1.3            REFERENCES**

- .1        American Society for Testing and Materials International, (ASTM).
  - .1        ASTM C423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - .2        ASTM C916-85(2001)e1, Standard Specification for Adhesives for Duct Thermal Insulation.
  - .3        ASTM C1071-00, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - .4        ASTM C1338-00, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
  - .5        ASTM G21-96(2002), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2        Department of Justice Canada (Jus).
  - .1        Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .3        Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1        Material Safety Data Sheets (MSDS).
- .4        National Fire Protection Association (NFPA).
  - .1        NFPA 90A-02, Standard for the Installation of Air Conditioning and Ventilating Systems.
  - .2        NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .5        North American Insulation Manufacturers Association (NAIMA).
  - .1        NAIMA AH116-5th Edition, Fibrous Glass Duct Construction Standards.
- .6        Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
  - .1        SMACNA, HVAC DCS, HVAC, Duct Construction Standards, Metal and Flexible-95 (Addendum No.1, Nov. 97).
  - .2        SMACNA IAQ Guideline for Occupied Buildings 95.
- .7        Transport Canada (TC).
  - .1        Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

- .8 Underwriter's Laboratories of Canada (ULC).

- .1 CAN/ULC-S102-03-EN, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

#### **1.4 SUBMITTALS**

- .1 Submit product data in accordance with Section 01 01 50 - General Instructions.

#### **1.5 HEALTH AND SAFETY**

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

#### **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Protect on site stored or installed absorptive material from moisture damage.

#### **1.7 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Place materials defined as hazardous or toxic in designated containers.
- .4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .5 Ensure emptied containers are sealed and stored safely.
- .6 Fold up metal banding, flatten and place in designated area for recycling.

### **Part 2 Products**

#### **2.1 DUCT LINER**

- .1 General:
  - .1 Mineral Fibre duct liner: air surface coated.
  - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102 and NFPA 90A, NFPA 90B.
  - .3 Fungi resistance: to ASTM C1338.
- .2 Rigid:
  - .1 Use on flat surfaces.
  - .2 25 mm thick, to ASTM C1071, Type 2, fibrous glass rigid board duct liner.
  - .3 Density: 48 kg/m<sup>3</sup> minimum.

- .4 Thermal resistance to be minimum 0.76 (m<sup>2</sup>.degrees C)/W for 25 mm thickness, 1.15 (m<sup>2</sup>.degrees C)/W for 38 mm thickness, 1.53 (m<sup>2</sup>.degrees C)/W for 50 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
- .5 Maximum velocity on faced air side: 20.3 m/sec.
- .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.
- .7 Recycled Content: EcoLogo certified containing minimum 45% by weight recycled content.
- .3 Flexible:
  - .1 Use on round or oval surfaces.
  - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
  - .3 Density: 24 kg/m<sup>3</sup> minimum.
  - .4 Thermal resistance to be minimum 0.37 (m<sup>2</sup>.degrees C)/W for 12 mm thickness, 0.74 (m<sup>2</sup>.degrees C)/W for 25 mm thickness, 1.11 (m<sup>2</sup>.degrees C)/W for 38 mm thickness, 1.41 (m<sup>2</sup>.degrees C)/W to 50 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
  - .5 Maximum velocity on coated air side: 25.4 m/sec.
  - .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

## **2.2 ADHESIVE**

- .1 Adhesive: to NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degreesC to plus 93 degreesC.
- .3 Water-based fire retardant type.

## **2.3 FASTENERS**

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

## **2.4 JOINT TAPE**

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

## **2.5 SEALER**

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

**Part 3            Execution**

**3.1                GENERAL**

- .1        Do work in accordance with SMACNA HVAC DCS except as specified otherwise.
- .2        Line inside of ducts where indicated.
- .3        Duct dimensions, as indicated, are clear inside duct lining.

**3.2                DUCT LINER**

- .1        Install in accordance with manufacturer's recommendations, and as follows:
  - .1        Fasten to interior sheet metal surface with 90% coverage of adhesive to ASTM C916
    - .1        Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
  - .2        In addition to adhesive, impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
    - .1        Spacing of mechanical fasteners in accordance with SMAC HVAC DCS.
- .2        In systems, where air velocities exceeds 20.3 m/sec, install galvanized sheet metal nosing to leading edges of duct liner.

**3.3                JOINTS**

- .1        Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
  - .1        Bed tape in sealer.
  - .2        Apply two coats of sealer over tape.
- .2        Replace damaged areas of liner at discretion of Departmental Representative.
- .3        Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Fans, motors, accessories and hardware for commercial use.

**1.2 REFERENCES**

.1 Air Conditioning and Mechanical Contractors (AMCA)

- .1 AMCA Publication 99-2003, Standards Handbook.
- .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
- .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

- .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

**1.3 SYSTEM DESCRIPTION**

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
- .2 Capacity: flow rate, total static pressure, bhp (W), efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
- .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

**1.4 SUBMITTALS**

.1 Product Data:



- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 - General Instructions. Include product characteristics, performance criteria, and limitations.
  - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 - General Instructions.
- .2 Shop Drawings:
  - .1 Submit shop drawings and product data in accordance with Section 01 01 50 - General Instructions.
- .3 Provide :
  - .1 Fan performance curves showing point of operation, BHP and efficiency.
  - .2 Sound rating data at point of operation.
- .4 Indicate:
  - .1 Motors, sheaves, bearings, shaft details.
  - .2 Minimum performance achievable with variable speed controllers as appropriate.
- .5 Quality assurance submittals: submit following in accordance with Section 01 01 50- General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
  - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 01 50- General Instructions.

## **1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## **1.6 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 01 50 - General Instructions.
    - .1 Spare parts to include:
      - .1 Matched sets of belts.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
    - .1 Bearings and seals.
    - .2 Addresses of suppliers.
    - .3 List of specialized tools necessary for adjusting, repairing or replacing.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50- General Instructions.

**Part 2 Products**

**2.1 FANS GENERAL**

- .1 Motors:
  - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
  - .2 For use with variable speed controllers.
  - .3 Sizes as indicated.
  - .4 Two speed with two windings and speeds of approximately 875 r/min low and 1750 r/min high.
  - .5 Two speed with split winding, constant or variable torque and speeds of 1750 r/min.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment. outlet dampers and vanes and as indicated.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as required.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

**2.2 CENTRIFUGAL FANS**

- .1 Fan wheels:
  - .1 Welded aluminum construction.
  - .2 Maximum operating speed of centrifugal fans not more than 40 % of first critical speed.
  - .3 Air foil backward inclined blades, as indicated.

- .2 Bearings: heavy duty grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 hours.
- .3 Shaft seals on fume hood and biological safety cabinet exhaust fans:
  - .1 Single disc seals.
- .4 Housings:
  - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, aluminum, for smaller wheels, braced, and with welded supports.
  - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
  - .3 Provide bolted airtight access doors with handles.
- .5 Variable volume control devices:
  - .1 Mounted by fan manufacturer.
  - .2 Adjustable inlet vanes: operated from a centre mechanism linked to each damper vane. Support each vane at ends in bronze bearings. On DWDI fans interconnect vanes to operate in unison. Provide locking devices for manual operation.
  - .3 Variable Speed Drives: refer to specification.

## **2.3 IN-LINE CENTRIFUGAL FANS**

- .1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct or belt drive.
- .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

## **2.4 ROOF EXHAUSTERS**

- .1 Centrifugal direct driven as specified.
  - .1 Housings: spun aluminum complete with resilient with mounted motor and fan.
  - .2 Impeller: aluminum non-overloading.
  - .3 12 mm mesh 2.0 mm diameter aluminum birdscreen.
  - .4 Automatic gasketed aluminum backdraft dampers.
  - .5 Disconnect switch within fan housing.
  - .6 Continuous curb gaskets, cadmium plated securing bolts and screws, and mated 300 mm high curbs. Hinge curb plate for access to internals for maintenance.
- .2 Curbs: of same manufacturer as fan and built to suit model specified.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2 FAN INSTALLATION**

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Bearings and extension tubes to be easily accessible.
- .3 Access doors and access panels to be easily accessible.

**3.3 ANCHOR BOLTS AND TEMPLATES**

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as required.

**3.4 CLEANING**

- .1 Proceed in accordance with Section 01 01 50- General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Variable volume boxes, constant volume bypass, and fan powered and electronic variable air volume boxes.

**1.2 REFERENCES**

.1 American National Standards Institute (ANSI)

- .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .2 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

.3 International Organization of Standardization (ISO)

- .1 ISO 3741-2001, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.4 Underwriter's Laboratories (UL)

- .1 UL 181-2003, Factory-Made Air Ducts and Air Connectors.

**1.3 SYSTEM DESCRIPTION**

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

**1.4 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions . Include product characteristics, performance criteria, and limitations.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.

.2 Test data: to ANSI/AMCA 210.

- .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.

- .2 Sound power level with minimum inlet pressure of 0.25 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
  - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
    - .1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Indicate the following:
    - .1 Capacity.
    - .2 Pressure drop.
    - .3 Noise rating.
    - .4 Leakage.
- .3 Samples:
  - .1 Submit duplicate samples and mock-ups in accordance with Section 01 01 50 General Instructions.
  - .2 Submit mock-ups in accordance with Section 01 01 50 General Instructions.
  - .3 Samples and mock-ups are required for following: .
- .4 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .5 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.

## **1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

## **1.7 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 01 50 General Instructions.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
    - .1 Bearings and seals.
    - .2 Addresses of suppliers.
    - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **Part 2 Products**

### **2.1 MANUFACTURED UNITS**

- .1 Terminal units of the same type to be product of one manufacturer.

### **2.2 VARIABLE VOLUME BOXES**

- .1 Pressure independent factory reset to air flow between zero minimum and maximum air volume.
- .2 Sizes, capacities, differential pressures and sound ratings: as indicated.
- .3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.
- .4 Sound ratings of assembly not to exceed NC at 10 Pa.
- .5 Complete with:
  - .1 Operator and controller: as specified under Section 01 01 50 General Instructions.
  - .2 Sound attenuator: as specified in Section 01 01 50 General Instructions.
  - .3 Multiport outlet adapter: as indicated.
  - .4 Reheat coil: as indicated.
  - .5 Pneumatic controller to operate damper operator between independent of maximum or minimum air volume settings:
- .6 Minimum 35 kPa reset span.
- .7 Adjustable reset start point.
- .8 Adjustable reset span to maximum 70 kPa when supplied with minimum 140 kPa main control air.
- .9 No control air bleed off through inlet sensor.
- .10 Operator to be factory mounted and calibrated:

- .1 Gauge taps for balancing with standard pressure gauge.
- .2 Controller to have adjustable flow settings.
- .11 Casing: constructed of mm thick galvanized steel, internally lined with 25 mm, 0.7 kg density fibrous glass, to UL181 and ANSI/NFPA 90A. Mount control components inside protective metal shroud.
- .12 Damper: mm thick galvanized steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.

### **2.3 ELECTRONIC VARIABLE AIR VOLUME BOXES**

- .1 Pressure independent, reset to air flow between zero and maximum air volume.
- .2 At inlet velocity of 10 m/s, differential static pressure for unit with attenuator section not to exceed 25 Pa.
- .3 Sound ratings of assembly not to exceed NC at 10 Pa.
- .4 Air velocity sensor resistance wire or pitot rack as standard to manufacturer.
- .5 Signals between temperature sensing device, velocity controller, velocity sensor and damper actuator analogue or digital as indicated. Shielded or twisted wire requirements is not acceptable.
- .6 Electronic thermostat furnished by terminal unit manufacturer and have set points and velocity adjustments located in thermostat. Heating and cooling set point range 13 to 30 degrees C. Set points not overlapping. Thermostat to have C proportional band at velocity settings.
- .7 Electronic control package factory calibrated and set at factory. Features to accommodate field calibration and readjustment of air volume settings to include:
  - .1 Metre taps for balancing with digital DC voltmeter.
  - .2 Adjustable flow settings at thermostat.
- .8 Factory installed 20 VA transformer, 115 V to 24 V. Power consumption of terminal not to exceed 15 VA.
- .9 Terminal unit to be CSA certified.
- .10 Casing: mm thick galvanized steel, internally lined with 25 mm. 0.7 kg density fibrous glass, to UL 181 and ANSI/NFPA 90A. Mount control components inside protective metal shroud.
- .11 Damper: mm thick steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .12 Sizes and capacity: as indicated.



**Part 3            Execution**

**3.1            MANUFACTURER'S INSTRUCTIONS**

- .1        Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2            INSTALLATION**

- .1        Install in accordance with manufacturers recommendations.
- .2        Support independently of ductwork.
- .3        Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4        Locate controls, dampers and access panels for easy access.

**3.3            FIELD QUALITY CONTROL**

- .1        Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1        Materials and resources.
  - .2        Storage and collection of recyclables.
  - .3        Construction waste management.
  - .4        Resource reuse.
  - .5        Recycled content.
  - .6        Local/regional materials.
  - .7        Low-emitting materials.

**3.4            CLEANING**

- .1        Proceed in accordance with Section 01 01 50 General Instructions.
- .2        Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

**.1 Section Includes:**

- .1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.

**1.2 SYSTEM DESCRIPTION**

**.1 Performance Requirements:**

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

**1.3 SUBMITTALS**

**.1 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 - General Instructions. Include product characteristics, performance criteria, and limitations.
- .2 Indicate following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

**.2 Samples:**

- .1 Submit samples in accordance with Section 01 01 50 - General Instructions.

**.3 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.**

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.4 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .2 Waste Management and Disposal:
    - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.
- 1.6 MAINTENANCE**
  - .1 Extra Materials:
    - .1 Provide maintenance materials in accordance with Section 01 01 50 - General Instructions.
    - .2 Include:
      - .1 Keys for volume control adjustment.
      - .2 Keys for air flow pattern adjustment.
- Part 2 Products**
  - 2.1 GENERAL**
    - .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
    - .2 Frames:
      - .1 Full perimeter gaskets.
      - .2 Plaster frames where set into plaster or gypsum board.
      - .3 Concealed fasteners.
    - .3 Concealed manual volume control damper operators.
    - .4 Colour: as directed by Departmental Representative.
  - 2.2 MANUFACTURED UNITS**
    - .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.
  - 2.3 SUPPLY GRILLES AND REGISTERS**
    - .1 Performance characteristics: as per Equipment Schedule, Section 23 90 00.
  - 2.4 RETURN AND EXHAUST GRILLES AND REGISTERS**
    - .1 Performance characteristics: as per Equipment Schedule, Section 23 90 00.
  - 2.5 DIFFUSERS**
    - .1 Performance characteristics: as per Equipment Schedule, Section 23 90 00.

**2.6 LINEAR GRILLES**

- .1 Performance characteristics: as per Equipment Schedule, Section 23 90 00.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2 INSTALLATION**

- .1 Install in accordance with manufacturers instructions.
- .2 Install with flat head screws (or tampered resistance screws as directed by Departmental Representative) in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere as indicated.

**3.3 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 - General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

**1.2 REFERENCES**

.1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)

- .1 ANSI/NFPA 96-04, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 American Society for Testing and Materials International (ASTM)

- .1 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.5 Society of Automotive Engineers (SAE)

**1.3 SYSTEM DESCRIPTION**

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

**1.4 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 for Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Indicate following:

- .1 Pressure drop.
- .2 Face area.
- .3 Free area.

.2 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .2 Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .3 Test Reports:
  - .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

## **1.5 QUALITY ASSURANCE**

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 01 50 - General Instructions.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 - General Instructions.

## **Part 2 Products**

### **2.1 GRAVITY ROOF RELIEF VENTS**

- .1 Factory manufactured aluminum.
  - .1 Complete with integral birdscreen of 2.7 mm diameter ss wire.
  - .2 Horizontal backdraft dampers on four faces.
  - .3 Maximum throat velocity: 3.3 m/s intake.
  - .4 Maximum loss through unit: 15 Pa exhaust static pressure.
  - .5 Maximum velocity through damper area: 1.5 m/s.
  - .6 Shape: as indicated.
- .2 Birdscreens:
  - .1 Complete with integral birdscreen of 2.7 mm diameter ss wire. Use 12 mm mesh on exhaust 19 mm mesh on intake.
- .3 Acceptable material: Greenheck FGR.

### **2.2 FIXED LOUVRES - ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.

- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm exhaust, 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: factory applied enamel.
- .9 Colour: to Departmental Representative approval.
- .10 Acceptable materials: Airolite Louvre type K6774X, Ruskin, Penn, Airstream.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

#### **3.2 INSTALLATION**

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

#### **3.3 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 - General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials, accessories and installation for breechings, chimneys and stacks.

**1.2 REFERENCES**

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
    - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Indicate following:
    - .1 Methods of sealing sections.
    - .2 Methods of expansion.
    - .3 Details of thimbles.
    - .4 Bases/Foundations.
    - .5 Supports.
    - .6 Guy details.
    - .7 Rain caps.
    - .8 .
- .3 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Closeout Submittals



- .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.

#### **1.4 QUALITY ASSURANCE**

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33.
- .3 Certificates:
  - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

### **Part 2 Products**

#### **2.1 BREECHINGS**

- .1 Shop fabricated 3.5 mm stainless steel welded, with sweep bends from boiler outlet to thimble or chimney as indicated.

#### **2.2 FUELS: PRESSURE CHIMNEY AND BREECHING**

- .1 ULC labelled, 760 degrees C rated.
- .2 Sectional, prefabricated, double wall with air space mineral wool insulation with mated fittings and couplings.
  - .1 Liner: mm thick, type 304, 316 stainless steel.
  - .2 Shell: mm thick, type 304, 316 stainless steel.
  - .3 Outer seals between sections: to suit application .
  - .4 Inner seals between sections: to suit application .

#### **2.3 TYPE B GAS VENT**

- .1 ULC labelled, 288 degrees C rating maximum, atmospheric gas vent only.

- .2 Sectional, prefabricated, double wall with 13 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

## **2.4 STEEL CHIMNEY REFRACTORY LINED**

- .1 Material:
  - .1 Prefabricated sections with 90 mm thick high temperature impervious insulating refractory lining, centrifugally spun into 3.5 mm thick circular casing.
- .2 Construction:
  - .1 Prefabricated sections, welded on site or at factory. Use high temperature insulating cement at joints in refractory lining.
- .3 Welding:
  - .1 To full thickness; grind welds smooth.
- .4 Supports:
  - .1 Welded gussets, cleats and bolts for installation on concrete base.
  - .2 Chimney self supporting or laterally and vertically braced, as indicated .
  - .3 Concrete base by Section 01 01 50 General Instructions.
- .5 Breeching entry:
  - .1 Tee section with 150 mm minimum refractory lined projection.
- .6 Access door: in bottom section.
- .7 Drain connection: at base of stack.
- .8 Dimensions: as indicated.

