

**Part 1 General**

**1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC equipment and materials, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances.
  - .2 Shop drawings and product data accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Acoustical sound power data, where applicable.
    - .3 Points of operation on performance curves.
    - .4 Manufacturer to certify current model production.
    - .5 Certification of compliance to applicable codes.
  - .3 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

**1.2 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for HVAC equipment and materials for incorporation into manual.
  - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .2 Operation data to include:
    - .1 Control schematics for systems including environmental controls.
    - .2 Description of systems and their controls.
    - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4 Operation instruction for systems and component.
    - .5 Description of actions to be taken in event of equipment failure.
    - .6 Valves schedule and flow diagram.
    - .7 Colour coding chart.
  - .3 Maintenance data to include:

- .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
- .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
  - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
  - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

- .9 Submit copies of as-built drawings for inclusion in final TAB report.

### **1.3 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
  - .1 One set of packing for each pump.
  - .2 One casing joint gasket for each size pump.
  - .3 One glass for each gauge glass.
  - .4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC equipment and materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling of pallets, padding, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 NOT USED**

**Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 PAINTING REPAIRS AND RESTORATION**

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

**3.3 SYSTEM CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

**3.4 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .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 PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .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.

**3.5 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio-visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.

**3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.7 PROTECTION**

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 CSA Group (CSA)
  - .1 CAN/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 Research Council Canada (NRC)
  - .1 National Fire Code of Canada 2015 (NFC).
- .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.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .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.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .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 recycling of padding packaging materials pallets crates in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 MATERIAL**

- .1 Paint: zinc-rich to CAN/CGSB-1.181.

- .1 Primers, Paints and Coating: in accordance with manufacturer's recommendations for surface conditions.

### **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, CAN/CSA B139 and National Fire Code of Canada.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer 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 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 CAN/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 butterfly valves at branch take-offs for isolating purposes except where specified.

.7 Install butterfly valves between weld neck flanges to ensure full compression of liner.

.8 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 in vertical pipes with downward flow and as indicated.
- .2 Install swing check valves in horizontal lines 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 fire stopping.
    - .2 Maintain the fire-resistance rating integrity of the fire separation.
  - .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 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation.
- .2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.
- .3 Insulated pipes: ensure integrity of insulation and vapour barriers.

**3.11 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 00 - Cleaning supplemented as specified in relevant mechanical sections.
- .2 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 48 hours minimum prior to performance of pressure tests.
- .2 Piping: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 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 74 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

## **Part 1           General**

### **1.1           REFERENCE STANDARDS**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
  - .2 ASME B40.200-2008, 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.
- .3 Efficiency Valuation Organization (EVO)
  - .1 International Performance Measurement and Verification Protocol (IPMVP)
    - .1 IPMVP 2007 Version.
- .4 Green Seal Environmental Standards (GS)
  - .1 GS-11-11, Standard for Paints and Coatings.
  - .2 GS-36-11, Standard for Commercial Adhesives.

### **1.2           ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test and Evaluation Reports:
  - .1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

### **1.3           DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store thermometers and pressure gauges indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect thermometers and pressure gauges from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for recycling of pallets, padding, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Design point to be at mid-point of scale or range.

### **2.2 DIRECT READING THERMOMETERS -**

- .1 Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length: to ASME B40.200.

- .1 Resistance to shock and vibration.

### **2.3 THERMOMETER WELLS**

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

### **2.4 PRESSURE GAUGES**

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

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 GENERAL**

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

### **3.3 THERMOMETERS**

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Heating boilers.
- .3 Install wells for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

### **3.4 PRESSURE GAUGES**

- .1 Install in locations as follows:
  - .1 Suction and discharge of pumps.
  - .2 Upstream and downstream of PRV's.
  - .3 Upstream and downstream of control valves.
  - .4 Outlet of boilers.
  - .5 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.

### **3.5 NAMEPLATES**

- .1 Install engraved lamicoid nameplates in accordance with Section 23 05 53 - Identification For HVAC Piping and Equipment, identifying medium.