## **2.5 ACCESSORIES**

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single double acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA) as indicated.
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 INSTALLATION - GENERAL**

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.
- .7 Provide approved/ULC listed flue vents and combustion air pipes for condensing boilers, high- efficiency furnaces and domestic hot water heaters as per manufacturer's instructions and to meet current codes.

### **3.3 FIELD QUALITY CONTROL**

- .1 Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Low-emitting materials.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Heating boiler units:
    - .1 Cast iron.
    - .2 Coil tube hot water.
    - .3 Gas burners.
    - .4 Installation.
    - .5 Commissioning.

**1.2 REFERENCES**

- .1 American Boiler Manufacturer's Association (ABMA)
- .2 American National Standards Institute (ANSI)
  - .1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .3 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.
- .4 Canadian Gas Association (CGA)
  - .1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.
  - .2 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.
- .5 Canadian Standards Association (CSA International)
  - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA B139-04, Installation Code for Oil Burning Equipment.
  - .3 CSA B140.7-05, Oil Burning Equipment: Steam and Hot-Water Boilers.
- .6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.

- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.
    - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Indicate the following:
    - .1 General arrangement showing terminal points, instrumentation test connections.
    - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
    - .3 Foundations with loadings, anchor bolt arrangements.
    - .4 Piping hook-ups.
    - .5 Equipment electrical drawings.
    - .6 Burners and controls.
    - .7 All miscellaneous equipment.
    - .8 Flame safety control system.
    - .9 Breeching and stack configuration.
    - .10 Stack emission continuous monitoring system to measure CO, O<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, stack temperature and smoke density of flue gases.
  - .3 Engineering data to include:
    - .1 Boiler efficiency at 25%, 50%, 75%, 100%, and 110% of design capacity.
    - .2 Radiant heat loss at 100% design capacity.
- .3 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals:
  - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.

#### **1.4 QUALITY ASSURANCE**

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 33.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## **1.6 MAINTENANCE**

- .1 Extra materials:
  - .1 Special tools for burners, manholes, hand holes and Operation and Maintenance.
  - .2 Spare parts for 1 year of operation.
  - .3 Spare gaskets.
  - .4 Spare gauge glass inserts.
  - .5 Probes and sealants for electronic indication.
  - .6 Spare burner tips.
  - .7 Spare burner gun.
  - .8 Safety valve test gauge.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Packaged boiler:
  - .1 Complete with burner and necessary accessories and controls.
  - .2 Laboratory factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7, CAN1-3.1, witnessed and certified by Departmental Representative.
  - .3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
  - .4 Designed and constructed to ANSI/ASME Boiler and Pressure vessel Code.
  - .5 CRN (Canadian Registration Number), to CSA B51.
  - .6 Boiler/burner package to bear ULC CGA label.
- .2 Performance:
  - .1 In accordance with American Boiler Manufacturers Association (ABMA), or ANSI Z21.13/CSA 4.9 (gas burning) testing procedures.
  - .2 Hot water: kW gross output. 93 degrees C supply. 82 degrees C return. kPa maximum operating pressure.
  - .3 Firing rate: natural gas; L/h and m<sup>3</sup>/h gas pressure at metre outlet: Pa.
  - .4 Boiler efficiency: 95 % minimum at 30% to 100% firing rates.
  - .5 Flue gas temperature leaving boiler:
    - .1 Not to exceed 260 degrees C.
    - .2 Above dewpoint conditions at minimum firing rate.

- .3 Electrical:
  - .1 Power: V, phase, 60 Hz.
  - .2 Controls: 120 V, 1 phase, 60 Hz.
  - .3 Electrical components: CSA approved.
- .4 Controls: factory wired. Enclosed in Electrical and Electronic Manufacturers' Association of Canada (EEMAC) 1 steel cabinet. Boiler control shall have BACNet provision for control and monitoring.
- .5 Thermal insulation:
  - .1 50 mm thick mineral fibre. Seal insulation at handholes, manholes, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
- .6 Jackets: heavy gauge metal, finished with heat resisting paint.
- .7 Mounting:
  - .1 Structural steel base, lifting lugs.
- .8 Anchor bolts and templates:
  - .1 Supply for installation by other Divisions. Anchor bolts to be sized to Section 01 01 50 General Instructions.
- .9 Start-up, instruction, on-site performance tests: 3 days per boiler.
- .10 Trial usage:
  - .1 Departmental Representative may use boilers for test purposes prior to acceptance and commencement of warranty period.
  - .2 Supply labour, materials and instruments required for tests.
- .11 Temporary use by contractor:
  - .1 Contractor may use boilers only after written approval from Departmental Representative.
  - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
  - .3 Refurbish to as-new condition before final inspection and acceptance.

**2.2 MODULAR HOT WATER BOILER, NATURAL GAS PULSE FIRED, CONDENSING TYPE**

- .1 Heating boiler seasonal efficiency rating: 95 %. Flue gas exhaust temperature: 45 to 55 degrees C, when operating in condensing mode.
- .2 Flue gas: individually direct vented. Combustion air: individually drawn from outdoors through plastic pipes as indicated and as recommended by manufacturer.
- .3 Factory-assemble each module to include:
  - .1 Combustion air inlet chamber.
  - .2 Pre-purge blower assembly.

- .3 Air-gas fuel control valve.
- .4 Cast pulse combustion chamber.
- .5 Welded absorption chamber with spiralled fire tubes and exhaust chamber.
- .6 House assembly in insulated jacket which includes boiler mounted electrical control panel enclosure with operation sequence indicator lights.
- .7 Provide coupling on combustion air inlet and exhaust chambers for connections of plastic piping, PVC for outside air intake and CPVC for outside exhaust.
- .8 Provide condensate drain fitting on exhaust chamber.
- .9 Boiler materials will enable operation with flue gas temperature below dewpoint without corrosion.
- .4 Absorption unit: constructed in accordance with Section IV of ASME Boiler and Pressure Vessel Code for Low Pressure Heating Boilers for 207 kPa working pressure.
- .5 Controls for each module to include:
  - .1 Solid state controller with auxiliary relay.
  - .2 Fan prove pressure switch and pressure sensing flame safeguard system.
  - .3 Provide combination gas control with:
    - .1 Manual shut off valve.
    - .2 System pressure controlled regulator.
    - .3 Automatic redundant shut off valves.
    - .4 High limit water temperature control with adjustable differential.
    - .5 ASME approved pressure relief valve and temperature/pressure indicator.
  - .4 Provide automatic isolation valves on boiler heating water supply line as required by boiler manufacturer's recommendation to isolate the non-operational boilers. Connect the valves to EMCS system.
- .6 Factory wire each module and operationally test.
  - .1 Each module suitable for individual firing.
  - .2 Step firing accomplished by firing individual modules without reducing their thermal efficiency.
  - .3 Control system: designed and provided for heating plant by manufacturer. Provide provisions for boilers to be control by building BACNet EMCS system.

## **2.3 AUXILIARIES**

- .1 Provide auxiliaries for each boiler and to meet ANSI/ASME requirements.
- .2 Hot water boilers:
  - .1 Relief valves: ANSI/ASME rated, set at kPa, to release entire boiler capacity .
  - .2 Pressure gauge: 90 mm diameter complete with shut-off cock.
  - .3 Thermometer: 115 mm diameter range 10 to 150 degrees C.
  - .4 Low water cut-off: with visual and audible alarms.
  - .5 Auxiliary low water cut-off: with separate cold water connection to boiler.
  - .6 Isolating gate valves: on supply and return connections.
  - .7 Drain valve: NPS 2.



- .8 Stack thermometer: range 65 to 400 degrees C.
- .9 Outdoor controller: to reset operating temperature controller.
- .10 One 1 set of cleaning tools.
- .3 Pot type chemical feeder .

## **2.4 GAS BURNERS**

- .1 General:
  - .1 Forced draft with:
    - .1 Built-in blower to supply combustion air, complete with motor, silencer and damper.
    - .2 High voltage ignition transformer.
    - .3 Flame observation port.
    - .4 Easy access to nozzles and electrodes.
  - .2 Gas pilot:
    - .1 To building code and provincial regulations including solenoid gas valve, pressure regulator, pressure gauge, manual shut-off valve.
  - .3 Main gas train:
    - .1 To building code and provincial regulations including main shut-off valve, pressure regulator, motorized electric shut-off valve, downstream block-test valve with test connection and pressure gauge.
  - .4 Controls:
    - .1 Electronic combustion control relay with flame rod, ultra-violet, infra-red, flame detector for combustion control and flame supervision.
    - .2 Control to shut off fuel within 5 seconds upon pilot flame or main flame failure or upon signal of safety interlock and to ensure, when restarted, in sequence:
      - .1 Pre-purge.
      - .2 Pilot ignition and supervision.
      - .3 Main gas valve opening.
      - .4 Pilot cut-off. Pilot-proving period not to exceed 10 seconds.
      - .5 Burner operation.
      - .6 Post-purge burner shut-down.
    - .3 Static pressure interlock. To shut off burner upon loss of combustion air pressure.
    - .4 Fuel-air mixture: control through:
      - .1 2-position motor with end switch to provide for low-fire start and high fire run.
      - .2 Two-position motor with linkage to control fuel and air and with end switches to prove low-fire start and energize high fire solenoid valve for high-low fire operation.
      - .3 Modulating motor with end switch to provide for low-fire start and fully modulating operation down to 20 % of design capacity.
    - .5 Immersion controllers:

- .1 Operating: to start and stop burner, and operating between adjustable setpoints.
- .2 High-low: to shift burner operation to high or low fire.
- .3 Modulating: to modulate burner output.
- .4 High limit: manual reset, set at kPa degrees C.
- .5 Controller range: 0 to kPa 30 to 121 degrees C.
- .6 Visual and audible alarms: to indicate burner shutdown due to flame failure, low water level, high pressure temperature, low air pressure, low gas pressure.
- .7 Selector switch: to permit manual and automatic firing at any rate between low and high fire .
- .8 Pilot lights: to indicate:
  - .1 Normal burner operation.
  - .2 All stages of burner operation .
- .9 Burner to start up in low fire position .
- .10 Burners shall be able to be controlled by building BACNet EMCS system.

## **2.5 EMISSION CONTROL**

- .1 Rate of discharge of air contaminants from boiler not to exceed:
  - .1 For nitrogen oxides expressed as nitrogen dioxide:
    - .1 150 ng/J of heat input when fired with solid fossil fuel.
    - .2 110 ng/J of heat input when fired with oil specified as type 4, 5, or 6, according to CGSB classification.
    - .3 43 ng/J of heat input when fired with oil specified as type1 or 2, according to CGSB classification.
    - .4 22 ng/J of heat input when fired with gaseous fuel.
  - .2 For sulphur dioxide:
    - .1 500 ng/J of heat input when fired with solid fossil fuel.
    - .2 500 ng/J of heat input when fired with oil specified as type 4, 5, or 6, according to CGSB classification.
    - .3 25 ng/J of heat input when fired with oil specified as type1 or 2, according to CGSB classification.
  - .3 For particulate matter measured undiluted, 160 mg/m<sup>3</sup>, when fired with solid fossil fuel.
  - .4 For carbon monoxide, 125 ng/J of heat input.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 INSTALLATION**

- .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Provide high-efficiency condensing type boilers with complete control provisions to allow BACNet EMCS control and monitoring.
- .3 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .4 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .5 Mount unit level using specified vibration isolation in Section 23 05 48.
- .6 Pipe hot water relief valves full size to nearest drain.
- .7 Natural gas fired installations - in accordance with CAN/CSA-B149.1.

### **3.3 MOUNTINGS AND ACCESSORIES**

- .1 Safety valves and relief valves:
  - .1 Run separate discharge from each valve.
  - .2 Terminate discharge pipe as indicated.
  - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

### **3.4 FIELD QUALITY CONTROL**

- .1 Commissioning:
  - .1 Manufacturer to:
    - .1 Certify installation.
    - .2 Start up and commission installation.
    - .3 Carry out on-site performance verification tests.
    - .4 Demonstrate operation and maintenance.
  - .2 Provide Departmental Representative at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.
- .2 Verification requirements in accordance with Section 01 01 50 General Instructions, include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Low-emitting materials.

**3.5 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute (ANSI) / American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 52.1-1992, Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .2 American National Standards Institute (ANSI) / Canadian Standards Association (CSA International)
  - .1 ANSI Z21.47-2007A/ CSA 2.3A-2007, Gas-Fired Central Furnaces.
  - .2 ANSI Z83.8 -2006/CSA 2.6-2006, CSA Standard for Gas Unit Heaters and Gas-Fired Duct Furnaces.
- .3 Canadian Electrical Code
- .4 Canadian Standards Association (CSA International) / Canadian Gas Association (CGA)
  - .1 CGA 3.2-1976(R2003), Industrial and Commercial Gas-Fired Package Furnaces.
- .5 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.
  - .2 CSA C22.2 No. 24-93(R2008), Temperature-Indicating and Regulating Equipment.
  - .3 CSA C22.2 No.46-M1988(R2001), Electric Air-Heaters.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for furnace units and furnace parts, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
  - .2 Submit manufacturer's written recommendations.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.
- .2 Include following:

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Provide spare parts as follows:
- .2 Extra Stock Parts:
  - .1 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative supply 1 complete set of filters for each filter unit or filter bank in accordance with Section 01 01 50 General Instructions.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, paddling, and packaging materials in accordance with Section 01 01 50 General Instructions.

**Part 2 Products**

**2.1 GENERAL**

- .1 Provide CSA, CGA approved, packaged factory assembled unit consisting of cabinet, fan, induced fan, fan motor, intake/exhaust assembly, heat exchanger, combustion chamber, burner, controls, air filter, condensate drain, and humidifier to Section 01 01 50 General Instructions.
- .2 High efficiency level range: 96%.
- .3 Certification of components and construction of factory assembled gas-fired unit: to ANSI Z21.47/CSA 2.3A for forced air central furnace, CGA 3.2 for industrial and commercial package furnace, ANSI Z83.8/CSA 2.6 for gas fired duct furnace.

**2.2 CAPACITY**

- .1 Output: Refer to section 23 90 00.

**2.3 TYPE**

- .1 Upflow type with gas burner.

**2.4 CABINET**

- .1 1.0 mm thick minimum steel with baked enamel finish.
- .2 Welded steel base for floor type.
- .3 Easily removed and secured access doors for components requiring service.

- .4 Thermally insulated cabinet.

## **2.5 HEAT EXCHANGER**

- .1 Primary: stainless steel tube with stainless steel fins.
- .2 Secondary: stainless steel tube with stainless steel fins.
- .3 Tertiary: stainless steel tube with stainless steel fins.
- .4 Warranty: non-prorated 10 years.

## **2.6 COMBUSTION CHAMBER**

- .1 Power vent, forced draft: to manufacturers standard.
- .2 Sealed type: 100% outside air, to ANSI Z21.64.

## **2.7 CIRCULATION BLOWER MOTOR ASSEMBLY**

- .1 Blower: centrifugal type:
  - .1 Statically and dynamically balanced.
  - .2 Rubber mounted.
  - .3 Speed adjustment: adjustable V-belt shieve.
  - .4 Wiring adjustment of multi-speed motor.
- .2 Motor: hp W motor, 1750 r/min. multi-speed, overload protection, adjustable mounts.

## **2.8 AIR FILTERS**

- .1 25 mm thick, glass fiber, disposable type, cleanable, permanent type, 45% efficiency to ASHRAE 52.

## **2.9 HEATER BURNER**

- .1 General: to bear CSA and ULC labels.
- .2 Gas burner:
  - .1 Continuous port steel or multislotting, non-clogging cast iron with adjustable combustion air supply.
  - .2 Electronic intermittent ignition combustion type gas burner.
  - .3 Pulsed combustion type with spark plug ignitor.

## **2.10 INTAKE AND VENT ASSEMBLY**

- .1 Provide manufacturer's standard wall, roof, combined concentric, separate vent and intake complete with termination assembly for high efficiency gas (condensing) furnace.
- .2 CPVC schedule 40 plastic pipe as per manufacturer's recommendation.

- .3 Manufacturer's external power venting kit.
- .4 Vent riser kit .

## **2.11 CONDENSATE DRAIN**

- .1 Provide CPVC condensate drain trap.
- .2 Condensate filter/neutralizer kit .

## **2.12 CONTROLS**

- .1 General: conform to CSA C22.2 No.24.
- .2 Gas firing:
  - .1 Operating controls:
    - .1 DDC thermostat.
    - .2 Electronic pilot ignition.
    - .3 Manual main shut-off valve, automatic safety pilot, automatic electric valve and gas pressure regulator.
    - .4 Fan operating control switch with adjustable set points and continuous operating switch.
    - .5 Automatic vent damper.
  - .2 Safety controls:
    - .1 Electronic combustion control relay with flame rectification sensor to detect and supervise flame by shutting off fuel upon flame failure or safety interlock signal within seconds, in sequence prepurge-pilot ignition, supervision-main valve opening-pilot cut-off-burner operation and roll out switch.
    - .2 Blocked vent shut-off switch or control system.
    - .3 Limit control to shut down furnace if heat exchanger temperature exceeds limit setting. Combination fan and limit control to be spiral wound.
    - .4 Door interlock switch on fan compartment access panel to shut down furnace when panel is removed.
    - .5 Internal float switch to shut off furnace if condensate do not drain properly.
    - .6 Electronic board built-in diagnostics.

## **Part 3 Execution**

### **3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.



**3.2                INSTALLATION**

- .1        Install in accordance with manufacturer's instructions, regulations of authorities having jurisdiction and to CAN/CSA-B139, CAN/CSA-B149.1, CAN/CSA-B149.2, Canadian Electric Code.
- .2        Co-ordinate with Concrete Division regarding concrete base[s] as indicated.
- .3        Provide Departmental Representative written report of test results.
- .4        Bacharach smoke density number not to exceed #1.
- .5        Provide a free-cooling modulating dampers section for each furnace.
- .6        Provide provisions for the furnaces to be controlled by the building BACNet EMCS system.

**3.3                CLEANING**

- .1        Clean in accordance with Section 01 01 50 General Instructions.
  - .1        Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2        Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Materials, components and installation for heat reclaim devices.

**1.2 REFERENCES**

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

- .1 ASHRAE 84-1991, Method of Testing Air-to-Air Heat Exchangers (ANSI approved).

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 for Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

- .1 Submit shop drawings in accordance with Section 01 01 50 - General Instructions.

.3 Quality assurance submittals: submit following in accordance with Section 01 01 50 - General Instructions.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.4 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 01 50 - General Instructions.

.5 Certificates:

- .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

**1.4 QUALITY ASSURANCE**

.1 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50- General Instructions.

## **1.6 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 01 50 - General Instructions.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
    - .1 Bearings and seals.
    - .2 Addresses of suppliers.
    - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Comply with ASHRAE 84.
- .2 Performance characteristics: as per Equipment Schedule, Section 23 90 00.

### **2.2 AIR TO AIR FIXED PLATE EXCHANGER**

- .1 Casing: 0.8 mm thick stainless steel or anodized aluminum.
- .2 Heat transfer surfaces: corrugated aluminum, edge sealed and bonded to casing.
- .3 Cross contamination: not permitted.
- .4 Condensate drain: NPS 2.
- .5 Removable access panels.
- .6 Accessories: automatic water wash.
- .7 Performance characteristics: as per Equipment Schedule, Section 23 90 00.

**Part 3            Execution**

**3.1            MANUFACTURER'S INSTRUCTIONS**

- .1        Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

**3.2            INSTALLATION**

- .1        Install in accordance with manufacturers recommendations.
- .2        Support independently of adjacent ductwork with flexible connections.
- .3        Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers.
- .4        Provide provisions for the heat recovery ventilators to be controlled by building BACNet EMCS system.

**3.3            FIELD QUALITY CONTROL**

- .1        Tests:
  - .1        Perform tests in accordance with Section 26 05 00 - Common Work Results – Electrical.

**3.4            CLEANING**

- .1        Proceed in accordance with Section 01 01 50 - General Instructions.
- .2        Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
  - .1 ANSI/ARI 430-99(R2002), Central-Station Air-Handling Units.
- .2 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-11-07, Environmental Standard for Paints.
- .5 Master Painters Institute (MPI)
  - .1 MPI-INT 5.3-2007, Galvanized Metal.
- .6 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)
  - .1 SCAQMD Rule 1113-04, Architectural Coatings.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 01 50 General Instructions.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for insulation, filters, adhesives, and paints, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of BC of Canada.
  - .2 Indicate following: fan curves showing point of operation, motor drive, bearings, filters, mixing box, dampers, VAV, coil; include performance data.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.

- .2 Include following: fan bearings, motor, damper, VAV, control, air volume, total cooling sensible cooling, EDB, EWB, OAT.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Provide maintenance materials in accordance with Section 01 01 50 General Instructions.
- .2 Provide one spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .4 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 01 50 General Instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, paddling, and packaging materials in accordance with Section 01 01 50 General Instructions.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 Factory assembled components to form units supplying air at designed conditions, as indicated.
- .2 Certify ratings: to ANSI/ARI 430 with ARI seal.
- .3 Horizontal and Vertical type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, dampers, bypass section, heating coil, cooling coil, humidifier, spray section, mixing box, blender air mixing device, and filter mixing box.

#### **2.2 CASINGS**

- .1 Galvanized steel minimum 18 gauge thickness, thickness as indicated reinforced and braced for rigidity.
  - .1 Removable panels, inspection doors, walk-in access doors: provide access for maintenance of internal parts.

- .2 Paint steel parts, where not galvanized, with corrosion resistant paint to CAN/CGSB 1.181, MPI-INT 5.3A.
  - .1 Paint: maximum VOC limit 250 g/L to standard GS-11.
- .3 Finish units, inside and out, with rust resistant enamel.
  - .1 Enamel Finish: maximum VOC limit 250 g/L to Standard GS-11 to SCAQMD Rule 1113.
- .2 Line casing with perforated solid steel liner.

### **2.3 ACOUSTIC LINER**

- .1 Ensure that expanded polystyrene and polyurethane insulation materials were not produced with ozone depleting substances.
- .2 Insulate internal surface of panels with 50 mm neoprene coated rigid duct liner of 72 kg/m<sup>3</sup> density.
  - .1 Recycled content: % (Post-Consumer + 1/2 Post-Industrial) in accordance with Section 01 01 50 General Instructions.
  - .2 Apply with 100% coverage of adhesive with clip pins.
    - .1 Adhesives: maximum VOC limit 80 g/L to SCAQMD Rule 1168 to GSES GS-36.
  - .3 Cover with 0.8 mm thick perforated galvanized sheet metal.
  - .4 Cover leading and trailing edges with sheet metal nosing and at edges around access doors and panels complete with 15 mm overlap.

### **2.4 DRAIN PANS**

- .1 Construction: stainless steel. Rounded corners.
- .2 Insulation: external foam type, minimum 13 mm thick.
- .3 Drain connection: in bottom at low point.
- .4 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.
- .5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

### **2.5 FANS**

- .1 Free standing, AMCA-rated for sound and performance centrifugal fans with forward curved wheels, selected to operate in stable part of performance curve at times and heavy duty 100,000 hours service self aligning split pillow block bearings.
  - .1 Provide internally mounted motor as indicated complete with adjustable V-belt drive and guard.
  - .2 Motor: to ASHRAE 90.1 hp W, r/min.
- .2 Maximum sound power levels, as indicated.

- .3 Internally mounted motor and fan.

## **2.6 VIBRATION ISOLATION**

- .1 Flexible connections at inlet and outlet of fan Section 23 05 48.
- .2 Vibration isolators on fan section as indicated complete with seismic restraints: in accordance with Section 23 05 48.

## **2.7 VARIABLE VOLUME DEVICES**

- .1 Variable speed drives: Provide variable speed drives with inverted duty motors for 30% to 100% of air flow controls.
- .2 Variable fan width disc, with control operator to move disc from rear of SWSI fan to front for 100% cut off.

## **2.8 FILTER BOX**

- .1 Material to match casing. For flat,V, bag, type filter arrangement: as indicated.
  - .1 Provide access to filter through hinged door, removable panels with suitable hardware.
- .2 Provide blank-off plates and gaskets to prevent air bypass.
- .3 Filters: in accordance with Section 21 05 01.
  - .1 Minimum Efficiency Reporting Value (MERV) value 8 filtration media to ASHRAE 52.2, to be used on return air section of air handling unit.
  - .2 Immediately prior to occupancy, replace filtration media with new filtration media with Minimum Efficiency Reporting Value (MERV) of 13 in accordance with ASHRAE 52.2.

## **2.9 MIXING BOX**

- .1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degrees C of design across face of outlet.
- .2 Dampers:
  - .1 Dampers for mixing boxes: in accordance with Section 23 33 14.

## **2.10 COILS**

- .1 Capacity: as indicated
- .2 Ratings: ARI certified.
- .3 Construction:
  - .1 Casings: 1.5 mm thick galvanized sheet steel.
  - .1 Supports of galvanized steel channel double angle frames.



- .2 Blank-off plates. Insulated sandwich construction.
- .2 Hot water coils: cleanable fins.
  - .1 Tubes: copper.
  - .2 Fins: copper.
  - .3 Headers: cast iron.
  - .4 Pressure tests: 1.7 MPa.
- .3 Direct expansion refrigerant coils:
  - .1 Serpentine type arranged to prevent trapping of oil.
    - .1 Liquid distributors to ensure even distribution of liquid refrigerant to all circuits.
    - .2 Silver solder or braze joints in refrigerant tubing.
    - .3 Evacuate and charge coil with nitrogen and seal before sending to site.
  - .2 Tubes: copper.
  - .3 Fins: copper.
  - .4 Headers: copper.
  - .5 Pressure tests: to Canadian Refrigeration Code. Dehydrated. Sealed with nitrogen charge.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

**3.2 INSTALLATION**

- .1 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Ensure adequate clearance for servicing and maintenance.
- .4 Unit shall have a single power supply, variable speed drives, contacts and relays for BACNet EMCS controls and fire alarm shut down.

**3.3 FANS**

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install internal vibration isolators.

**3.4 DRIP PANS**

- .1 Install deep seal P-traps and trap seal primer on drip lines.
  - .1 Depth of water seal to be 1.5 times static pressure at this point.

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 01 50 General Instructions.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.

**END OF SECTION**

Approved: 2003-12-31

**Part 1            General**

**1.1            RELATED SECTIONS**

- .1        Section 01 01 50 – General Instructions.
- .2        Section 23 09 33 - Electric and Electronic Control System for HVAC.
- .3        Section 26 05 00 - Common Work Results - Electrical.

**1.2            PRODUCT DATA**

- .1        Submit product data in accordance with Section 01 01 50 - General Instructions.
- .2        Product data to include:
  - .1        Replacement data for motor element, thermostat and switch.
  - .2        Mounting methods.
  - .3        kW rating, voltage, phase.
  - .4        Cabinet material thicknesses.
  - .5        Physical size.
  - .6        Finish.
  - .7        Thermostat, transformer, controls where integral.

**1.3            WASTE MANAGEMENT AND DISPOSAL**

- .1        Separate and recycle waste materials in accordance with Section 01 01 50 - General Instructions.

**Part 2           Products**

**2.1            FORCED AIR HEATERS**

- .1        Forced air heaters, wall mounted as follows:
  - .1        Enclosure:
    - .1        Steel, 1.2 mm thick.
    - .2        Knockouts for 12 mm diameter conduit left, right, bottom and rear.
    - .3        Grill and frame finished.
  - .2        Elements and Fan:
    - .1        Nickel chromium alloy.
    - .2        Motor: totally enclosed, shaded pole, impedance protected motor.
- .2        Controls:
  - .1        Wall mounted DDC thermostat: Refer to Section 25 for detail. Provide provisions for DDC control.

- .3 Built-in tamperproof controls. 'On-Off-Fan Only' selector switch and temperature control knob.
- .4 Capacity: as per Equipment Schedule, Section 23 90 00.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install heaters in accordance with manufacturer's instructions.
- .2 Make power and control connections.
- .3 Provide provisions for DDC control and monitoring.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

**.1 Section Includes:**

- .1 Base board and finned tube radiation, and cabinet convectors including installation.**

**1.2 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)**
  - .1 Material Safety Data Sheets (MSDS).**
- .2 Hydronic Institute of Boiler and Radiator Manufacturers (IBR)**

**1.3 SUBMITTALS**

**.1 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 General Instructions. Include product characteristics, performance criteria, and limitations.**
  - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 01 50 General Instructions.**

**.2 Shop Drawings:**

- .1 Submit shop drawings in accordance with Section 01 01 50 General Instructions.**
  - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.**
- .2 Indicate:**
  - .1 Equipment, capacity, piping, and 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 Special enclosures.**

**.3 Samples:**

- .1 Submit samples in accordance with Section 01 01 50 General Instructions.**
- .2 Submit 1200 mm length sample enclosure showing method of securing to structure and connecting to adjacent length of enclosure.**

**.4 Quality assurance submittals: submit following in accordance with Section 01 01 50 General Instructions.**

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.**
- .2 Instructions: submit manufacturer's installation instructions.**

- .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
  - .5 Closeout Submittals:
    - .1 Submit maintenance data for incorporation into manual specified in Section 01 01 50 General Instructions.
- 1.4 QUALITY ASSURANCE**
  - .1 Health and Safety:
    - .1 Do construction occupational health and safety in accordance with Section 01 01 50 General Instructions.
- 1.5 DELIVERY, STORAGE, AND HANDLING**
  - .1 Packing, shipping, handling and unloading:
    - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 01 50 General Instructions.
  - .2 Waste Management and Disposal:
    - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 50 General Instructions.
- Part 2 Products**
  - 2.1 DAMPERS**
    - .1 Factory built, internal damper, at enclosure air outlet grille for each convection type heating unit not thermostatically controlled. Refer to schedules on drawings.
  - 2.2 CAPACITY**
    - .1 As indicated, based on 93 degrees C average water temperature, 11 degrees C temperature drop and 18 degrees C at entering air temperature.
  - 2.3 BASEBOARD RADIATION**
    - .1 Heating elements: NPS ¾", 1 copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins, one tube end belled.
    - .2 Enclosure: minimum 1.6 mm thick steel prefinished surface mounted with 1.0 mm thick back and top of one piece construction. Front panel removable. Run wall to wall unless otherwise indicated. Provide panel corners, joiner pieces and end caps. Assemble with stainless steel no.10 oval head sheet metal screws. Finish factory applied baked on enamel.
    - .3 Element brackets: 1.2 mm thick galvanized steel to support front panel and element cradle. Space brackets 900 mm centres maximum.
    - .4 Provide for noiseless expansion of components.

## **2.4 FINNED TUBE RADIATION**

- .1 Heating elements: NPS 1 seamless copper tubing, 1.2 mm minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, 100 x 100 mm nominal, 130 fins per metre suitable for sweat fittings.
- .2 Element hangers: ball bearings, plastic lined, cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets 900 mm centres maximum.
- .3 Standard enclosures: 2.0 mm thick steel complete with components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Joints and filler pieces clear of grilles located to provide easy access to valves and vents. Provide access doors for valves, vents, traps. Finish cabinet with factory applied baked primer coat.
- .4 Special enclosures: as indicated.
- .5 Dimensions for enclosures: measure site conditions. Do not scale from drawing.
- .6 Provide for noiseless expansion of components.
- .7 Expansion compensators:

## **2.5 CABINET CONVECTORS**

- .1 Heating element: seamless copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins and cast iron headers, steel side plates and supports.
- .2 Cabinet: type as indicated, 1.6 mm thick steel back and ends, exposed corners rounded, secured removable front panel, braced and reinforced for stiffness. Provide access doors for valves, vents, traps. Finish cabinet with factory applied baked primer coat.
- .3 Catalogue rating: certified commercial standard CS-140-47, certified IBR ratings.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Install in accordance with piping layout and approved shop drawings.
- .3 Provide for pipe movement during normal operation.

- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .6 Valves:
  - .1 Install valves with stems upright or horizontal unless approved otherwise.
  - .2 Install isolating gate valves on inlet and lock shield globe balancing valves on outlet of each unit.
- .7 Venting:
  - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
  - .2 Install automatic air vent on continuous finned tube radiation.
- .8 Clean finned tubes and comb straight.
- .9 Install flexible expansion compensators as indicated.

### **3.3 FIELD QUALITY CONTROL**

- .1 Verification requirements in accordance with Section 01 01 50 General Instructions , include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.
  - .6 Local/regional materials.
  - .7 Low-emitting materials.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 01 50 General Instructions.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 01 01 50 – General Instructions.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 01 50 – General Instructions.
- .2 Submit product data sheets for unit heaters. Include:
  - .1 Product characteristics.
  - .2 Performance criteria.
  - .3 Mounting methods.
  - .4 Physical size.
  - .5 kW rating, voltage, phase.
  - .6 Cabinet material thicknesses.
  - .7 Limitations.
  - .8 Colour and finish.
- .3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, and cleaning procedures.

**1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 01 50 – General Instructions.
- .2 Indicate:
  - .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.

**1.4 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Section 01 01 50 – General Instructions.

**1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 01 50– General Instructions.

**Part 2 Products**

**2.1 CABINET UNIT HEATERS**

- .1 Acceptable manufacturers:

- .1 Modine, Engineered Air.
- .2 Cabinet: type surface, 1.6 mm thick steel with rounded exposed corners and edges, removable panels, glass fibre insulation and integral air outlet and inlet.
- .3 Finish with factory applied primer coat.
- .4 Special cabinets: as indicated.
- .5 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa.
- .6 Electric coils: nickel-chrome resistance coils embedded in refractory material and enclosed in steel sheathing with low watt density extended fins.
  - .1 Two stage heating with magnetic contactors, high temperature limit switch, and fan override switch.
  - .2 Control heating elements in conjunction with fan by common control switch.
- .7 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.
- .8 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.
- .9 Filters: removable 25 mm thick fibrous glass throwaway type.
- .10 Capacity: as indicated in Equipment Schedule, Section 23 90 00.
- .11 Control:
  - .1 Control thermostat: integral room electric, DDC low voltage, electronic, Energy Star Certified, rating to suit cabinet unit heater, locking cover, set point locking device, concealed adjustment, plastic cover and guard, thermometer in cover.

## **2.2 HORIZONTAL UNIT HEATERS**

- .1 Acceptable products:
  - .1 Modine, Engineered Air.
- .2 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.
- .3 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 MPa.
- .4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.
- .5 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.
- .6 Air outlet: two-way adjustable louvres.
- .7 Capacity: as indicated in Equipment Schedule, Section 23 90 00.

- .8 Control room thermostat: low voltage, electronic DDC, Energy Star Certified, locking cover, set point locking device, concealed adjustment, plastic cover and guard.