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.7**

#### **PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by thermometer and gauge installation.

**END OF SECTION**

**Part 1 General****1.1 REFERENCE STANDARDS**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International (ASTM)
  - .1 ASTM A125-1996 (2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 National Research Council Canada (NRC)
  - .1 National Plumbing Code of Canada 2015 (NPC).
- .6 Underwriter's Laboratories of Canada (ULC)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit shop drawings for:
    - .1 Bases, hangers and supports.
    - .2 Connections to equipment and structure.
    - .3 Structural assemblies.
- .4 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturers' Instructions:

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

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .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 recycling of packaging materials pallets, crates, padding, in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 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 ASME B31.1 or MSS SP58.
  - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
  - .4 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.
  - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

### **2.2 GENERAL**

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

### **2.3 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized after manufacture.

- .2 Use hot dipped galvanizing process.
- .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .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 carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL 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, UL listed.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .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 UL listed 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 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, UL listed, 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 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: galvanized.
  - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized , with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

**2.4 RISER CLAMPS**

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

**2.5 INSULATION PROTECTION SHIELDS**

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

**2.6 CONSTANT SUPPORT SPRING HANGERS**

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

**2.7 VARIABLE SUPPORT SPRING HANGERS**

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

**2.8 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings.

**2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

**2.10 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 Concrete: to Structural Engineers specifications.

**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, 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.
- .6 Use approved constant support type hangers where:
  - .1 Vertical movement of pipework is 13 mm or more,
  - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
  - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
  - .2 Variation in supporting effect does not exceed 25 % of total load.

**3.3 HANGER SPACING**

- .1 Plumbing piping: to National Plumbing Code of Canada (NPC).

- .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 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size: NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .7 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 tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

### **3.8 CLEANING**

.1 Clean in accordance with Section 01 74 00 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

## **General**

### **1.1 SUMMARY**

- .1 Section Includes:
  - .1 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including mechanical equipment and services, electrical light fixtures, transformers, MCC's, UPS, diesel generators, standby power, fire protection, communications, equipment and systems, both vibration isolated and statically supported.

### **1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA G40.20/G40.21, 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)

### **1.3 DEFINITIONS**

- .1 SRS: acronym for Seismic Restraint System.

### **1.4 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 Critical infrastructure to remain in operation after event.
- .4 Designed by Professional Engineer specializing in design of SRS and registered in Province of Newfoundland.

### **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Newfoundland.
- .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 33 00 - Submittal Procedures.
    - .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 Contractor will make available 1 copy of systems supplier's installation instructions.
  - .6 Closeout Submittals:
    - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

## **1.6 QUALITY ASSURANCE**

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

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

- .1 Deliver, store and handle materials in accordance with manufacturer's written 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: to NFPA requirements
- .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:
    - .1 Slack cable restraint system.
    - .2 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 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
  - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
    - .1 After delivery and storage of Products.
    - .2 After preparatory work is complete but before installation commences.
    - .3 Twice during the installation, at 25% and 60% completion stages.
    - .4 Upon completion of installation.
  - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
- .2 Inspection and Certification:
  - .1 SRS: inspected and certified by Seismic Engineer upon completion of installation.
  - .2 Provide written report to Departmental Representative with certificate of compliance.
- .3 Commissioning Documentation:
  - .1 Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "as-built" conditions.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - 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                REFERENCE STANDARDS**

- .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.
  - .2        NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Product Data:
- .2    Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3    Product data to include paint colour chips, other products specified in this section.
- .4    Samples:
  - .1        Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2        Samples to include nameplates, labels, tags, lists of proposed legends.

**1.3                QUALITY ASSURANCE**

- .1    Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Health and Safety:
  - .1        Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

**1.4                DELIVERY, STORAGE, AND HANDLING**

- .1    Packing, shipping, handling and unloading:
  - .1        Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2        Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2    Waste Management and Disposal:
  - .1        Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .2        Dispose of unused paint and coating material at official hazardous material collections site approved by Departmental Representative .

- .3 Do not dispose of unused coating and paint material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

## **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 EXISTING IDENTIFICATION SYSTEMS**

- .1 Apply existing identification system to new work.
- .2 Before starting work, obtain written approval of identification system from Departmental Representative.

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

- .1 Identification:
  - .1 Sprinklers: to NFPA 13.
  - .2 Standpipe and hose systems: to NFPA 14.

### **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:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

- .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Boiler feed water	Yellow	BLR. FEED WTR
No. 2 fuel oil suction	Yellow	# 2 FUEL OIL SUCTION
No. 2 fuel oil return	Yellow	# 2 FUEL OIL RETURN

**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 has been completed.

**3.3 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC / 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 74 00 - 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 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 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 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 ACTION AND INFORMATIONAL 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 3 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.
- .2 Do TAB of systems, equipment, components, controls specified Division 23.
- .3 Qualifications: personnel performing TAB qualified to standards of NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of 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).

**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                REFERENCE STANDARDS**

- .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 ASTM 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) Jacketing 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 Safety Data Sheets (SDS).
- .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.

## **1.2 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.

## **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Safety Data Sheets (SDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .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 HEALTH AND SAFETY:**

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 - 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 and Section 01 61 00 - Common Product Requirements.
- .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 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .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 ASTM C547.
  - .2 Maximum "k" factor: to CAN/ULC-S702.