### **2.3 VERTICAL UNIT HEATERS**

- .1 Acceptable products:
  - .1 Modine, Engineered Air.
- .2 Casing: 1.6 mm thick cold rolled steel, glossed enamel finish, with threaded connections for hanger rods.
- .3 Coils: seamless copper tubing, silver brazed to steel headers and with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 Mpa.
- .4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish.
- .5 Motor: speed as indicated, continuous duty, ball bearing motor with built-in overload protection, and resilient motor supports.
- .6 Air outlet: adjustable multi-vane diffuser with finish to match casing.
- .7 Control room thermostat: low voltage, electronic DDC, Energy Star Certified, locking cover, set point locking device, concealed adjustment, plastic cover and guard.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Provide sealed combustion and vents to each unit heater.
- .3 Provide double swing pipe joints as indicated.
- .4 Check final location with Departmental Representative if different from that indicated prior to installation.
  - .1 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .5 Clean finned tubes and comb straight.
- .6 Provide supplementary suspension steel as required.
- .7 Install thermostats in locations indicated. Provide provisions for DDC control and monitoring.
- .8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

**END OF SECTION**

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## 1.0 EXHAUST FAN SCHEDULE

Equipment Tag	EF-1	EF-2	EF-3	EF-4	EF-5
Location	Electrical Room 137	Multi Purpose Room 147	Mech Room 150	Attic	Attic
Room Served	Electrical Room 137	Multi Purpose Room 147	Mech Room 150	Attic of Adm Area	Attic of Living Pod
Manufacturer	Greenheck	Greenheck	Greenheck	Greenheck	Greenheck
Model	CSP-900	CSP-A1050	CSP-A710	CSP-A390	CSP-A390
Air (l/s)	375	476	235	140	140
E.S.P. (Pa)	63	63	63	63	63
RPM	950	1100	1080	1350	1350
Power Supply	115/1/60	115/1/60	115/1/60	115/1/60	115/1/60
Motor (Watts)	328	455	325	140	140
Motor (HP)					
Sones	2.0	2.5	2.5	2.0	2.0
Note	1, 3, 4, 5, 6	1, 3, 4, 5, 6	1, 3, 4, 5, 6	1, 3, 4, 5, 6	1, 3, 4, 5, 6

Equipment Tag	RH-1 RH-2	RH-3 RH-4
Location	Kitchen 118	Kitchen 218
Room Served	Kitchen 118	Kitchen 218
Manufacturer	Broan	Broan
Model	QS330SSN	QS330SSN
Air (l/s)	113	113
E.S.P. (Pa)	50	50
RPM	-	-
Power Supply	120/1/60	120/1/60
Motor (Watts)	2.9 amp	2.9 amp
Motor (HP)		
Sones	0.4	0.4
Note	5,9, 10	5, 9,10

### Notes

- 1 Exhaust fan to be controlled by DDC room thermostat.
- 2 Exhaust fan to be controlled by variable speed controller (VSD). VSD to be supplied by Mechanical and installed by Electrical
- 3 Install variable speed controller for balancing
- 4 Insulated cabinet
- 5 Backdraft damper
- 6 Hanging vibration isolators
- 7 Factory insulated roof curb with hinged base for maintenance
- 8 Disconnect switch
- 9 Interlock with dampers for furnaces
- 10 Unit completed with filter, 3 level light settings and bulbs, heat sentry detector, duct adaptor

## 2.0 UNIT HEATERS SCHEDULE

Equipment Tag	CUH-1	CUH-2	CUH-3	CUH-4
Description	Cabinet Unit Heater	Cabinet Unit Heater	Cabinet Unit Heater	Cabinet Unit Heater
Location	Vestibule RM 131	Vest RM 149	Stair A1	Deleted
Manufacturer	Trane	Trane	Trane	
Model	FFEB030	FFEB030	FFDB020	
Heat Output (KW)	8.8	8.8	5.9	
Water Flow (l/s)	0.11	0.11	0.08	
Coil WPD (KPa)	12.8	12.8	17.8	
SW Temp (°F)	160	160	160	
Fuel Type	Hot water	Hot water	Hot water	
Coil Row	3	3	2	
Unit size (LxWxH)	28"x22"x11"	28"x22"x11"	34"x32"x11"	
Air Flow (cfm)	300	300	200	
Blower Type	Centrifugal	Centrifugal	Centrifugal	
Motor (HP)	1/12	1/12	1/12	
Motor (RPM)	1050	1050	1050	
Power Supply	115/1/60	115/1/60	115/1/60	
Total Amps	1.3	1.3	1.1	
Note	1, 3, 6, 7,8	1, 3, 6, 7,8	1, 2, 6, 7,8	
(Continue Next Page)				

### Notes

- 1 All unit heaters to be controlled by DDC room thermostat.
- 2 Horizontal exposed surface mounted unit, back stamped louver inlet, bottom stamped louver outlet .
- 3 Horizontal concealed unit, bottom stamped louver inlet and outlet
- 4 Adjustable discharge grilles
- 5 Return grilles
- 6 Provision for DDC control
- 7 Vibration isolation kit
- 8 Air filters

## 2.0 UNIT HEATERS SCHEDULE (cont.)

Equipment Tag	UH-1	UH-2
Description	Hot Water Unit Heater	Hot Water Unit Heater
Location	Mech RM 150	Mech RM 150a
Manufacturer	Trane	Trane
Model	UHSA18	UHSA18
Heat Output (KW)	4.5	4.5
Water Flow (l/s)	0.13	0.13
Coil WPD (KPa)	12.8	12.8
SW Temp (°F)	160	160
Fuel Type	Hot water	Hot water
Coil Row	3	3
Unit size (LxWxH)	15"x10"x15"	15"x10"x15"
Air Flow (cfm)	300	300
Blower Type	Propeller	Propeller
Motor (HP)	1/12	1/12
Motor (RPM)	1050	1050
Power Supply	115/1/60	115/1/60
Total Amps	1.3	1.3
Note	1, 2, 4, 6, 7,8	1, 2, 4, 6, 7,8

### Notes

- |   |   |
|---|---|
| 1 | All unit heaters to be controlled by DDC room thermostat. |
| 2 | Horizontal discharge                                      |
| 3 | Downward deflector hood                                   |
| 4 | Adjustable discharge louvre and inlet guard               |
| 5 | Fan guard   |
| 6 | Provision for DDC control                                 |
| 7 | Vibration isolation kit                                   |

### 3.0 CONDENSING UNIT SCHEDULE (For AHU-2)

<b>Equipment Tag</b>	<b>CU-1</b>
<b>Description</b>	Condensing Unit
<b>Location</b>	Outdoor
<b>Manufacturer</b>	Eng. Air
<b>Model</b>	CUEA 103
<b>Capacity (ton)</b>	10
<b>Power Supply</b>	575/3/60
<b>MCA Amp</b>	22.5
<b>Dimension (L x W x H mm)</b>	2207 x 1041 x 1067
<b>Net Weight (kg)</b>	500
<b>Notes</b>	1,2,3, 4, 5, 6

#### Notes

1. Separate dual circuit refrigerating circuits
2. Low noise sound attenuation package
3. Provision for BACNET EMC 5 control and monitor.
4. External vibration isolation
5. Fan Guard
6. Interlock with AHU-2



#### 4.0 HEAT RECOVERY VENTILATOR SCHEDULE

Equipment Tag	HRV-1	HRV-2	HRV-3 HRV-4
<b>Description</b>	Plate Type Heat Recovery Ventilator	Plate type HRV	Plate type HRV
<b>Location</b>	Mech Rm 150	Mech Rm 150	Mech Rm 112 Mech Rm 212
<b>Area Served</b>	Main Floor	2 <sup>nd</sup> Floor	Main Floor 2 <sup>nd</sup> Floor
<b>Manufacturer</b>	Nu Air	Nu Air	Nu Air
<b>Model</b>	Nu 1200 HRV	Nu 1200 HRV	
<b>Supply Air</b>			
Air Flow (l/s)	500	500	220
EDBT / EWBT (°F)	86 / 68 (Cool) 14 / 13 (Heat)	86 / 68 (Cool) 14 / 13 (Heat)	86 / 68 (Cool) 14 / 13 (Heat)
LDBT / LWBT (°F)	80 / 65.8 (Cool) 39.4 (Heat)	80 / 65.8 (Cool) 39.4 (Heat)	80 / 65.8 (Cool) 39.4 (Heat)
Energy Recovery for Cooling / Heating (MBH)	20.11 / 97.62	20.11 / 97.62	20.11 / 97.62
Unit E.S.P. in Pa	125	125	125
No. of Supply Air Fans	1	1	1
RPM	1625	1625	1625
Motor (W)	235	235	250
<b>Exhaust Air</b>			
Air Flow (l/s)	500	500	500
EDBT (°F)	74 (Cool) / 72 (Heat)	74 (Cool) / 72 (Heat)	74 (Cool) / 72 (Heat)
Entering RH	50% (Cool) / 46% (Heat)	50% (Cool) / 46% (Heat)	50% (Cool) / 46% (Heat)
LAT (°F)	79.9 (Cool) / 46.7 (Heat)	79.9 (Cool) / 46.7 (Heat)	79.9 (Cool) / 46.7 (Heat)
Unit E.S.P. in Pa	125	125	125
No. of Supply Air Fans	1	1	1
RPM	1625	1625	1275
Motor (W)	235	235	250
<b>Heat Exchange</b>			
Type	Plate	Plate	Plate
Material	Aluminum	Aluminum	Aluminum
Face Area (Sq. Ft.)	7.9	7.9	7.9
<b>Electrical</b>			
Power Supply	115/ 1/60	115/ 1/60	115/ 1/60
MCA (amp)	20	20	4.5
<b>Remark</b>			
Total Unit Weight (kg)			
Unit Size (mm)	1372 x 762 x 659	1372 x 762 x 659	914x584 x 432
Accessories	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 2, 3, 4, 5, 6, 7, 8, 9

**Notes**

1. Unit to be single power supply, and with disconnect switch
2. Provision for BACNeT EMCS control and monitor
3. Exhaust fan shut down defrost
4. Internal vibration isolations
5. MERV 7 (2") filters
6. CO2 sensor
7. Fire alarm shut down
8. Pre-wired controls
9. ECM motors on supply fan and exhaust fan

### 5.0 AIR HANDLING UNITS SCHEDULE

Equipment Tag	AHU-1	AHU-2
Location	Mech Rm 150	Mech Rm 150
Area Served	Main Floor Level	2 <sup>nd</sup> Floor Level
Manufacturer	Eng Air	Eng Air
Model	LM 3/C	LM 4/C
Supply Air		
Volume (l/s)	1270	1505
Unit E.S.P (Pa)	250	250
Fan Type	12/12 DWDI Forward Curve Fan	12/12 DWDI Forward Curve Fan
Fan Speed (RPM)	1200	1200
Fan HP (kw)	3.75	3.75
Minimum Outdoor Air (l/s)	335	405
Return Air		
Volume (l/s)	1270	1505
Unit ESP (Pa)	125	125
Type	12/12 DWDI Forward Curve Fan	12/12 DWDI Forward Curve Fan
Fan Speed	1000	1000
Fan Hp (Kw)	2.25	2.25
Hot Water Heating Section		
Heat Output (Kw)	15	36
Face Velocity (m/s)	2.5	2.5
EWT/ LWT (°C)	65/ 52.1	65/54
EAT/LWT (°C)	10/20	10/29.8
Air P.D./ Flow (Pa)(l/s)	18.1/1270	17.5/1505
Fluid P.D./ Flow (kPa)(l/s)	5.1/0.28	10.8/0.33
DX Cooling Coil		
Total Cooling Capacity (Kw)	-	34.73
Sensible Cooling (Kw)	-	22.41
DX Coil LDBT/LWBT (°C)	-	13/ 12.1
Refrigerant:	-	R410A
Condensate Drain Size (mm)	-	40
Electrical		-
Power Supply	575/3/60	575/3/60
MCA (amp)	15	15
Remark		
Total Unit Weight (kg)	570	660
Size (mm) LxWxH	3251x1067x915	3775 x 1300 x 1050
Filter	Merv 13	Merv 13
Note	1, 2, 3, 4, 6, 7,9, 11, 12	1,2,3,4, 5, 6, 7, 8, 10, 11, 12

#### Note

- 1 Unit to complete with variable speed drives on supply fan and return fan.
- 2 Unit to complete with flow measuring station at supply and return fan inlet.
- 3 Unit complete with 100% free cooling economizer section
- 4 Unit to be minimum outdoor air intake section.

- 5 Unit to be single power supply, with disconnect switch
- 6 Provision for BACNeT EMCS control and monitor
- 7 Internal vibration Isolation
- 8 Separated dual circuit refrigerating circuits
- 9 Interlock with smudging zone exhaust fans
- 10 Interlock with heat recovery ventilator
- 11 CO2 sensor
- 12 Fire alarm shut down

## **6.0 ELECTRIC FORCE FLOW HEATERS SCHEDULE**

<b>Equipment Tag</b>	<b>FFH-1</b>
<b>Room Served</b>	Stair B2
<b>Power Supply</b>	208/1/60
<b>KW</b>	1.5
<b>Manufacturer</b>	QMARK
<b>Model</b>	LFK204
<b>Remark</b>	1, 2

### **Notes**

- 1 Provide ceiling surface mounting for installation for electric force flow heaters.
- 2 Provision for DDC control.

## 7.0 PUMP SCHEDULE

Equipment Tag	P-1, P-2	P-3, P-4
Description	In-Line Pump	In-Line Pump
Service	Boiler Heating Water Pump	Secondary Heating Hot Water Pump
Location	Mechanical Room MR 150a	Mechanical Room MR 150a
Manufacturer	Armstrong	Armstrong
Model	H-H53	4380-1.5x8
Capacity (gpm, l/s)	23.0, 1.45	31.0, 1.95
Diff. Pressure (ft, Kpa)	25.0, 73.5	60.0, 176.0
Pump RPM	1800	1800
Motor Power (HP)	0.5	2
Power Supply	115/1/60	208/3/60
Remark	1, 2, 4	1, 2, 3, 4

Equipment Tag	P-5	
Description	In-Line Circulator	
Service	Domestic Hot Water Recirc.	
Location	Mechanical Room MR 150a	
Manufacturer	Armstrong	
Model	E7.2B BRZ	
Capacity (gpm, l/s)	5.0, 0.31	
Diff. Pressure (ft, Kpa)	20.0, 59.0	
Pump RPM	1800	
Motor Power (HP)	1/6	
Power Supply	115/1/60	
Remark	1, 2, 4, 5	

### Notes

- 1 Provide inlet strainer, suction diffuser and discharge triple duty valves.
- 2 Provision for DDC control.
- 3 Provide variable speed drive with inverted duty motor
- 4 Provide proper transition pipes and flexible connectors on suction and discharge
- 5 All bronze construction
- 6 Manufacturer: Bell & Gossett, Armstrong, Grundfoss

## 8.0 GRILLES AND DIFFUSERS

Type	S-1	S-2	S-3	L-1
Service	Square Plaque Diffuser	Square Cone Diffuser	Double Deflection Grille	Outdoor Louvre
Manufacturer	E.H. Price	E.H. Price	E.H. Price	E.H. Price
Model	SPD	SCD	520/F/S/O	DE439
Accessories/Note	2, 3	2, 3, or 4, 10	2, 4	4, 5, 6, 8, 9

Type	R-1	R-2	E-1	E-2
Service	Egg crate Face Return	Return	Egg Crate Face Exhaust	Louvered Exhaust
Manufacturer	E.H. Price	E.H. Price	E.H. Price	E.H. Price
Model	80/F/O	510Z	80/F/O	530/F/L/O
Accessories/Note	2, 3 or 4, 11	1, 4, 6	2, 4, 11	2, 3 or 4, 11

Type	DG-1			
Service	Transfer/Door Grille			
Manufacturer	E.H. Price			
Model	ATG1/BF			
Accessories/Note	5, 12			

### Accessories and Notes

1. Opposed blade volume damper
2. Off-White baked enamel finish
3. T-Bar Mount
4. Surface Mount
5. Aluminum construction
6. Finish colour to Architect
7. Tamper resistance screw
8. Welded construction
9. Bird screen
- 10 Face size of either 600x600 or 300x300. Refer to Drawing M3.
- 11 See Drawing M3 and M6 for grille sizes.
- 12 Aluminum finish

## 9.0 GAS FIRED FURNACES SCHEDULE

Equipment Tag	FU-1	FU-2
Description	Gas-Fired Furnace	Gas-Fired Furnace
Location	Mech Room MR 112	Mech Room MR 212
Manufacturer	Lennox	Lennox
Model	SLP98UH090V60	SLP98UH090V60
Heat Input (MBH)	88	88
Heat Output (MBH)	85	85
Air Temp Rise (°F)	60-90	60-90
Fuel Type	Natural Gas	Natural Gas
Air E.S.P (in)	0.6	0.6
Gas Pipe Size (in)	1/2	1/2
Intake/Exhaust PVC Pipe (in)	4	4
Air Flow (cfm)	2010	2010
Blower Type	Centrifugal	Centrifugal
Motor (HP)	1	1
Motor (RPM)	1050	1050
Power Supply	115/1/60	115/1/60
Total Amps	20 MOCP	20 MOCP
Note	1, 2, 3, 4, 5, 6, 7,8	1, 2, 3, 4, 5, 6, 7,8

### Notes

- 1 All furnaces to be controlled by BACNet DDC room thermostat.
- 2 Horizontal/Vertical concentric vent kit
- 3 Variable speed blower motor
- 4 Variable capacity gas control valve, variable speed combustion air inducer, surelight ignition control
- 5 2" 30/30 air filters
- 6 Provision for BACNet DDC control  
Vibration isolation kit
- 7 Discharge air temperature sensors
- 8 100% free cooling dampers economizer section



## 10.0 WATER HEATER SCHEDULE

<b>TAG</b>	<b>DHW-1 – DHW-2</b>
<b>Location</b>	Mech Room 150a
<b>TYPE</b>	High efficient Gas-fired
<b>INPUT KW (MBH)</b>	44 (150)
<b>RECOVERY AT 56 DEG °C, L/Hr</b>	654
<b>STORAGE (LITRE)</b>	379
<b>WEIGHT KG</b>	400
<b>VOLTAGE/PH/HZ</b>	120/1/60
<b>MANUFACTURER</b>	A.O Smith
<b>MODEL</b>	BTH-150
<b>REMARKS</b>	
<b>ACCESSORIES</b>	See Below

### Accessories

1. Provide manufacturer recommended vent and combustion piping kits, condensate drain neutralized kits and pressure relief valves.

## 11.0 BOILER SCHEDULE

<b>TAG</b>	<b>B-1 – B-2</b>
<b>Location</b>	Mechanical Room
<b>TYPE</b>	High Efficiency- Condensing
<b>INPUT KW (MBH)</b>	285 (970)
<b>OUTPUT KW (MBH)</b>	265 (902)
<b>Heating Medium</b>	Water
<b>HW TEMP IN/OUT -°C (°F)</b>	48/71 (120/160)
<b>Water Flow e/s (Gpm)</b>	1.5 (23)
<b>Weight – Kg (lbs)</b>	115 (246)
<b>Burner HP</b>	Fract
<b>Voltage/ PH/ HZ</b>	115/1/60
<b>Manufacturer</b>	Weil-Mclain
<b>Model</b>	Ultra 230
<b>Remarks</b>	<ol style="list-style-type: none"> <li>1. Concentric vent kits</li> <li>2. Provision to be controlled by BACNet</li> <li>3. Condensate drain neutralized kits</li> <li>4. LWCO</li> </ol>

## 12.0 Radiant Panels

Unit Type	A	B
Location	Offices	Storage (Utility)
Manufacturer	E.H. Price RPL	EH Price RPLA
Width (mm)	600	600
Capacity (W/m)	226	226
E.W.T. (°C)	60°C	60°C
L.W.T. (°C)	48.8°C	48.8°C
Notes	4, 3, 5,6,7	1, 2, 4, 5, 6, 7

### Notes

- 1 Sloped security panel installation c/w secured access panels.
- 2 Free Hang Installation. Top cover, mitered corners
- 3 T-bar or drywall ceiling installation. Refer to Architectural Drawings.
- 4 Extruded aluminum construction. Smooth face finish  
 See mechanical drawings for total panel allowable length (ie. Active and inactive lengths).  
 Follow T-bar grid to separate the sections of radiant panels. Panels to be wall to wall.
- 5 Contractor shall provide active lengths capable of the output requirements outlined below:
- 6 25 mm foil faced back insulation
- 7 Maximum length of each section of panels to be 3 meters.