### **2.3 INSULATION SECUREMENT**

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.

- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

## **2.4 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 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 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: white.
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 65 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: 0.5 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.

## **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, flanges and unions at equipment, primary flow measuring elements.
- .2 Design: to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: 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 bands at 300 mm on centre.
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code 1501-H.
- .3 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.

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

Hot Water Heating	up to 59	A-1	25	25	25	25
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- .4 Finishes:
- .1 Exposed indoors: PVC jacket.
  - .2 Exposed in mechanical rooms: PVC jacket.
  - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
  - .4 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
  - .5 Installation: to appropriate TIAC code CRF/1 through CPF/5.

### 3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - 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                REFERENCE STANDARDS**

- .1    ASTM 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        Safety Data Sheets (SDS).

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Product Data:
  - .1        Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2    Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1        Instructions: submit manufacturer's installation instructions.
    - .1            Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.3                QUALITY ASSURANCE**

- .1    Health and Safety:
  - .1        Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

**1.4                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 61 00 - Common Product Requirements.
- .2    Waste Management and Disposal:
  - .1        Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**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 AND STEAM 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. 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 hours 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).

### 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 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 - Testing, Adjusting and Balancing for HVAC.
  - .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, 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 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - 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                REFERENCE STANDARDS**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME-B16.3-2006, Malleable-Iron Threaded Fittings: Classes 150 and 300.
  - .2 ASME-B16.9-2007, Factory-Made Wrought Steel Buttwelding Fittings.
- .2 ASTM International (ASTM)
  - .1 ASTM A47/A47M-99 (2004), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .4 ASTM B75M-99 (2005), Standard Specification for Seamless Copper Tube Metric.
- .3 Canadian Environmental Protection Act (CEPA)
  - .1 CCME PN 1326-2008, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems for Petroleum Products and Allied Petroleum Products.
- .4 CSA Group (CSA)
  - .1 CSA-B139-09, Installation Code for Oil Burning Equipment.
  - .2 CSA-B140.0-03, Oil Burning Equipment: General Requirements.
  - .3 CSA-C282-05, Emergency Electrical Power Supply for Buildings.
- .5 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-11-2008, 2nd Edition, Paints and Coatings.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Safety Data Sheets (SDS).
- .7 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS)
  - .1 MSS-SP-80-08, Bronze Gate, Globe, Angle and Check Valves.
- .8 National Association of Corrosion Engineers (NACE)
  - .1 NACE SP0169-2007, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.
- .9 National Research Council Canada (NRC)
  - .1 National Fire Code of Canada 2015 (NFC).
- .10 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.

- .11 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN/ULC S603.1-03, External Corrosion Protection Systems for Steel Underground Tanks for Flammable and Combustible Liquids.
  - .2 ULC ORD-C107.12-1992, Line Leak Detection Devices for Flammable Liquid Piping.

## **1.2 ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-Installation Meeting:
  - .1 Convene pre-installation meeting one week prior to beginning work of this Section.
    - .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.

## **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Indicate on manufacturer's catalogue literature the following: valves.
    - .2 Provide two copies of WHMIS SDS in accordance with Section 01 35 29 - Health and Safety Requirements.
- .3 Indicate VOC's for adhesive and solvents during application and curing.
- .4 Test Reports:
  - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturers' Instructions: provide manufacturer's installation instructions.

## **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

## **1.5 QUALITY ASSURANCE**

- .1 Ensure piping is installed by individual company authorized by authority having jurisdiction.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .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 recycling of crates, packaging materials padding, pallets, in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 FILL VENT AND CARRIER PIPE**

- .1 Materials as per CSA-B139
- .2 Steel: to ASTM A53/A53M, Schedule 40, continuous weld or electric resistance welded, screwed.

### **2.2 STEEL PIPE COATING**

- .1 Bituminous paint: in accordance with manufacturer's recommendations.
- .2 Paints: in accordance with manufacturer's recommendations for surface conditions.

### **2.3 JOINTING MATERIAL**

- .1 Screwed fittings: Teflon tape.
- .2 Brazed fittings: 85/15.

### **2.4 FITTINGS**

- .1 Steel:
  - .1 Malleable iron: screwed, banded, Class 150 to ASME-B16.3.
  - .2 Welding: butt-welding to ASME-B16.9.
  - .3 Unions: malleable iron, brass to iron, ground seat, screwed, to ASTM A47/A47M.
  - .4 Nipples: Schedule 40, to ASTM A53/A53M.

### **2.5 BALL VALVES**

- .1 NPS 2 and under: bronze body, screwed ends, TFE seal, hard chrome ball, 4 MPa, WOG.