### OUTPUT REQUIREMENTS (W):

Unit	Room	Area/ Room	Output Requirements (W)	Total Active length (m)	Total Approx. length (m)	
A	Rm 145	Activity	1582	7	7	
A	Rm 146	Multi purpose	2260	10	10	
A	Rm147	Multi purpose	1582	7	7	
B	Rm 151	Storage	678	3	3	
A	Rm 233	Multi purpose	1130	5	5	
A	Rm 241	Lunch room	2260	10	10	
A	Rm 243	Office	1130	5	7	
A	Rm 244	Office	565	2.5	3.5	
A	Rm 245	Office	452	2	3	
A	Rm 246	Meeting	1356	6	7	
A	Rm 247	Office	678	3	3	
A	Rm 249	Admin	1695	7.5	7.5	
B	Rm 249a	Storage	339	1.5	1.5	

### 13.0 Tank Schedule

Tag	ET-1	ET-2
Service	Heating System Expansion	Domestic hot water expansion
Location	Rm 150a Mech Room	Rm 150a Mech Room
Type	Pre-pressurized diaphragm type	Diaphragm type
Capacity (l)	125	53
Dimension (mm)	375 x 1175	419 (D)x491 (H)
Manufacturer	Amtrol	Amtrol
Model	5 x 60V	ST-30V-C
Accessories	1, 2,4	1, 3, 4

#### Notes

- 1 Non-metallic polypropylene liner to meet FDA and NSF 61 Standards.
- 2 Combination package for air, expansion, pressure and filling.
- 3 stainless steel Shell
- 4 Constructed per ASME

#### 14.0 Air Conditioning Unit Schedule

<b>Indoor Unit Tag</b>		<b>AC-1</b>
<b>Location</b>		Comm Room 136 , Wall
<b>Area Served</b>		Comm Room 136
<b>Manufacturer</b>		Sanyo
<b>Model</b>		KS0971
<b>Type</b>		Wall mounted
<b>Unit Cooling Capacity (W)</b>		2,640
<b>Volume (l/s)</b>		133
<b>ESP ( Pa)</b>		2.0
<b>Motor Power (W)</b>		46
<b>Face Velocity (m/s)</b>		2.1
<b>Cooling Capacity</b>		¾ ton
<b>Power Supply</b>		115/1/60
<b>Physical Data</b>		
<b>Overall LxWxH (mm)</b>		815x285x325
<b>Overall Weight (kg)</b>		9
<b>Condensing Unit Tag</b>		<b>CU-1</b>
<b>Location</b>		Outside Elect Room 137
<b>Make/ Model</b>		KS0971
<b>Power Supply</b>		115/1/60
<b>FLA</b>		7.6; 20 MCA
<b>Physical Data</b>		
<b>Overall LxWxH (mm)</b>		720x270x548
<b>Overall Weight (kg)</b>		33
<b>Accessories</b>		1, 2, 3, 4, 5

#### Notes

- Included microprocessor control system and factory start-up and automatic condensate pump and controls.
- 1 controls.
  - 2 Air Filter
  - 3 Refrigerant Piping
  - 4 BACNet control monitor provisions
  - 5 Thermostat (wireless type with wall mounted lock box).

**15.0 ATB Box Schedule (E.H. Prior Model SDV 5110 with 1.2 meter silencer)**

ATB Box No.	VAV Box Size	Space No. Serving	Air Flow [l/s]		Reheat Coil	Reheat Coil Performance Data at: EAT = 13.3°C, EWT = 60°C, MAX HD = 9 KPa					
			Min	Max		No. of Rows [-]	W. Flow [l/s]	HD [Pa]	H. Capac. Sens. [Kw]	LWT [°C]	LAT [°C]
ATB-101	7	Lobby 1234, 138, 140, 141	90	305	H	2	0.06	25.8	2.9	49	30
ATB-102	6	Rm 142, 148	35	118	H	1	0.02	17.2	1	49	30
ATB-103	8	Rm 145	85	282	H	2	0.05	24.7	2.2	49	30
ATB-104	8	Rm 146	85	282	H	1	0.02	16.0	0.6	49	30
ATB-105	8	Rm 147	99	329	H	1	0.03	20.0	1.6	49	30
ATB-201	8	Rm 233	85	282	H	1	0.03	15.2	1.5	49	30
ATB-202	8	Rm 241	70	235	H	1	0.01	11.8	0.5	49	30
ATB-203	8	Rm 243, 244, 245	70	240	H	1	0.02	12.8	0.8	49	30
ATB-204	7	Rm 246	60	197	H	1	0.01	11.8	0.5	49	30
ATB-205	8	Rm 242, 247 248, 249,	103	334	H	1	0.02	15.2	1.2	49	30
ATB-206	8	Rm 240, 231, 237	66	217	H	2	0.06	23.2	2.7	49	30

Project No.: R.052462.001  
Abbotsford, BC - Fraser Valley Institution  
**TWENTY BED LIVING UNIT**

Section 23 90 00  
**EQUIPMENT SCHEDULE**  
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**Part 1 General****1.1 SUMMARY****.1 Section Includes.**

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:

- .1 Start-up testing and verification of systems.
- .2 Check out demonstration or proper operation of components.
- .3 On-site operational tests.

**.2 Related Sections.**

- .1 Section 01 01 50 - General Instructions.
- .2 Section 01 91 00 - Commissioning.
- .3 Section 25 05 01 - EMCS: General Requirements.

**1.2 DEFINITIONS**

.1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

.2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

- .1 Outage of main power supply in excess of back-up power sources, provided that:
  - .1 Automatic initiation of back-up was accomplished.
  - .2 Automatic shut-down and re-start of components was as specified.
- .2 Failure of communications link, provided that:
  - .1 Controller automatically and correctly operated in stand-alone mode.
  - .2 Failure was not due to failure of any specified EMCS equipment.
- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
  - .1 System recorded said fault.
  - .2 Equipment defaulted to fail-safe mode.
  - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

**1.3 DESIGN REQUIREMENTS**

.1 Confirm with Departmental Representative that Design Criteria and Design Intentions are still applicable.



- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

#### **1.4 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50– General Instructions .
- .2 Final Report: submit report to Departmental Representative.
  - .1 Include measurements, final settings and certified test results.
  - .2 Bear signature of commissioning technician and supervisor
  - .3 Report format to be approved by Departmental Representative before commissioning is started.
  - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 01 50– General Instructions.
  - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

#### **1.5 CLOSEOUT SUBMITTALS**

- .1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 01 50 – General Instructions.

#### **1.6 COMMISSIONING**

- .1 Do commissioning in accordance with Section 01 91 00 - Commissioning.
- .2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative and PWGSC Commissioning Manager.
- .3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
  - .1 Location and part of system to be tested or commissioned.
  - .2 Testing/commissioning procedures, anticipated results.
  - .3 Names of testing/commissioning personnel.
- .4 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 Load system with project software.
- .7 Perform tests as required.

**1.7 COMPLETION OF COMMISSIONING**

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and PWGSC Commissioning Manager.

**1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION**

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

**Part 2 Products****2.1 EQUIPMENT**

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances : higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

**Part 3 Execution****3.1 PROCEDURES**

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Commissioning Manager and Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by Commissioning Manager and Departmental Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

### 3.2 FIELD QUALITY CONTROL

- .1 Pre-Installation Testing.
  - .1 General: consists of field tests of equipment just prior to installation.
  - .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
  - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.
  - .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
  - .5 Additional instruments to include:
    - .1 DP transmitters.
    - .2 VAV supply duct SP transmitters.
    - .3 DP switches used for dirty filter indication and fan status.
  - .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
  - .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
  - .8 Departmental Representative to mark instruments tracking within 0.5 % in both directions as "approved for installation".
  - .9 Transmitters above 0.5 % error will be rejected.
  - .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
  - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.
    - .4 Test each DI to ensure proper settings and switching contacts.
    - .5 Test each DO to ensure proper operation and lag time.
    - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    - .7 Test operating software.
    - .8 Test application software and provide samples of logs and commands.
    - .9 Verify each CDL including energy optimization programs.
    - .10 Debug software.
    - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

- .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative. This document will be used in final startup testing.
- .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and Commissioning Manager and provide:
  - .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
  - .2 Detailed daily schedule showing items to be tested and personnel available.
  - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
  - .4 Commissioning to commence during final startup testing.
  - .5 O&M personnel to assist in commissioning procedures as part of training.
  - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
  - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
  - .8 Operate systems as long as necessary to commission entire project.
  - .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
  - .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
    - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
  - .2 Test to last at least 30 consecutive 24 hour days.
  - .3 Tests to include:
    - .1 Demonstration of correct operation of monitored and controlled points.
    - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
  - .4 System will be accepted when:
    - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    - .2 Requirements of Contract have been met.
  - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  - .6 Correct defects when they occur and before resuming tests.

- .5 Commissioning Manager and Departmental Representative to verify reported results.

### **3.3 ADJUSTING**

- .1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

### **3.4 DEMONSTRATION**

- .1 Demonstrate to Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 01 50 – General Instructions.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes.
  - .1       Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.
- .2    Related Sections.
  - .1       Section 01 01 50 - General Instructions.
  - .2       Section 25 05 01 - EMCS: General Requirements.

**1.2            DEFINITIONS**

- .1    CDL - Control Description Logic.
- .2    For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3            SUBMITTALS**

- .1    Submittals in accordance with Section 01 01 50 – General Instructions, supplemented and modified by requirements of this Section.
- .2    Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
  - .1       List name of trainer, and type of visual and audio aids to be used.
  - .2       Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3    Submit reports within one week after completion of Phase 1 and Phase 2 training program that training has been satisfactorily completed.

**1.4            QUALITY ASSURANCE**

- .1    Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2    Departmental Representative reserves right to approve instructors.

**1.5            INSTRUCTIONS**

- .1    Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2    Training to be project-specific.

**1.6 TIME FOR INSTRUCTION**

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

**1.7 TRAINING MATERIALS**

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.
  - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

**1.8 TRAINING PROGRAM**

- .1 To be in 2 phases over 6 month period.
- .2 Phase 1: 1 day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative.
  - .1 Train O&M personnel in functional operations and procedures to be employed for system operation.
  - .2 Supplement with on-the-job training during 30 day test period.
  - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: 1 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.
  - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
    - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
    - .2 Equipment maintenance training: provide personnel with 2 days training within 5 day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
    - .3 Programmers: provide personnel with 2days training within 5 day period in following subjects in approximate percentages of total course shown:
      - Software and architecture: 10%
      - Application programs: 15%
      - Controller programming: 50%
      - Trouble shooting and debugging:10%
      - Colour graphic generation: 15%

**1.9 ADDITIONAL TRAINING**

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

**1.10 MONITORING OF TRAINING**

- .1 Departmental Representative to monitor training program and may modify schedule and content.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.
- .2 Related Sections:
  - .1 Section 01 01 50 – General Instructions.
  - .2 Section 01 35 33 - Health and Safety Requirements.
  - .3 Section 09 91 23 - Painting.
  - .4 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  - .5 Section 25 05 54 - EMCS: Identification.
  - .6 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
  - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
  - .1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1-B-2002, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Electrical and Electronic Manufacturers Association (EEMAC).
  - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

- .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

### **1.3 ACRONYMS AND ABBREVIATIONS**

- .1 Acronyms used in EMCS:
  - .1 AEL - Average Effectiveness Level.
  - .2 AI - Analog Input.
  - .3 AIT - Agreement on International Trade.
  - .4 AO - Analog Output.
  - .5 BACnet - Building Automation and Control Network.
  - .6 BC(s) - Building Controller(s).
  - .7 BECC - Building Environmental Control Center.
  - .8 CAD - Computer Aided Design.
  - .9 CDL - Control Description Logic.
  - .10 CDS - Control Design Schematic.
  - .11 COSV - Change of State or Value.
  - .12 CPU - Central Processing Unit.
  - .13 DI - Digital Input.
  - .14 DO - Digital Output.
  - .15 DP - Differential Pressure.
  - .16 ECU - Equipment Control Unit.
  - .17 EMCS - Energy Monitoring and Control System.
  - .18 HVAC - Heating, Ventilation, Air Conditioning.
  - .19 IDE - Interface Device Equipment.
  - .20 I/O - Input/Output.
  - .21 ISA - Industry Standard Architecture.
  - .22 LAN - Local Area Network.
  - .23 LCU - Local Control Unit.
  - .24 MCU - Master Control Unit.
  - .25 NAFTA - North American Free Trade Agreement.
  - .26 NC - Normally Closed.
  - .27 NO - Normally Open.
  - .28 OS - Operating System.
  - .29 O&M - Operation and Maintenance.
  - .30 OWS - Operator Work Station.
  - .31 PC - Personal Computer.
  - .32 PCI - Peripheral Control Interface.
  - .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
  - .34 PID - Proportional, Integral and Derivative.
  - .35 RAM - Random Access Memory.

- .36 SP - Static Pressure.
- .37 ROM - Read Only Memory.
- .38 TCU - Terminal Control Unit.
- .39 USB - Universal Serial Bus.
- .40 UPS - Uninterruptible Power Supply.
- .41 VAV - Variable Air Volume.

#### **1.4 DEFINITIONS**

- .1 Point: may be logical or physical.
  - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
  - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
  - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
    - .1 Area descriptor: building or part of building where point is located.
    - .2 System descriptor: system that point is located on.
    - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25 character field for each point identifier.
  - .2 Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
  - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
    - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
  - .1 AI (analog input).
  - .2 AO (analog output).
  - .3 DI (digital input).
  - .4 DO (digital output).
  - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
  - .1 Printouts: to ANSI/IEEE 260.1.
  - .2 Refer also to Section 25 05 54- EMCS: Identification.

## **1.5 SYSTEM DESCRIPTION**

- .1 Work covered by sections referred to consists of fully operational EMCS, including, but not limited to, following:
  - .1 Building Controllers.
  - .2 Control devices as listed in I/O point summary tables.
  - .3 OWS(s).
  - .4 Data communications equipment necessary to effect EMCS data transmission system.
  - .5 Field control devices.
  - .6 Software/Hardware complete with full documentation.
  - .7 Complete operating and maintenance manuals.
  - .8 Training of personnel.
  - .9 Acceptance tests, technical support during commissioning, full documentation.
  - .10 Wiring interface co-ordination of equipment supplied by others.
  - .11 Miscellaneous work as specified in these sections and as indicated.
- .2 Design Requirements:
  - .1 Design and provide conduit and wiring linking elements of system.
  - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
  - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
  - .4 Provide utility power to EMCS and emergency power to EMCS.
  - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .3 Language Operating Requirements:
  - .1 Provide English operator selectable access codes.
  - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
  - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.
  - .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
  - .5 Include, in English:
    - .1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).
    - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points.

- .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

## **1.6 SUBMITTALS**

- .1 Make submittals in accordance with Section 01 01 50 – General Instructions and 25 05 02 - EMCS: Submittals and Review Process.
- .2 Co-ordinate submittal requirements and provide submittals as required.
- .3 Submit for review:
  - .1 Equipment list and systems manufacturers at time of bid/tender within 48 h, and within 10 days after award of contract.
  - .2 List existing field control devices to be re-used included in tender, along with unit price.
- .4 Quality Control:
  - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
  - .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
  - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
  - .6 Permits and fees: in accordance with general conditions of contract.
  - .7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.
  - .8 Existing devices intended for re-use: submit test report.

## **1.7 QUALITY ASSURANCE**

- .1 Have local office within 50 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.5 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

**1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 01 50 for Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Place materials defined as hazardous or toxic in designated containers.
- .4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal, regulations.
- .5 Label location of salvaged material's storage areas and provide barriers and security devices.
- .6 Ensure emptied containers are sealed and stored safely.

**Part 2 Products**

**2.1 EQUIPMENT**

- .1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 and ASHRAE STD 135.
- .2 Complete list of equipment and materials to be used on project and forming part of bid/tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

**2.2 ADAPTORS**

- .1 Provide adaptors between metric and imperial components.

**Part 3 Execution**

**3.1 MANUFACTURER'S RECOMMENDATIONS**

- .1 Installation: to manufacturer's recommendations.

**3.2 NETWORKING**

- .1 The EMCS/BAS system of this building shall be Ethernet connected to the BAS system in the existing building A (AR 63 IT Room in Penthouse) of the FVI site and the Central Boiler Plant. It allows the Boiler Plant to remotely control and monitor the mechanical system operation of this building.

- .2 Provide fibre optics for the site Ethernet. Coordinate with electrical and communication trade for the site services of conduits and fibre optics. Division 27 shall provide fibre optics from the Room 136 Communication Room of this new building to Building A AR 63 IT Room. Division 25 shall provide all the connections from the Hub panels provided by Division 27 to the building BAS DDC panels and OWS.
- .3 Provide update and upgrade as required to existing software and graphics.
- .4 Provide programming, testing and commissioning to integrate this building control system into existing Delta front end systems and OWS in the FVI Building A and the Central Heating Plant.

### **3.3 PAINTING**

- .1 Painting: in accordance with Section 09 91 23 - Painting, supplemented as follows:
  - .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
  - .2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
  - .3 Clean and prime exposed hangers, racks, fastenings, and other support components.
  - .4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).
- .2 Related Sections.
  - .1 Section 01 01 50 – General Instructions.
  - .2 Section 25 05 01 - EMCS: General Requirements.
  - .3 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**1.2 DEFINITIONS**

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

**1.3 DESIGN REQUIREMENTS**

- .1 Preliminary Design Review: to contain following contractor and systems information.
  - .1 Location of local office.
  - .2 Description and location of installing and servicing technical staff.
  - .3 Location and qualifications of programming design and programming support staff.
  - .4 List of spare parts.
  - .5 Location of spare parts stock.
  - .6 Names of sub-contractors and site-specific key personnel.
  - .7 Sketch of site-specific system architecture.
  - .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - .9 Descriptive brochures.
  - .10 Sample CDL and graphics (systems schematics).
  - .11 Response time for each type of command and report.
  - .12 Item-by-item statement of compliance.
  - .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

**1.4 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50 – General Instructions and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by Departmental Representative.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.



- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

## **1.5 PRELIMINARY SHOP DRAWING REVIEW**

- .1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
  - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
  - .2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.
  - .3 Spare point capacity of each controller by number and type.
  - .4 Controller locations.
  - .5 Auxiliary control cabinet locations.
  - .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
  - .7 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

## **1.6 DETAIL SHOP DRAWING REVIEW**

- .1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
  - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
  - .2 Wiring diagrams.
  - .3 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
  - .4 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
    - .1 Sensing element type and location.
    - .2 Transmitter type and range.
    - .3 Associated field wiring schematics, schedules and terminations.
    - .4 Complete Point Name Lists.
    - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
    - .6 Software and programming details associated with each point.
    - .7 Manufacturer's recommended installation instructions and procedures.

- .8 Input and output signal levels or pressures where new system ties into existing control equipment.
- .5 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
- .6 Graphic system schematic displays of systems with point identifiers and textual description of system, and typical floor plans as specified.
- .7 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
- .8 Listing and example of specified reports.
- .9 Listing of time of day schedules.
- .10 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
- .11 Type and size of memory with statement of spare memory capacity.
- .12 Full description of software programs provided.
- .13 Sample of "Operating Instructions Manual" to be used for training purposes.
- .14 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

## **1.7 QUALITY ASSURANCE**

- .1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:
  - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
  - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
  - .3 Review interface requirements of materials supplied by others.
  - .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes.
  - .1    Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.
- .2    Related Sections.
  - .1    Section 01 01 50 – General Instructions.
  - .2    Section 25 05 01 - EMCS: General Requirements.
  - .3    Section 25 05 02 - EMCS: Submittals and Review Process.
  - .4    Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**1.2            DEFINITIONS**

- .1    BECC - Building Environmental Control Centre.
- .2    OWS - Operator Work Station.
- .3    For additional acryonyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3            SUBMITTALS**

- .1    Submittals in accordance with Section 01 01 50– General Instructions, supplemented and modified by requirements of this Section.
- .2    Submit Record Documents, As-built drawings, Operation and Maintenance Manual to Departmental Representative in English.
- .3    Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
  - .1    Binders to be 2/3 maximum full.
  - .2    Provide index to full volume in each binder.
  - .3    Identify contents of each manual on cover and spine.
  - .4    Provide Table of Contents in each manual.
  - .5    Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

**1.4            AS-BUILTS**

- .1    Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
  - .1    Changes to contract documents as well as addenda and contract extras.
  - .2    Changes to interface wiring.
  - .3    Routing of conduit, wiring and control air lines associated with EMCS installation.

- .4 Locations of obscure devices to be indicated on drawings.
- .5 Listing of alarm messages.
- .6 Panel/circuit breaker number for sources of normal/emergency power.
- .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.
- .3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

## **1.5 O&M MANUALS**

- .1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide 4 complete sets of hard and soft copies prior to system or equipment tests
- .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .4 Functional description to include:
  - .1 Functional description of theory of operation.
  - .2 Design philosophy.
  - .3 Specific functions of design philosophy and system.
  - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
  - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
  - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.
- .5 System operation to include:
  - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
  - .2 Operation of computer peripherals, input and output formats.
  - .3 Emergency, alarm and failure recovery.
  - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command

so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

- .6 Software to include:
  - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
  - .2 Detailed descriptions of program requirements and capabilities.
  - .3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
  - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
  - .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
  - .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
  - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
  - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.
- .2 Related Sections.
  - .1 Section 01 01 50 – General Instructions.
  - .2 Section 25 05 01 - EMCS: General Requirements.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

**1.3 DEFINITIONS**

- .1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.4 SYSTEM DESCRIPTION**

- .1 Language Operating Requirements: provide identification for control items in English.

**1.5 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50 – General Instructions supplemented and modified by requirements of this Section.
- .2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

**Part 2 Products**

**2.1 NAMEPLATES FOR PANELS**

- .1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
- .2 Sizes: 25 x 67 mm minimum.
- .3 Lettering: minimum 7 mm high, black.
- .4 Inscriptions: machine engraved to identify function.

## **2.2 NAMEPLATES FOR FIELD DEVICES**

- .1 Identify by plastic encased cards attached by chain.
- .2 Sizes: 50 x 100 mm minimum.
- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

## **2.3 NAMEPLATES FOR ROOM SENSORS**

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

## **2.4 WARNING SIGNS**

- .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's.

## **2.5 WIRING**

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

## **2.6 CONDUIT**

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".



**Part 3            Execution**

**3.1                NAMEPLATES AND LABELS**

- .1        Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).
- .2 Related Sections.
  - .1 Section 01 01 50 – General Instructions.
  - .2 Section 25 05 01 - EMCS: General Requirements.
- .3 References.
  - .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
  - .2 Canadian Standards Association (CSA International).
    - .1 CSA Z204-94(R1999), Guidelines for Managing Indoor Air Quality in Office Buildings.

**1.2 DEFINITIONS**

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 01 01 50– General Instructions.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
  - .1 Point name and location.
  - .2 Device type and range.
  - .3 Measured value.
  - .4 System displayed value.
  - .5 Calibration detail
  - .6 Indication if adjustment required,
  - .7 Other action taken or recommended.

- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 01 50 for Closeout Submittals.
  - .1 Maintain records and logs of each maintenance task on site.
  - .2 Organize cumulative records for each major component and for entire EMCS chronologically.
  - .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Departmental Representative in accordance with Section 01 01 50 – General Instructions "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

#### **1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD**

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
  - .1 Initiate service calls when EMCS is not functioning correctly.
  - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
  - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
  - .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
  - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
  - .1 Serial number identifying component involved.
  - .2 Location, date and time call received.
  - .3 Nature of trouble.
  - .4 Names of personnel assigned.
  - .5 Instructions of work to be done.
  - .6 Amount and nature of materials used.
  - .7 Time and date work started.
  - .8 Time and date of completion.
- .5 Provide system modifications in writing.
  - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

**1.5 SERVICE CONTRACTS**

- .1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.
- .2 Service Contracts to include:
  - .1 Annual verification of field points for operation and calibration.
  - .2 4 visits per year.
  - .3 Complete inventory of installed system.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 FIELD QUALITY CONTROL**

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
  - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
  - .2 Check and calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.
  - .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
  - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
  - .2 Check equipment cooling fans as required.
  - .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
  - .4 Review system performance with Departmental Representative to discuss suggested or required changes.
- .5 Major inspections to include, but not limited to:
  - .1 Minor inspection.

- .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
- .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
- .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
- .5 Provide mechanical adjustments, and necessary maintenance on printers.
- .6 Run system software diagnostics as required.
- .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
  - .1 Perform network analysis and provide report as described in Submittal article.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place, after facility has been accepted, taken over and fully occupied.
  - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).
- .2 Related Sections:
  - .1 Section 25 05 01 - EMCS: General Requirements.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
  - .2 CSA T530-99(R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
  - .1 IEEE Std 802.3<sup>TM</sup>-2002, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
  - .1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
  - .2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .4 Treasury Board Information Technology Standard (TBITS).
  - .1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

**1.3 DEFINITIONS**

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS - General Requirements.

**1.4 SYSTEM DESCRIPTION**

- .1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A and TBITS 6.9.
  - .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

- .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .2 Data communication network to include, but not limited to:
  - .1 EMCS-LAN.
  - .2 Modems.
  - .3 Network interface cards.
  - .4 Network management hardware and software.
  - .5 Network components necessary for complete network.

## **1.5 DESIGN REQUIREMENTS**

- .1 EMCS Local Area Network (EMCS-LAN).
  - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
  - .2 EMCS-LAN to: BACnet.
  - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
  - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
  - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
  - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
  - .7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
  - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
  - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
  - .1 Network medium: fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

<b>Part 3</b>	<b>Execution</b>
<b>3.1</b>	<b>NOT USED</b>
.1	Not Used.

**END OF SECTION**



**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1    Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.
- .2    Related Sections:
  - .1    Section 25 05 01 - EMCS: General Requirements.
  - .2    Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  - .3    Section 25 05 03 - EMCS: Project Record Documents.
  - .4    Section 25 30 01 - EMCS: Building Controllers.
  - .5    Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

**1.2            DEFINITIONS**

- .1    Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.
- .2    Secondary OWS: serves as backup to primary OWS, is storage and retrieval facility of soft copy of as-built contractor supplied data as described in Section 25 05 03 - EMCS: Project Record Documents.
- .3    Portable OWS: used as remote dial-up OWS with same capabilities as primary OWS including graphic display.
- .4    Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

**1.3            OWS SYSTEM DESCRIPTION**

- .1    Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.
- .2    EMCS Contractor shall provide OWS, all software, graphics, programming, testing and commissioning to the OWS systems of ISS Building and Boiler Plant.

**1.4            SUBMITTALS**

- .1    Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

**1.5            MAINTENANCE**

- .1    Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

**Part 2        Products**

**2.1        OWS CONTROL SOFTWARE**

- .1        OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.
- .2        Time Synchronization Module.
  - .1        System to provide Time Synchronization of real-time clocks in controllers.
  - .2        System to perform this feature on regular scheduled basis and on operator request.
- .3        User Display Interface Module.
  - .1        OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.
  - .2        Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.
- .4        General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:
  - .1        Operator Log-in from user interface device.
  - .2        Communication messages: errors, failures and recovery.
  - .3        Event notifications and alarms by category.
  - .4        Record of operator initiated commands.
- .5        General Event Log:
  - .1        Hold minimum of 4 months information and be readily accessible to operator.
  - .2        Able to be archived as necessary to prevent loss of information.
- .6        Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:
  - .1        Automatic logging of digital alarms and change of status messages.
  - .2        Automatic logging of analog alarms.
  - .3        System changes: alarm limits, set-points, alarm lockouts.
  - .4        Display specific point values, states as selected.
  - .5        Provide reports as requested and on scheduled basis when required.

- .6 Display graphics as requested, and on alarm receptions (user's option).
  - .7 Display list of points within system.
  - .8 Display list of systems within building.
  - .9 Direct output of information to selected peripheral device.
  - .10 On-line changes:
    - .1 Alarm limits.
    - .2 Setpoints.
    - .3 Deadbands.
    - .4 Control and change of state changes.
    - .5 Time, day, month, year.
    - .6 Control loop configuration changes for controller-based CDLs.
    - .7 Control loop tuning changes.
    - .8 Schedule changes.
    - .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.
  - .11 According to assigned user privileges (password definition) following functions are to be supported:
    - .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.
    - .2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.
  - .12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.
- .7 Dial-up host Module for off site OWSs.
- .1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.
  - .2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.
  - .3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.
- .8 Message Handling Module - and Error Messages: to provide message handling for following conditions:
- .1 Message and alarm buffering to prevent loss of information.
  - .2 Error detection correction and retransmission to guarantee data integrity.
  - .3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.

- .4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.
- .9 Access ControlModule.
  - .1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:
    - .1 Guest: no password data access and display only.
    - .2 Operator Level: full operational commands including automatic override.
    - .3 Technician: data base modifications.
    - .4 Programmer: data base generation.
    - .5 Highest Level : system administration - password assignment addition, modification.
  - .2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.
- .10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.
  - .1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.
  - .2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96 h basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.
  - .3 Control loop plot utility: for AO Points provide for concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.
  - .4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

- .5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.
- .11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.
  - .1 Reports to include time, day, month, year, report title, operator's initials.
  - .2 Software to provide capability to:
    - .1 Generate and format reports for graphical and numerical display from real time and stored data.
    - .2 Print and store reports as selected by operator.
    - .3 Select and assign points used in such reports.
    - .4 Sort output by area, system, as minimum.
  - .3 Periodic/automatic report:
    - .1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.
    - .2 Reports to include:
      - .1 Power demand and duty cycle summary: see application program for same.
      - .2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.
      - .3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.
      - .4 Summary of run time alarms: include point name, run time to date, alarm limit.
      - .5 Summary of start/stop schedules: include start/stop times and days, point name.
      - .6 Motor status summary.
  - .4 Report types:
    - .1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:
    - .2 Points in accessible from this OWS (total connected for this location), multiple "areas".
    - .3 Area (points and systems in Area).
    - .4 Area, system (points in system).
    - .5 System (points by system type).
    - .6 System point (points by system and point object type).

- .7 Area point (points by system and point object type).
- .8 Point (points by point object type).
- .5 Summary report: printout or display of point object data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.
- .6 Include preformatted reports as listed in Event/Alarm Module.
- .12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
  - .1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlaid with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.
  - .2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.
  - .3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.
  - .4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:
    - .1 Modify portion of graphic picture/schematic background.
    - .2 Delete graphic picture.
    - .3 Call up and cancel display of graphic picture.
    - .4 Define symbols.
    - .5 Position and size symbols.
    - .6 Define background screens.
    - .7 Define connecting lines, curves.
    - .8 Locate, orient, size descriptive text.
    - .9 Define, display colours of elements.
    - .10 Establish co-relation between symbols or text and associated system points or other graphic displays.
  - .5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.
  - .6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

- .7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.
- .8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Departmental Representative. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and , flow sensor. Diagram to be single line schematic of ductwork as well as associated heating coil or radiation valve. Departmental Representative to provide CAD floor layouts. Provide display of TCU -VAV's in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.
- .9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.
- .10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English language.
- .13 Event/Alarm Module : displays in window alarms as received and stored in General Event Log.
  - .1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.
  - .2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.
  - .3 Alarm reports.
    - .1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.
    - .2 Analog alarm limit summary: include point name, alarm limits, deviation limits.
    - .3 Summary of alarm messages: include associated point name, alarm description.
  - .4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.
  - .5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:
    - .1 Critical - 5 seconds.
    - .2 Cautionary - 10 seconds.
    - .3 Maintenance - 10seconds.
  - .6 Display alarm messages in English.

- .7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.
- .8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.
- .9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
  - .1 Controller not responding - where possible delineate between controller and communication line failure.
  - .2 Controller responding - return to normal.
  - .3 Controller communications bad - high error rate or loss of communication.
  - .4 Controller communications normal - return to normal.
- .10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.
- .14 Archiving and Restoration Module.
  - .1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.
  - .2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.
  - .3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.
- .15 CDL Generator and Modifier Module.
  - .1 CDL Generator module to permit generation and modification of CDLs.
  - .2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
  - .3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of



CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.

- .4 Module to permit testing of code before downloading to building controllers.

## **2.2 ADDITIONAL UTILITY SOFTWARE**

- .1 Supply and install on primary OWS, following CAD software products by Autodesk Inc. and include:

- .1 AutoCAD LT latest version.
- .2 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.
- .3 Enter soft copy submissions, including "Record" drawings specified in Section 25 05 03 - EMCS: Project Record Documents in OWS.
- .4 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Departmental Representative.

## **Part 3 Execution**

### **3.1 INSTALLATION REQUIREMENTS**

- .1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment.
  - .1 Install tamper locks on breakers of circuit panels.
  - .2 Provide all necessary software, graphics and programming to the OWS systems of ISS building and Boiler Plant.
  - .3 Refer to UPS requirements stated under OWS Hardware in PART 2.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for building automation controllers including:
    - .1 Master Control Unit (MCU).
    - .2 Local Control Unit (LCU).
    - .3 Equipment Control Unit (ECU).
    - .4 Terminal Control Unit (TCU).
  - .2 Related Sections:
    - .1 Section 25 05 01 - EMCS: General Requirements.
    - .2 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
    - .3 Section 25 05 03 - EMCS: Project Record Documents.
    - .4 Section 25 30 02 - EMCS: Field Control Devices.
    - .5 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE 2003, Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA International).
  - .1 C22.2 No.205-M1983(R1999), Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
  - .1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

**1.3 DEFINITIONS**

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

**1.4 SYSTEM DESCRIPTION**

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided for the proposed System Architecture to support building systems and associated sequence(s) of operations as detailed in these specifications.
  - .1 Provide sufficient controllers to meet intents and requirements of this section.
  - .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.

- .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
- .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
- .3 Capable of interfacing with operator interface device.
- .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
  - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
- .3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.
  - .1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.
  - .2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

## **1.5 DESIGN REQUIREMENTS**

- .1 To include:
  - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
  - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
  - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
  - .4 Control of systems as described in sequence of operations.
  - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
  - .1 To: CSA C22.2 No.205.
  - .2 Electronically interface sensors and control devices to processor unit.
  - .3 Include, but not be limited to, following:
    - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
    - .2 Power supplies for operation of logics devices and associated field equipment.
    - .3 Lockable wall cabinet.
    - .4 Required communications equipment and wiring (if remote units).
    - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
    - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

- .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
- .4 AI interface equipment to:
  - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
  - .2 Provide for following input signal types and ranges:
    - .1 4 - 20 mA;
    - .2 0 - 10 V DC;
    - .3 100/1000 ohm RTD input;
  - .3 Meet IEEE C37.90.1 surge withstand capability.
  - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
  - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 4 - 20 mA.
    - .2 0 - 10 V DC.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
  - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
  - .2 Meet IEEE C37.90.1 surge withstand capability.
  - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
  - .2 Switch up to 5 amps at 220 V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
  - .1 Provide for conduit entrance from top, bottom or sides of panel.
  - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
  - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

## **1.6 SUBMITTALS**

- .1 Make submittals in accordance with Section 01 01 50 – General Instructions and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  - .1 Submit product data sheets for each product item proposed for this project.

## **1.7 MAINTENANCE PROCEDURES**

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

## **Part 2 Products**

### **2.1 MASTER CONTROL UNIT (MCU)**

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
  - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
  - .1 MCU I/O points as allocated in I/O Summary Table.
  - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
  - .1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
  - .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
  - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
    - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
  - .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

- .5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.
  - .1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.
  - .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
  - .3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.
  - .4 Functions to include, but not be limited to, following:
    - .1 Start and stop points.
    - .2 Modify setpoints.
    - .3 Modify PID loop parameters.
    - .4 Override PID control.
    - .5 Change time/date.
    - .6 Add/modify/start/stop weekly scheduling.
    - .7 Add/modify setpoint weekly scheduling.
    - .8 Enter temporary override schedules.
    - .9 Define holiday schedules.
    - .10 View analog limits.
    - .11 Enter/modify analog warning limits.
    - .12 Enter/modify analog alarm limits.
    - .13 Enter/modify analog differentials.
  - .5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.
  - .6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.
  - .7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
  - .8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

## **2.2 LOCAL CONTROL UNIT (LCU)**

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.

- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
  - .1 Include minimum 2 interface ports for connection of local computer terminal.
  - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
  - .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
  - .4 Include power supplies for operation of LCU and associated field equipment.
  - .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
  - .6 Provide conveniently located screw type or spade lug terminals for field wiring.

### **2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)**

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
  - .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

### **2.4 SOFTWARE**

- .1 General.
  - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
  - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
  - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.
  - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
  - .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
  - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
  - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.