## **2.6 SWING CHECK VALVES**

- .1 NPS 2 and under, screwed: to MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc suitable for oil service, screw in cap, regrindable seat.

## **2.7 LUBRICATED PLUG COCKS**

- .1 NPS 2 and under, screwed: to ASTM B61, Class 150, 1 MPa, bronze body.

## **2.8 OIL FILTER**

- .1 Duplex type replaceable cartridge type as recommended by oil burner manufacturer.
- .2 Furnish spare filter cartridge.

## **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 PIPING**

- .1 Install piping in accordance with Section 23 05 15 – Common Installation Requirements of HVAC Pipework, supplemented as specified.
- .2 Install oil piping system in accordance with CSA-B139.
- .3 Slope piping down in direction of storage tank unless otherwise indicated.
- .4 Above ground piping to be protected from physical impact due to impact.
- .5 Piping inside building:
  - .1 Ensure piping in solid flooring is installed to CSA-B139 and authority having justification.
  - .2 Use approved fitting to CSA-B139 for steel piping.
  - .3 Install filter, gate valve, and fire valve at burners.
- .6 Clearly label piping runs in legible form indicating:
  - .1 Piping product content.
  - .2 Direction of flow.
  - .3 Identify transfer points in piping systems to CPPI Colour-Symbol System to Mark Equipment and Vehicles for Product Identification

### **3.3 VALVES**

- .1 Install valves with stems upright or horizontal unless approved otherwise by Departmental Representative.
- .2 Install ball valves at branch take-offs, to isolate pieces of equipment and as indicated.
- .3 Install globe valves for balancing and in by-pass around control valves.

- .4 Install swing check valves on discharge of pumps and as indicated.
- .5 Install plug cocks as indicated.

### **3.4 OIL FILTERS**

- .1 Install ULC approved in supply line to burner.
- .2 At time of acceptance, replace filter cartridge with new.

### **3.5 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Test system to CSA-B139 and CSA-B140.0 and authorities having jurisdiction.
  - .2 Isolate tanks from piping pressure tests.
  - .3 Maintain test pressure during backfilling.

### **3.6 CLEANING**

- .1 Clean in accordance with Section manufacturer's written recommendations, supplemented as follows:
  - .1 Flush after pressure test with number 2 fuel oil for a minimum of two hours. Clean strainers and filters.
  - .2 Dispose of fuel oil used for flushing out in accordance with requirements of authority having jurisdiction.
  - .3 Ensure vents from regulators, control valves are terminated in approved location and are protected against blockage and damage.
  - .4 Ensure entire installation is approved by authority having jurisdiction.
  - .5 Clean in accordance with Section 01 74 00 - Cleaning.
    - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

**END OF SECTION**

## **Part 1           General**

### **1.1           REFERENCE STANDARDS**

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C111/A21.11-06, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.1-10, Grey Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
  - .2 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
  - .3 ASME B16.5-09, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
  - .4 ASME B16.9-07, Factory-Made Wrought Buttwelding Fittings.
  - .5 ASME B18.2.1-10, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
  - .6 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .3 ASTM International (ASTM)
  - .1 ASTM A47/A47M-99 (2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-10, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
  - .3 ASTM A536-84 (2009), Standard Specification for Ductile Iron Castings.
  - .4 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .6 ASTM E202-10, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 CSA Group (CSA)
  - .1 CSA B242-05 (R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
  - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
  - .1 MSS-SP-67-2002a, Butterfly 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-80-08, Bronze Gate, Globe, Angle and Check Valves.

- .5 MSS-SP-85-02, Grey Iron Globe and Angle Valves, Flanged and Threaded Ends.

## **1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings:
    - .1 Components and accessories.

## **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
  - .1 Include special servicing requirements.

## **1.4 EXTRA STOCK MATERIALS**

- .1 Supply spare parts as follows:
  - .1 Valve seats: 1 minimum for every ten valves, each size. Minimum one.
  - .2 Discs: 1 minimum for every ten valves, each size. Minimum one.
  - .3 Stem packing: 1 minimum for every ten valves, each size. Minimum one.
  - .4 Valve handles: 2 minimum of each size.
  - .5 Gaskets for flanges: 1 minimum for every ten flanges.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse recycling of pallets, packaging materials crates, padding, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 PIPE**

- .1 Steel pipe, as follows:
  - .1 Carbon Steel, A-53B Type E or S, (Type F pipe not recommended for 2" and smaller sizes), or A-106B
  - .2 Wall Thickness
    - .1 To NPS 6: Schedule 40
    - .2 NPS 8 and Over: Schedule 80
  - .3 Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining.
  - .4 Pipe ends to be grooved in accordance with Manufacturer's listed standards conforming to ANSI/AWWA C-606