- .4 Operator Terminal interface.
  - .1 Operating and control functions include:
    - .1 Multi-level password access protection to allow user/manager to limit workstation control.
    - .2 Alarm management: processing and messages.
    - .3 Operator commands.
    - .4 Reports.
    - .5 Displays.
    - .6 Point identification.
- .5 Pseudo or calculated points.
  - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
  - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .6 Control Description Logic (CDL):
  - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
  - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
  - .3 Perform changes to CDL on-line.
  - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
  - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
  - .6 MCU to be able to perform following pre-tested control algorithms:
    - .1 Two position control.
    - .2 Proportional Integral and Derivative (PID) control.
  - .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
  - .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
  - .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches,



MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

- .7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.
- .8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
  - .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
    - .1 Time of day scheduling.
    - .2 Calendar based scheduling.
    - .3 Holiday scheduling.
    - .4 Temporary schedule overrides.
    - .5 Optimal start stop.
    - .6 Night setback control.
    - .7 Enthalpy (economizer) switchover.
    - .8 Peak demand limiting.
    - .9 Temperature compensated load rolling.
    - .10 Fan speed/flow rate control.
    - .11 Cold deck reset.
    - .12 Hot deck reset.
    - .13 Night purge.
  - .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
  - .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
  - .1 MCUs to accumulate and store automatically run-time for binary input and output points.
  - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
  - .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
  - .4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.
  - .5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWh, litres, tonnes, etc.).

- .6 Store event totalization records with minimum of 9,999,999 events before reset.
- .7 User to be able to define warning limit and generate user-specified messages when limit reached.

## **2.5 LEVELS OF ADDRESS**

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
  - .1 Display analog values digitally to 1 place of decimals with negative sign as required.
  - .2 Update displayed analog values and status when new values received.
  - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
  - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

## **2.6 POINT NAME SUPPORT**

- .1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

## **Part 3 Execution**

### **3.1 LOCATION**

- .1 Location of Controllers to be approved by Departmental Representative

### **3.2 INSTALLATION**

- .1 Install Controllers in secure locking enclosures as indicated or as directed by Departmental Representative.
- .2 Provide new controllers to all mechanical equipment of this project, and the new controllers shall be fully compatible and integrated to existing EMCS system on site.
- .3 Provide necessary power from local 120V branch circuit panel for equipment.
- .4 Install tamper locks on breakers of circuit breaker panel.
- .5 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

**END OF SECTION**

**Part 1            General**

**1.1            SUMMARY**

.1            Section Includes:

.1            Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, and low voltage current transformers.

.2            Related Sections:

- .1            Section 07 84 00 - Firestopping.
- .2            Section 23 33 15 - Dampers - Operating.
- .3            Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
- .4            Section 25 05 01 - EMCS: General Requirements.
- .5            Section 25 05 02 - EMCS: Submittals and Review Process.
- .6            Section 25 05 54 - EMCS: Identification.
- .7            Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
- .8            Section 26 05 01 - Common Work Results - Electrical.
- .9            Section 26 27 10 - Modular Wiring System.
- .10          Section 26 27 26 - Wiring Devices.

**1.2            REFERENCES**

.1            American National Standards Institute (ANSI).

- .1            ANSI C12.7-1993(R1999), Requirements for Watthour Meter Sockets.
- .2            ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.

.2            American Society for Testing and Materials International, (ASTM).

- .1            ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.

.3            National Electrical Manufacturer's Association (NEMA).

- .1            NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4            Air Movement and Control Association, Inc. (AMCA).

- .1            AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.

.5            Canadian Standards Association (CSA International).

- .1            CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

**1.3            DEFINITIONS**

- .1            Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

## **1.4 SUBMITTALS**

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Pre-Installation Tests.
  - .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .3 Manufacturer's Instructions:
  - .1 Submit manufacturer's installation instructions for specified equipment and devices.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant, assembly.
- .3 Operating conditions: 0 - 32 degrees C with 10 - 90% RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.
- .9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

### **2.2 TEMPERATURE SENSORS**

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
  - .1 Thermocouples: limit to temperature range of 200 degrees C and over.
  - .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
  - .3 Sensing element: hermetically sealed.

- .4 Stem and tip construction: copper or type 304 stainless steel.
- .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
- .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 or 150 mm as required.
- .2 Room temperature sensors and display wall modules.
  - .1 Temperature sensing and display wall module.
    - .1 LCD display to show space temperature and temperature setpoint.
    - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
    - .3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit for access to zone bus.
    - .4 Integral thermistor sensing element 10,000 ohm at 24 degrees.
    - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
    - .6 Stability 0.02 degrees C drift per year.
    - .7 Separate mounting base for ease of installation.
  - .2 Room temperature sensors.
    - .1 Wall mounting, in slotted type covers having brushed stainless steel finish, with guard.
    - .2 Element 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
- .3 Duct temperature sensors:
  - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.
  - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.
- .4 Outdoor air temperature sensors:
  - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

## **2.3 TEMPERATURE TRANSMITTERS**

- .1 Requirements:
  - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
  - .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.
  - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
  - .4 Input and output short circuit and open circuit protection.

- .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
- .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
- .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.
- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees C.
- .10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.
- .11 Transmitter ranges: select narrowest range to suit application from following:
  - .1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
  - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
  - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
  - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
  - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

## **2.4 GAS METER FLOW INTERFACE**

- .1 Communications:
  - .1 Collect pulse data from up to two inputs and store data as a function of time.
  - .2 Data can be retrieved through RS-232 protocols.

## **2.5 STATIC PRESSURE SENSORS**

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

## **2.6 STATIC PRESSURE TRANSMITTERS**

- .1 Requirements:
  - .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
  - .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
  - .3 Accuracy: 0.4 % of span.
  - .4 Repeatability: within 0.5 % of output.
  - .5 Linearity: within 1.5 % of span.
  - .6 Deadband or hysteresis: 0.1% of span.
  - .7 External exposed zero and span adjustment.
  - .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

## **2.7 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES**

- .1 Requirements:

- .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
- .2 Adjustable setpoint and differential.
- .3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC
- .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
- .5 Accuracy: within 2% repetitive switching.
- .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
- .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

## **2.8 TEMPERATURE SWITCHES**

- .1 Requirements:
  - .1 Operate automatically. Reset automatically, except as follows:
    - .1 Low temperature detection: manual reset.
    - .2 High temperature detection: manual reset.
  - .2 Adjustable setpoint and differential.
  - .3 Accuracy: plus or minus 1 degrees C.
  - .4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
  - .5 Type as follows:
    - .1 Room: for wall mounting on standard electrical box with protective guard as indicated.
    - .2 Duct, general purpose: insertion length = 460 mm.
    - .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
    - .4 Low temperature detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
    - .5 Strap-on: with helical screw stainless steel clamp.

## **2.9 CURRENT / PNEUMATIC (I/P) TRANSDUCERS**

- .1 Requirements:
  - .1 Input range: 4 to 20 mA.
  - .2 Output range: proportional 20-104 kPa or 20-186 kPa as applicable.
  - .3 Housing: dustproof or panel mounted.
  - .4 Internal materials: suitable for continuous contact with industrial standard instrument air.
  - .5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2 % of full scale over entire range.
  - .6 Integral zero and span adjustment.
  - .7 Temperature effect: plus or minus 2.0 % of full scale/ 50 degrees C or less.
  - .8 Regulated supply pressure: 206 kPa maximum.
  - .9 Air consumption: 16.5 ml/s maximum.

- .10 Integral gauge manifold c/w gauge (0-206 kPa).

## **2.10 SOLENOID CONTROL AIR VALVES**

- .1 Coil: 120V AC or 24V DC, as indicated.
- .2 Capacity: to pass a minimum of 0.15 l/s air at 140 kPa differential.

## **2.11 AIR PRESSURE GAUGES**

- .1 Diameter: 38 mm minimum.
- .2 Range: zero to two times operating pressure of measured pressure media or nearest standard range.

## **2.12 ELECTROMECHANICAL RELAYS**

- .1 Requirements:
  - .1 Double voltage, DPDT, plug-in type with termination base.
  - .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
  - .3 Contacts: rated at 5 amps at 120 V AC.
  - .4 Relay to have visual status indication

## **2.13 SOLID STATE RELAYS**

- .1 General:
  - .1 Relays to be socket or rail mounted.
  - .2 Relays to have LED Indicator
  - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
  - .4 Operating temperature range to be -20 degrees C to 70 degrees C.
  - .5 Relays to be CSA Certified.
  - .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
  - .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
  - .1 Control voltage, 3 to 32 VDC.
  - .2 Drop out voltage, 1.2 VDC.
  - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output:
  - .1 AC or DC Output Model to suit application.

## **2.14 CURRENT TRANSDUCERS**

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:



- .1 4-20 mA DC.
- .2 0-1 volt DC.
- .3 0-10 volts DC.
- .4 0-20 volts DC.
- .3 Frequency insensitive from 10 - 80 hz.
- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

## **2.15 CURRENT SENSING RELAYS**

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

## **2.16 CONTROL DAMPERS**

- .1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 mm high. Three or more sections to be operated by jack shafts.
- .2 Materials:
  - .1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
  - .2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
  - .3 Bearings: maintenance free, synthetic type of material.
  - .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
  - .5 Seals: synthetic type, mechanically locked into blade edges.
    - .1 Frame seals: synthetic type, mechanically locked into frame sides.
- .3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
  - .1 Size/Capacity: refer to damper schedule
  - .2 25 L/s/m<sup>2</sup> maximum allowable leakage against 1000 Pa static pressure for outdoor air and exhaust air applications.
  - .3 Temperature range: minus 40 degrees C to plus 100 degrees C.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 Jack shafts:

- .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
- .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
- .3 Install using manufacturers installation guidelines.
- .4 Use same manufacturer as damper sections.

## **2.17 PNEUMATIC CONTROL DAMPER ACTUATORS**

.1 Requirements:

- .1 Piston type with spring return for "fail-safe" in Normally Open or Normally Closed position, as indicated.
- .2 Operator: size to control dampers against maximum pressure and dynamic opening/closing pressure, whichever is greater.
- .3 Adjustable spring and stroke external stops to limit strokes in either direction.
- .4 For modulating applications provide with full relay type positioner with interconnecting linkage for mechanical feedback. Adjust to operate between range of 20-90 kPa unless otherwise indicated in control sequence of operation or input/output summary sheet.
- .5 Positioners not required on single damper sections with less than 1 m<sup>2</sup> face area.

## **2.18 ELECTRONIC CONTROL DAMPER ACTUATORS**

.1 Requirements:

- .1 Direct mount proportional type as indicated.
- .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
- .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
- .4 Power requirements: 5 VA maximum at 24 V AC.
- .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
- .6 For VAV box applications floating control type actuators may be used.
- .7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

## **2.19 PANELS**

- .1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.

- .3 Panels to be lockable with same key.

## **2.20 WIRING**

- .1 In accordance with Section 26 27 10 - Modular Wiring System, 26 27 26 - Wiring Devices.
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
  - .1 Field wiring to digital device: #18AWG.
  - .2 Analog input and output: shielded #18 minimum solid copper.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.
- .6 Electrical:
  - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results - Electrical.
  - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
  - .3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
  - .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  - .5 Install communication wiring in conduit.
    - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

- .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
- .3 Maximum conduit fill not to exceed 40%.
- .4 Design drawings do not show conduit layout.
- .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.
- .7 Mechanical: supply and install in accordance with Section 23 09 43 - Pneumatic Control System for HVAC.
  - .1 Air flow stations, dampers, and other devices.

### **3.2 TEMPERATURE AND HUMIDITY SENSORS**

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

### **3.3 PANELS**

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

**3.4 MAGNEHELIC PRESSURE INDICATORS**

- .1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by Departmental Representative.
- .2 Locations: as indicated.

**3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS**

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
  - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

**3.6 I/P TRANSDUCERS**

- .1 Install air pressure gauge on outlet.

**3.7 AIR PRESSURE GAUGES**

- .1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.
- .2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

**3.8 IDENTIFICATION**

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

**3.9 TESTING AND COMMISSIONING**

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .2 In the sequence of operation of each unique process where reference is made to dead bands, set points, delays, interlocks, timers, etc. these values shall be unique to each process and shall be individually and readily adjustable or changeable by the operator. The value of the various parameters shall be as determined by the control contractor to provide a smooth operating system on start-up, shutdown and continuous operation.
- .3 For each air or water system that has on/off control from the SCU or ASC, provide one system start/stop point, with subsequent interlocks to associated equipment performed automatically with the necessary delays, etc. Where the program is restarting systems after a power failure or on time programming, there shall be delays automatically inserted in the system start/stop routines to minimize the electrical demand and surges on the system.
- .4 Where the BAS is commanding a motor on and the motor fails to start or stops operating, an alarm shall be initiated in the BAS. Provide the necessary delays on start-up to eliminate the alarm.
- .5 Where the BAS has commanded a motor off and the motor fails to stop, an alarm shall be initiated in the BAS. Provide the necessary delays on stopping to eliminate the alarm.
- .6 Consult with the Department Representatives during the shop drawing stage to finalize the control sequences for each system. The set points, sequences, etc. shall be reviewed by the Departmental Representatives and shall be modified by the control contractor, as required, at no cost to the Department Representatives to meet the overall intent of the plans and specifications.
- .7 Provide all the control points as required to meet the control sequences as described in this section.
- .8 The EMCS/BAS system of this building shall be Ethernet connected to the BAS system in the existing building A of the FVI site and the Central Boiler Plant. It allows the Boiler Plant to remotely control and monitor the mechanical system operation of this building.

**Part 2 Products****2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution****3.1 General**

- .1 Provide data base for all hardware and software points listed with supply, installation, programming, testing and commissioning for system operation to meet specification operating sequences.
- .2 Provide Ethernet connection of the BAS system of this building to BAS network system in the existing Building A on the FVI site and the existing Central Boiler Plant. It allows the Central Boiler Plant to remotely control and monitor the mechanical system operation of this building.

**3.2 Sequencing of Operations**

- .1 Hot Water Heating Systems- Boilers B-1, B-2, Pumps P-1 to 4
  - .1 The heating system consists of three boilers B-1 and B-2 with their own primary loop circulating pumps P-1 and P-2, two secondary loop system pumps P-3 and P-4 (VFD controls) each sized for 100% system load.
  - .2 The boilers shall be staged by the BAS to maintain a temperature in the common boiler header relative to the load in the system and providing a minimum return water temperature to the boilers. When the return water temperature in the primary loop to the boilers is below the required setting, the second boiler shall be brought on line and the boilers operated in parallel. When the load on the boilers has decreased i.e. the boilers are at minimum load for an adjustable period of time, the second boiler shall be deselected. Provide the required delays to prevent short cycling and provide the required delays between the selection of boilers.
  - .3 When a boiler is brought on line, the boiler circulation pump shall operate continuously; when the boiler is deselected the pump shall continue to operate for an adjustable period of time.
  - .4 The secondary loop system pumps P-3 and P-4 shall be set up on a lead lag basis with one pump operating at all times. The lag pump shall operate on a standby basis as well and shall come on and remain operating on failure of the operating pump. The system must be manually reset by the operator. The system pumps are controlled by VFDs to maintain the heating water set pressure.
  - .5 The supply water to the system shall be reset from outside air temperature.
  - .6 The stand-by boiler shall rotate every two weeks (adjustable).
- .2 Heat Recovery Ventilator systems – HRV-1, 2, 3 and 4
  - .1 General
    - .1 The heat recovery ventilator is a package unit with supply fans, return fan/exhaust fans, heat recovery heat exchanger section, air filters and complete with motorized fresh, return air and exhaust air dampers. The unit shall come complete with the necessary temperature, operating and safety controls as well as the necessary cooling operating and safety controls. A low temperature thermostat shall be part of the unit.
  - .2 System Start/Stop
    - .1 The HRV unit will normally be energized via the BAS, according to a time program. During the occupied period the unit shall run continuously

and during the unoccupied time the unit shall remain off or operate as directed by the Departmental Representatives.

- .2 The unit shall be interlocked with the associated air handling unit or furnace and motorized dampers in operation.
- .3 Low Temperature thermostats and defrost cycle
  - .1 Upon sensing a low temperature, the supply fan shall stop, and outdoor air dampers shall close. The low temperature thermostat must be reset manually.
  - .2 Supply air and exhaust air temperature sensors are used to control and monitor the operation temperatures.
  - .3 BAS is used to control the defrost cycle of the heat recovery system.
- .4 CO2 Sensing
  - .1 A CO2 sensor in the return air shall provide the signal to monitor the air quality.
- .3 Heat/Cool Air Handling Systems – AHU-1 and 2
  - .1 General
    - .1 The air handling unit is a custom package unit with supply fans, heating water modulating heating coil section, DX cooling coils (for AHU-2), air filters and complete with 100% free-cooling economizer motorized fresh, return air and exhaust air dampers. The unit shall come complete with the necessary temperature, operating and safety controls as well as the necessary cooling operating and safety controls. A low temperature thermostat shall be part of the unit.
  - .2 System Start/Stop
    - .1 The air-handling unit will normally be energized via the BAS, according to a time program. During the occupied period the unit shall run continuously and during the unoccupied time the unit shall remain off or operate in reduced speed and flow as directed by the Department Representatives.
    - .2 The minimum outside air shall be nominally 50% (adjustable). Interlocking the associated HRV and motorized dampers to balance the outdoor air intake and exhaust air to the building.
  - .3 Static and Volume Control
    - .1 The supply fan VFDs shall be controlled from the BAS to maintain the static pressure in the supply ductwork.
    - .2 The return fan VFDs shall be controlled from the BAS to maintain a constant flow volume between the supply and return air fans.
    - .3 Provide high limit safeties in the supply duct and the suction of the supply fan.
  - .4 Low Temperature thermostats
    - .1 Upon sensing a low temperature, the supply fan shall stop, the outdoor air dampers shall close. The low temperature thermostat must be reset manually.
  - .5 Heating Mode



- .1 When the outdoor air temperature is below 10 deg. C (adjustable), the heating shall be enabled.
  - .2 Supply air temperature set points shall be scheduled by the outdoor air temperatures; and reset by the room temperature demand.
  - .3 BAS is used to modulate the gas-fired heating section to maintain the set supply air temperature.
  - .4 When the AHU is shutdown in unoccupied hours, the BAS shall control the associated radiant panels and heaters to maintain the set temperatures.
- .6 Cooling Mode
  - .1 When the outdoor air temperature is above 13 deg. C (adjustable), the cooling shall be enabled.
  - .2 Supply air temperature set points shall be scheduled by the outdoor air temperatures; and reset by the room temperature demand.
  - .3 For AHU-2, BAS is used to control the DX cooling coils and to stage the condensing unit CU-2 to maintain the set supply air temperature.
  - .4 For AHU-1, BAS is used to modulate the free cooling economizer damper section to flush the occupied areas.
- .7 VAV Reheat Coils or Radiant Panel Heating Control
  - .1 BAS thermostats are used to modulate/cycle the associated electric reheat coils or electric baseboard heaters to maintain the space set temperatures.
  - .2 Space temperatures shall provide feed back to the BAS system to reset the supply air temperature.
- .8 CO2 Sensing
  - .1 A CO2 sensor in the return air shall provide the signal to monitor the air quality, and to modulate the amount of outdoor air intake.
- .9 Smudging Ventilation Control
  - .1 BAS is used to control the exhaust fan EF-1 and the associated exhaust air dampers and the VAV box damper operation.
  - .2 The return air damper of the room shall be closed.
  - .3 The associated AHU-1 shall provide make-up air to the building and balance the building pressure.
- .4 VAV Box and Radiant Panel Control
  - .1 A room sensor (each sensor with temperature display and temperature set point adjustment) shall provide the signal to the VAV controller to vary the air volume and the heating valve in sequence to maintain temperature.
  - .2 In the heating mode, where there is a reheat coil and/or a radiant heating panel, the heating control valve shall be modulated and sequenced with the air volume to bring on the heating at the minimum air flow, and operate the reheat coil valve and radiant panel valve in sequence.
  - .3 In the cooling mode, when the space temperature increases, the VAV air flow shall be gradually increased to provide cooling to maintain the space set temperature.
  - .4 After office hours, the Air Handling Unit shall be off or shall be at the minimum flow as directed by the Departmental Representatives and staff, the VAV boxes shall be used to maintain a minimum set temperature.