**2.2 MECHANICAL COUPLINGS FOR JOINING CARBON STEEL PIPE**

- .1 Standard Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa).
  - .1 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
    - .1 2" (DN50) through 12" (DN300): Installation ready rigid coupling for direct stab installation without field disassembly. Center-leg gasket with pipe stop to ensure proper groove engagement, alignment, and pipe insertion depth. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
    - .2 10" (DN250) through 12" (DN300): Standard rigid coupling. Gasket shall be Grade "E" EPDM compound with green color code designed for operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).
  - .2 Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
    - .1 2" (DN50) through 8" (DN200): Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C).
    - .2 10" (DN250) through 12" (DN300): Standard flexible couplings. Gasket shall be Grade "E" EPDM compound with green color code designed for

operating temperatures from -30 deg F (-34 deg C) to +230 deg F (+110 deg C).

- .3 Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges and for direct connection to ANSI Class 300 flanges.
  - .1 Grooved couplings shall meet the requirements of ASTM F-1476.
- .4 Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.
  - .1 Reference shall always be made to the latest published Manufacturer's Selection Guide for proper gasket selection for the intended service.
- .2 Grooved End Fittings:
  - .1 Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
- .3 Hole-Cut Branch Outlets:
  - .1 Bolted Branch Outlet: Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.
  - .2 Strapless Outlet: 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).
  - .3 Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

## 2.3 VALVES

- .1 Connections:
  - .1 NPS 2 and under: screwed ends.
  - .2 NPS 2-1/2 and larger: grooved ends.
- .2 Screwed end valves
  - .1 Gate valves: application: isolating equipment, control valves, pipelines:
    - .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:
  - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc.
    - .1 Body: with long disc guides, screwed bonnet.
    - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
    - .3 Operator: handwheel.
  - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc
    - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
    - .2 Operator: Handwheel.
- .2 Globe valves: to application: throttling, flow control, emergency bypass:
  - .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:
    - .1 Mechanical Rooms: with PTFE disc, Class 125.
      - .1 Body and bonnet: screwed bonnet.
      - .2 Disc and seat: renewable rotating PTFE disc, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
      - .3 Operator: handwheel.
    - .2 Elsewhere: globe, with composition disc to suit service conditions.
- .3 Balancing, for TAB:
  - .1 Automatic Flow Control Valve.
    - .1 Body: Brass or ferrous metal.
    - .2 Flow Control Assembly, Provide either of the following:
    - .3 Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
    - .4 Elastomeric Diaphragm and Polyphenylsulfone Orifice Plate: Operating ranges within differential pressure.

- .5 Combination Assemblies: Include nickel-plated brass-alloy ball valve, union connection, air-vent PT port, and 20-mesh strainer. Repairable stem without removing valve from line.
- .6 Identification Tag: Marked with zone identification, valve number, and flow rate.
- .7 Size: Same as pipe in which installed.
- .8 Performance: Maintain constant flow within plus or minus 5 percent, regardless of system pressure fluctuations.
- .9 Minimum CWP Rating: 175 psig (1207 kPa).
- .10 Maximum Operating Temperature: 200 deg F (93 deg C).
- .4 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc.
- .5 Bypass valves on gate valves NPS 8 and larger: Globe, with PTFE disc.
- .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, swing type, composition disc, Class 200:
    - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
    - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
  - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
    - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
    - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
  - .6 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: Class125, 860 kPa steam.
    - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
    - .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.
- .3 Grooved End Valves
  - .1 Butterfly Valves
    - .1 2"(DN50) through 12"(DN300) Sizes: 300 psi CWP (2065 kPa) suitable for bidirectional and dead-end service at full rated pressure. Body shall be grooved end black enamel coated ductile iron conforming to ASTM A536. Disc shall be electroless nickel plated ductile iron with blowout proof 416 stainless steel stem. Disc shall be offset from the stem centerline to allow full 360 degree circumferential seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat. Valve shall be complete with ISO flange for actuation mounting. Valve operators shall be gear operated, with memory stop feature and chainwheel.
  - .2 Check Valves:
    - .1 2"(DN50) through 3"(DN80) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, stainless steel non-slam tilting disc, stainless steel spring and brass shaft, nickel-plated seat surface, 365 psi (2517 kPa).
    - .2 4"(DN100) through 12"(DN300) Sizes Spring Assisted: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa).
    - .3 2"(DN50) through 4"(DN100) Sizes Horizontal Swing: Horizontal installation, ductile iron body, ASTM A-536, Grade 65-45-12, and Type 316 stainless steel clapper. Synthetic rubber bumper & bonnet seals suitable for intended service, stainless steel wetted parts, 300 psi (2065 kPa).