- .5 A pushbutton in the room sensor of room # 249 (Administration Area) shall allow for after hours operation of the Air Handling Unit, and HRV or Furnaces for a predetermined time period, if not operating, with the space temperature at the occupied setting. If the time extends into the normal occupied time the space set points throughout shall revert to the occupied settings.
- .6 For each space sensor provide an occupied setting when the Air Handling Unit is on and an unoccupied setting when the unit is off.
- .7 Provide separate single software commands to index the VAV boxes as follows to assist in the commissioning and balancing of the systems;
  - .1 All VAV boxes are indexed to their maximum volumes
  - .2 All VAV boxes are indexed to their minimum volumes
  - .3 All reheat coil/radiant heating panel valves are closed
  - .4 All reheat coil/radiant heating panel valves are fully open
  - .5 VAV box supply air temperature.
- .5 Gas-fired Furnace Systems – FU-1 and 2
  - .1 General
    - .1 The furnace unit is a custom package unit with supply fans, gas-fired modulating heating section, air filters and complete with motorized fresh, return air and exhaust air dampers. The unit shall come complete with the necessary temperature, operating and safety controls as well as the necessary cooling operating and safety controls. A low temperature thermostat shall be part of the unit.
  - .2 System Start/Stop
    - .1 The furnace unit will normally be energized via the BAS, according to a time program. During the occupied period the unit shall run continuously and during the unoccupied time the unit shall remain off or operate in reduced speed and flow as directed by the Department Representatives.
    - .2 The minimum outside air shall be nominally 50% (adjustable). Interlocking the associated HRV and motorized dampers to balance the outdoor air intake and exhaust air to the building.
  - .3 Low Temperature thermostats
    - .1 Upon sensing a low temperature, the supply fan shall stop, the outdoor air dampers shall close. The low temperature thermostat must be reset manually.
  - .4 Heating Mode
    - .1 When the outdoor air temperature is below 10 deg. C (adjustable), the heating shall be enabled.
    - .2 Supply air temperature set points shall be scheduled by the outdoor air temperatures; and reset by the room temperature demand.
    - .3 BAS is used to modulate the gas-fired heating section to maintain the set supply air temperature.
    - .4 Space temperature sensors (4 per floors) are used to reset the supply air temperatures.
  - .5 Cooling Mode

- .1 When the outdoor air temperature is above 13 deg. C (adjustable), the cooling shall be enabled.
  - .2 Supply air temperature set points shall be scheduled by the outdoor air temperatures; and reset by the room temperature demand.
  - .3 BAS is used to modulate the 100% free-cooling economizer outdoor air, return and exhaust air dampers to flush the building with outdoor air and to maintain the set supply air temperatures.
- .6 Kitchen Exhaust Ventilation Control
  - .1 Kitchen exhaust hood shall be operated by manual switches on the hood to control the fan speeds.
  - .2 BAS is used to monitor the associated kitchen exhaust hood operation and speeds.
  - .3 The associated furnace and HRV and damper sections shall be interlocked to provide proper make-up air to the building and balance the building pressure.
- .7 Electric Reheat Coils or Baseboard heaters Control
  - .1 BAS thermostats are used to modulate/cycle the associated electric reheat coils or electric baseboard heaters to maintain the space set temperatures.
  - .2 Space temperatures shall provide feed back to the BAS system to reset the supply air temperature.
- .8 CO2 Sensing
  - .1 A CO2 sensor in the return air shall provide the signal to monitor the air quality, and to modulate the amount of outdoor air intake.
- .6 Domestic Hot Water
  - .1 The system shall consist of gas-fired heaters DHWT-1 and 2 complete with all operating and safety controls. The system supply temperature shall be monitored and shall be alarmed on high or low temperature.
  - .2 The recirculation pump shall be controlled through time programming.
- .7 Exhaust Fans
  - .1 All the exhaust fans shall be connected to the BAS system and shall operate as follows:
    - .1 Interlocked with an Air Handling units and Make up Air unit.
    - .2 Cycled based on a room temperature setting from the BAS
    - .3 Operated on time programming schedule.
- .8 Communication, Electrical, Elevator Machine Rooms
  - .1 Where there is an exhaust or transfer fan provided, the room sensor through the BAS shall cycle the fan, motorized O/A and E/A dampers to maintain the room temperature.
  - .2 Where there is a DX split fan coil unit provided, the room sensor through the BAS shall cycle the fan and modulate the DX cooling system to maintain the room temperature. A high temperature alarm shall be activated when the room temperature is above the high point set temperature.

- .3 IT/Communication Rooms, room sensors shall indicate the room temperature and humidity and initiate an alarm on a high or low temperature or humidity. An alarm and run status contact shall be connected to each of the units.
- .9 Building Energy Metering
  - .1 Provide a paddle wheel sensor on the building incoming domestic cold water line (installed by mechanical) to allow the BAS to monitor domestic water flow.
  - .2 Provide gas metering to monitor the natural gas consumption. See Section 23 11 23 for coordination.
- .10 Force Flow Heater Units and Unit Heaters
  - .1 BAS shall cycle the fan and the hot water heating valve (or electrical heater for electric unit heaters) of the associated unit to maintain the room set temperature and ventilation.
- .11 Fire Alarm System and Sprinkler System
  - .1 The Fire Alarm system shall be monitored by the BAS to indicate a separate Trouble and Alarm condition in the Fire Alarm system.
  - .2 Provide status of the fire jockey pump.
  - .3 Provide trouble alarm to monitor the sprinkler system.
- .12 Mechanical Room Ventilation System
  - .1 A hot water unit heater is controlled by the BAS to maintain the room set temperature.
  - .2 A supply air fan is controlled by the BAS to ventilate the room in the summer time when the room temperature is above the set point. BAS is used to open the motorized relief air damper to open when the supply fan is activated.
- .13 Hot Water Radiations
  - .1 Hot water radiation valve is controlled by the BAS to maintain the room set temperature.

**END OF SECTION**

1.0 GENERAL

1.1 GENERAL

- .1 A point is a specific software address which is resident in the MCU and which is identified with a particular field sensor, instrument or sensor.
- .2 The point schedule contains a general list and description of the points to be connected. The Contractor shall examine the point schedule and ensure that all points required to make the described control sequences work are provided whether included in the point schedule or not.
- .3 The relationships between the points, systems and building are described in the control sequences, Section 25 90 01 – EMCS: Site Requirements, Application and Systems Sequence of Operation.
- .4 Consult with the Departmental Representative during the shop drawing stage to finalize the physical terminal address of each point within the MCU.

2.0 PRODUCTS

2.1 NOT APPLICABLE

3.0 EXECUTION

- .1 Refer to the attached Point List legend.
- .2 Refer to the attached Point Lists/Schedules

### POINT LIST LEGEND

DO	Digital Output
DI	Digital Input
AO	Analog Output (0-10 VDC)
AI	Analog Input

### ANALOG INPUT SENSORS

#### .1 Temperature

<u>Application</u>	<u>Type</u>
Duct Mounted	Tp
Pipe Well Mounted	Tw
Averaging	Ta
Space Temp.	Tr
Outside Air	To
Surface Temp	Ts

#### .2 Relative Humidity

<u>Application</u>	<u>Type</u>
Duct mounted	Hp
Space	Hr
Outside air	Ho

#### .3 Pressure

<u>Application</u>	<u>Type</u>
Static-water	Ps
Static-air	Sp
Instrument	Ia
Velocity pressure monitoring station(air)	Vp
Velocity pressure monitoring station (water,	Pv

steam)

Velocity	Vpi
Pressure - Fan	
Inlet Air Flow	
Traverse	
Probes	

.4 Electrical

<u>Application</u>	<u>Type</u>
Watt meters	kW
Current transformers	Ct

#### ANALOG OUTPUT DEVICES

<u>Application</u>	<u>Type</u>
To damper motors	De
To valve actuators	Ve

#### DIGITAL INPUT DEVICES

<u>Application</u>	<u>Type</u>
Pressure Switches	Pd
Temperature	Td
Current Sensing Relays	Ri
Motor status Relays	St
Level	Ls
Motion	Md

#### DIGITAL OUTPUT DEVICES

<u>Application</u>	<u>Type</u>
Relays	Ry

**Heating System – B-1 to 2; P-1 to**

System: **4**

Rev: **1**

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
<b>Boiler B-1</b> Supply Water Temp Supply Water Reset Boiler Alarm Pump P-1 Status Pump P-1 Control	Tw	TT							
	Cr	ZT				X		XX	
	Rc	BA		X					
	Ri	XS		X					
	Ry	JZ	X			X			
<b>Boiler B-2</b> Supply Water Temp Supply Water Reset Boiler Alarm Pump P-2 Status Pump P-2 Control	Tw	TT							
	Cr	ZT				X		XX	
	Rc	BA		X					
	Ri	XS		X					
	Ry	JZ	X			X			
<b>System</b> Boiler Comm Supply Temperature Boiler Comm Return Temperature Supply Supply Temperature Supply Return Temperature System Pressure System Differential Pressure	Tw	TT					X	XX	
	Tw	TT					X	XX	
	Tw	TT					X	XX	
	Tw	TT					X	XX	
	Ps	PT					X	XX	
	Ps	PDT					X	XX	
<b>Secondary Loop Pump P-3 and P-4</b> Status Start/Stop Speed Control									2 Pumps
	Rc	XS		X					
	Ry	JZ	X				X	XX	
	VFD	SC				X			

\* Refer to Spec Section 259002 For Point Type Specifications



**Heat Recovery Ventilator System -**  
**HRV-1, 2, 3 and 4**

System:

Rev: 1

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan Status Start/Stop Speed Control	Rc	XS		X					
	Ry	JZ	X						
	VFD	SC				X			
Return Fan Status Start/Stop Speed Control	Rc	XS		X			X	XX	
	Ry	JZ	X						
	VFD	SC				X			
System O/A Damper Control E/A Damper Control Return Air Temperature Supply Air Temperature Heat Recovery Coil Control HRV Discharge Temp Low Temperature Htg Setpoint Reset Filter pressure different CO2 sensor	De	FV				X			
	De	FV				X			
	Tp	TT					X	XX	
	Tp	TT					X	XX	
	Tp	TT				2X	2X	XX	
	Tp	TT					X	XX	
	Td	TSL		X	X				
	Cr	ZT				X			
				X					
							X	XX	

\* Refer to Spec Section 259002 For Point Type Specifications

Air Handling Unit System / AHU-  
1 (M/F Offices)

System:

Rev: 1

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan	Status	XS		X					
	Start/Stop	JZ	X						
	Speed Control	SC				X			
Return Fan	Status								
	Start/Stop	XS		X					
	Speed Control	JZ	X						
		SC				X			
System									
	O/A Damper Control	FV				X			
	R/A Damper Control	FV				X			
	E/A Damper Control	FV				X			
	Return Air Temperature	TT					X	XX	
	Supply Air Temperature	TT					X	XX	
	Low Temperature	TSL		X	X				
	HWS Temperature	TT					X		
	HWR Temperature	TT					X		
	Htg Setpoint Reset	ZT				X			
	Hot Water Heating valve	Fv				X			
	Heating valve status	Xs					X	XX	
	Prefilter pressure different			X					
Duct Smoke sensor				X					
							X	XX	
							X	XX	

\* Refer to Spec Section 259002 For Point Type Specifications

System: Air Handling Unit System / AHU-2 (2/F Offices)

Rev: 1

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan									
Status	Rc	XS		X					
Start/Stop	VFD	JZ	X						
Speed Control	VFD	SC				X			
Return Fan									
Status	Rc	XS		X					
Start/Stop	VFD	JZ	X						
Speed Control	VFD	SC				X			
System									
O/A Damper Control	De	FV				X			
R/A Damper Control	De	FV				X			
E/A Damper Control	De	FV				X			
Return Air Temperature	Tp	TT					X	XX	
Supply Air Temperature	Tp	TT					X	XX	
HWS Temperature	TW	TT					X		
HWR Temperature	TW	TT					X		
Low Temperature	Td	TSL		X	X				
Htg Setpoint Reset	Cr	ZT				X			
Hot Water Heating valve	Ve	Fv				X			
Heating valve status	Rc	Xs					X	XX	
DX cooling stage 1 (on/off)			X						
Cooling stage 1 status				X	X				
DX cooling stage 2 (on/off)			X						
Cooling stage 2 status				X	X				
Prefilter pressure different				X					
Final filter pressure different				X					
CO2 sensor							X	XX	
Duct Smoke sensor							X	XX	

\* Refer to Spec Section 259002 For Point Type Specifications

System: Furnace System / FU-1 and FU-2

Rev: 1

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan Status Start/Stop	Rc	XS		X					
	Ry	JZ	X						
System O/A Damper Control R/A Damper Control E/A Damper Control Mixed Air Temperature Return Air Temperature Supply Air Temperature Low Temperature Htg Setpoint Reset Gas Heating valve Gas valve status Prefilter pressure different Final filter pressure different CO2 sensor Duct Smoke sensor	De	FV				X			
	De	FV				X			
	De	FV				X			
	Tp	TT					X	XX	
	Tp	TT					X	XX	
	Tp	TT					X	XX	
	Td	TSL		X	X				
	Cr	ZT				X			
	Ve	Fv				X			
	Rc	Xs		X			X	XX	
				X					
				X					
							X	XX	
							X	XX	

\* Refer to Spec Section 259002 For Point Type Specifications

Electrical, Communication, Elevator Machine Rooms,  
Mechanical Room, Boiler Room Ventilation Units

System:

Rev: 1

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL		ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS
Fan and Dampers (5 sets) Space Temp  Fan Control Fan Status Fan on/off  O/A Damper Control E/A Damper Control	Tr	TT					X	XX
	Ri	XS		X		X		
	Ry	JZ	X					
	De	FV				X		
	De	FV				X		
Note 1								

\* Refer to Spec Section 259002 For Point Type Specifications

Note 1: Refer to Equipment Schedule and drawings for number of equipment

POINT DESCRIPTION	System: <u>Miscellaneous</u>		Rev: 1				REMARKS	
	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL		ANALOG			
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS
O/A Temperature								
North #1	To	TT					X	
North #2	To	TT					X	
Exhaust Fan (EF-1 to 5)								
Start Stop	Ry	JZ	X					
Status	Ri	XS		X				
Temperature	Tr	TT					X	
Dampers						X		
Jockey Pump								
Status	Ri	SA		X	X			
Fire Sprinkler Air Compressor								
Low Air Pressure	Pd	PS		X	X			
Air Dryer Alarm	Rc	SA		X	X			
Domestic Hot Water								
Recirc Pump P-5 Status	Ri	XS		X				
Recirc Pump P-5 Start/Stop	Ry	JZ	X					
System Supply Temp	Tw	TT					X	XX
System Return Temp	TW	TT					X	XX
Electrical Measurement and monitoring in Main Elect Rm								
Lighting								
Mechanical equipment							2X	
Kitchen Hoods (A total of 4)							2X	
Run Status	Ri	XS		X				
Alarm	Rc	SA		X	X			
DDC points to monitor and measure the following:								
Gas meter				X				
Water meter				X				
Digital information meter						X		
Fire alarm				X				

Typical for each fan, Note 1

\* Refer to Spec Section 259002 For Point Type Specifications

Note 1: Refer to Equipment Schedule and drawings for number of equipment

System: Terminal Control

Rev: 1

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
VAV Box Reheat Coils (A total of 11)									Typical for each VAV Reheat zone, Note 1
Space Temp. Setpoint	Tr	TZ					X		
Space Temperature	Tr	TT					X	X X	
Air Flow Control	Vp	FT					X	X X	
S/A Temp	Tr	TT					X	X X	
Damper Open	De	FV				X			
Damper Close	De	FV				X		X X	
Reheat Coil Valve	Ve	FV				X			Note 1
Radiant Panels and Radiation Heaters									Typical for each Heater, Note 1
Space Temp. Setpoint	Tr	TZ					X		
Space Temperature	Tr	TT					X	X X	
Heating Valve Control	Ve	Fv				X			
Electric Force Flow Heaters (FFH-1)									Typical for each Heater, Note 1
Space Temp	Tr	TT					X	XX	
Fan Status	Ri	XS		X	X				
Fan on/off	Ry	JZ	X						
Hot Water Unit Heaters (UH-1 and 2, CUH-1 to 3)									Typical for each Heater, Note 1
Space Temp	Tr	TT					X	XX	
Fan Status	Ri	XS		X	X				
Fan on/off	Ry	JZ	X						
Heating valve control	Ve	Fv	X						

\* Refer to Spec Section 259002 For Point Type Specifications  
Note 1: Refer to Equipment Schedule and drawings for number of equipment

**END OF SECTION**