- .4 2”(DN50) through 4”(DN100) Swing Check Valve: Horizontal installation, original grooved, black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, with orange enamel coated access cap and closure coupling. ASTM A351 Grade CF8M stainless steel clapper, (302/304 stainless steel torsion spring in sizes 2-1/2” through 4”), Grade EHP: EPDM elastomer seat and closure gasket suitable for intended service, rated for service to 750 psi (5170 kPa).
- .5 4”(DN100) through 12”(DN300) Sizes Venturi Check: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12 with venturi-like taps, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi (2065 kPa).
- .3 Tri-Service Valve Assembly: Combination shut-off, throttling and non-slam check valve.
  - .1 2-1/2”(DN65) through 12”(DN300) Butterfly valve with memory stop feature assembled (2-1/2” & 3”) (DN65 & DN75) or Venturi Check (4” – 12”) (DN100-DN300) with venturi like taps for flow measurement. Working pressures to 300 psi (2065 kPa).
- .4 Ball Valves
  - .1 1-1/2”(DN40) through 6”(DN150) sizes, ASTM A-536, Grade 65-45-12, ductile iron body, chrome plated carbon steel ball and stem, TFE seats, with Fluoroelastomer seals. 800 psi (5515 kPa).
- .5 Plug Valves
  - .1 3”(DN75) through 12”(DN300) sizes, with memory stop for throttling, metering or balancing service. Unidirectional bubble-tight shut-off, bi-directional sealing optional. ductile iron body, bonnet, and plug, ASTM A-536, Grade 65-45-12. Plug encapsulated with synthetic rubber suitable for intended service. Welded-in nickel seat, stainless steel self-lubricating bearings. 175 PSI (1200 kPa). AWWA rigid groove dimensions may be adapted to IPS sized system through the use of transition couplings.
- .6 Circuit Balancing Valves:
  - .1 2”(DN50) and Smaller Sizes: 300 psi (2065 kPa), y-pattern, globe type with soldered or threaded ends, non-ferrous DZR brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter.
    - .1 Install union port fitting and strainer/ball valve combination to complete terminal hookup at coil outlet.
    - .2 Install differential pressure controller to stabilize differential pressure and ensure stable and accurate modulating control. brass copper alloy body, bonnet, cone and spindles, threaded ends only.
  - .2 2-1/2”(DN65) and Larger Sizes: 300 psi (2065 kPa), y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other metal parts of DZR brass copper alloy, EPDM O-ring seals. 8, 12 or 16-turn digital readout handwheel for balancing, hidden memory

- feature with locking tamper-proof setting, and connections for portable differential meter.
- .3 Differential Pressure Controller: For use in conjunction with TA Balancing valves to stabilize differential pressure and ensure stable and accurate modulating control. Ductile iron or Brass Copper Alloy body, brass copper alloy bonnet, cone, and spindles, flanged ends only.
- .7 Tooling:
  - .1 Tools shall be manufactured and supplied by the manufacturer. Use roll sets or cut groovers compatible with the pipe material and wall thickness per Manufacturer's installation instructions.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 PIPING INSTALLATION**

- .1 Install pipework in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

#### **3.3 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.

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

- .1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

#### **3.5 TESTING**

- .1 Test system in accordance with Section 23 05 00 - Common Work Results for HVAC.

#### **3.6 BALANCING**

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 In accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

**3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.8 PROTECTION**

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 ASME
  - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 ASTM International (ASTM)
  - .1 ASTM A47/A47M-99 (2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01 (2011), Standard Specification for Grey Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-84 (2009), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canada Green Building Council (CaGBC)
  - .1 LEED Canada-NC Version 1.0-2004, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Package For New Construction and Major Renovations (including Addendum 2007).
  - .2 LEED Canada-CI Version 1.0-2007, LEED (Leadership in Energy and Environmental Design): Green Building Rating System Reference Guide For Commercial Interiors.
  - .3 LEED Canada 2009 for Design and Construction-2010, LEED Canada 2009 for Design and Construction Leadership in Energy and Environmental Design Green Building Rating System Reference Guide.
  - .4 LEED Canada for Existing Buildings, Operations and Maintenance-2009, LEED Canada 2009 Leadership In Energy and Environmental Design Green Building Rating System Reference Guide.
- .4 CSA Group (CSA)
  - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate on drawings:

- .1 General arrangement, connections, construction
- .2 Waterflow Rates
- .3 Pressure Drop
- .4 Fluid Velocity
- .5 Tank Volume, Acceptance Volume
- .6 Mounting Arrangement
- .7 Dimensions and weight
- .8 Recommended Clearances

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse recycling of crates, padding, packaging materials pallets, as specified in Waste Reduction Workplan Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 HYDRONIC EXPANSION TANK – VERTICAL, DIAPHRAGM TYPE**

- .1 Application
  - .1 For use in closed, non-potable hydronic heating and chilled water systems.
  - .2 Suitable in propylene glycol applications with mixtures up to 50%.
  - .3 Meets all ASME Section VIII, Division 1 code standards.
  - .4 With sight glass.
- .2 Construction

- .1 Shell: ASME Approved Steel
  - .2 Diaphragm: Heavy Duty Butyl/EPDM
  - .3 System Connection: Malleable Iron
  - .4 Finish: Red Oxide Primer
  - .5 Air Valve: Schrader Valve w/ EPDM Seats
  - .6 Factory Precharge: 12 PSIG (0.8 bar)
- .3 Performance
- .1 Max. Operating Temperature: 240° F (116° C)
  - .2 Max. Working Pressure: 125 PSIG (8.6 bar) through 300 PSIG (21 bar).

## **2.2 AUTOMATIC AIR VENT**

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 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.

## **2.3 AIR SEPARATOR - BOILER MOUNTED**

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

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

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

## **2.5 COMBINATION HYDRAULIC, AIR, DIRT AND MAGNETIC SEPARATOR.**

- .1 General
  - .1 The separator must be designed with an epoxy resin painted steel body, a brass blowdown drain valve and automatic brass air vent with brass shutoff valve.
  - .2 The separator design must include ANSI B16.5 Class 150 RF flanges, a 300 series stainless steel internal element and A brass drywell for an external removable neodymium rare-earth magnet with up to 100% ferrous impurities, including magnetite, separation efficiency.
  - .3 The separator must be designed and built in accordance with Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code and tagged and registered with the National Board of Boiler and Pressure Vessel Inspector, and CRN registered, and stamped for 150 psi (10 bar) working pressure, with ASME U stamp.
- .2 Materials
  - .1 Separator Body: Epoxy Resin Painted Steel
  - .2 Air Vent Body: Brass

- .3 Shut Off and Drain Valve Body: Brass
- .4 Internal Element: 300 Series Stainless Steel
- .5 Air Vent Seal: VITON
- .6 Air Vent Float: Stainless Steel
- .7 Magnet: Neodymium Rare-Earth
- .8 Magnet Probe: Brass
- .3 Performance
  - .1 Suitable fluids: water and non-hazardous glycol solution up to 50%
  - .2 Max. Operating pressure: 150 psi (10 bar)
  - .3 Temperature range:
    - .1 With insulation: 32–220°F (0–105°C)
    - .2 Without insulation (vessel) 32–270°F (0–132°C)
  - .4 Particle separation capacity: 5 µm (0.2 mil)
  - .5 Air separation efficiency: 100% removal to micro-bubble level
  - .6 Ferrous impurities separation efficiency: up to 100% removal

## **2.6 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.

## **2.7 GROOVED END SPECIALTIES**

- .1 Expansion Joints:
  - .1 2”(DN50) through 6”(DN150) Sizes: Packless, gasketed, type with grooved end telescoping body, suitable for axial end movement to 3”. 350 psi (2410 kPa).
  - .2 3/4”(DN20) and Larger Sizes: Expansion joint consisting of a series of grooved end nipples joined with flexible-type couplings. Joint movement and expansion capabilities determined by number of couplings / nipples used in the joint.
- .2 Dielectric Waterways:
  - .1 ½” (DN15) through 4” (DN100) sizes, IPS to copper-tubing size dielectric transition fitting. Fittings shall be a copper-silicon casting conforming to UNS C87850, and UL classified in accordance with ANSI / NSF-61 for potable water service. Fittings shall have threaded ends, grooved ends, or a combination.
  - .2 1”(DN25) through 8”(DN200) sizes, grooved, plain end, or threaded end, ASTM A-53 carbon steel or ASTM A-536 ductile iron body, zinc electroplated, with LTHS high temperature stabilized polyolefin polymer liner.
- .3 Strainers - Grooved-End
  - .1 T-Type Strainer. 2” (DN50) through 12”(DN300) sizes, 300 PSI (2065 kPa) T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2”-

- 3" (DN50-DN75) strainer sizes, or No. 6 mesh, 4"-12" (DN100-DN300) strainer sizes.
- .2 Y-Type Strainer. 2"(DN50) through 18"(DN450) sizes, 300 PSI (2065 kPa) Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" (1,6mm) diameter perforations 2"-3" (DN50-DN75) strainer sizes, 1/8" (3,2mm) diameter perforations 4"-12" (DN100-DN300) strainer sizes, and 0.156" (4mm) diameter perforations 14" -18" (DN350-DN450) strainer sizes.
- .4 Suction Diffuser
  - .1 Flanged outlet with grooved inlet connections, rated to 300 psi (2065 kPa). Ductile iron (ASTM A-536) body, 304 stainless steel frame and perforated sheet diffuser with 5/32" (4,0mm) diameter holes. Removable 20 mesh 304 stainless steel start-up pre-filter, outlets for pressure/temperature drain connections, and base support boss.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic specialties installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative .
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative .

#### **3.2 APPLICATION**

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

#### **3.3 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 tappings for ancillaries and for equipment operating weights.

#### **3.4 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 as indicated.

### **3.5 AIR VENTS**

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

### **3.6 EXPANSION TANKS**

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

### **3.7 PRESSURE SAFETY RELIEF VALVES**

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

### **3.8 SUCTION DIFFUSERS**

- .1 Install on inlet to pumps.

### **3.9 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group (CSA)
  - .1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.
- .3 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .4 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2011, Motors and Generators.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets 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 Indicate on drawings:
    - .1 Waterflow rates
    - .2 Head
    - .3 Efficiency at duty point
    - .4 Motor Power
    - .5 NPSHr
    - .6 Electrical characteristics
    - .7 Dimensions and Weight
    - .8 Accessories and controllers.

**1.3                CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse recycling of padding, pallets, crates, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

#### **Part 2 Products**

##### **2.1 EQUIPMENT**

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

##### **2.2 SPLIT COUPLED, INLINE, VERTICAL, SENSORLESS PUMPS**

- .1 General
  - .1 The pumps shall be a split-coupled, inline for vertical installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 250° F and 175 PSIG working pressure (or optional operations at up to 250° F and 250 PSIG working pressures with EPR/Carbon/Tungsten/Carbide/SS seal). Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
  - .2 The pumps shall have a 416 stainless steel shaft that is guided by a carbon graphite lower throttle bushing.
  - .3 Pump shall be equipped with a Unitized inside mechanical seal assembly with flush line. The seal assembly shall have an EPR elastomer bellows and a positive metal-to-metal drive system to reduce torsional stress on the bellows. The bellows will be pressure supported without creases or folds for long life. The mechanical seal shall have a rotating carbon face against a stationary ceramic face. (As an option, an outside mechanical seal may be used in lieu of the inside mechanical seal design. The outside seal materials shall be EPR elastomer with carbon-ceramic faces.)
  - .4 Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.5-2000. The allowable residual imbalance conforms to ANSI

- grade 6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.
- .5 The pump shall include a spacer coupling of high tensile aluminum, split to allow the servicing of the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design.
  - .6 The combination motor bracket and volute coverplate shall be a one-piece unit to ensure concentric alignment of the motor to the pump casing. A carbon steel coupler guard conforming to both ANSI B15.1-2000 and OSHA 1910.219 standards shall be mounted on the motor bracket for safety.
  - .7 Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges (Optional 250 PSIG working pressures are available and are 250# flange drilled). Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
  - .8 Motors shall be NEMA Premium efficient and shall be the size, voltage, and enclosure called for on the plans. Motors shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load for which the pump is designed.
  - .9 Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the Departmental Representative.
  - .10 Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
  - .11 Pump manufacturer shall be ISO-9001 certified.
  - .12 Each pump shall be factory tested and name-plated before shipment.
  - .13 As an option, the pump may include an internal stainless steel casing wear rings.
  - .14 Where noted on schedule pumping equipment may require one or all of the following optional tests: Certified Lab tests (unwitnessed), Hydraulic Institute Level B tests, or Witnessed Tests.
- .2 Accessories
- .1 Provide one mechanical seal for each model type of primary pump.
- .3 Integrated VFD with sensorless pump control
- .1 Integrated Pump Controller shall be factory mounted, wired, with a mains disconnect switch and menu-driven graphical interface.
  - .2 Integrated Pump Controller shall provide near unity displacement power factor ( $\cos \phi$ ) without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.
  - .3 Integrated Pump Controller shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple currents to increase DC link capacitor lifetime.
    - .1 Test system operation under load, if such condition exists, identify source of any harmful harmonics and add external passive harmonic filters to its source.

- .4 Integrated Pump Controller shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements.
- .5 Integrated Pump Controller orientation shall be specified as orientation 1
- .6 Integrated Pump Controller shall support direct communication with the building management system (BMS) with built-in support for the following protocols: BACnet™ MS/TP
- .7 Integrated Pump Controller shall be provided in an Enclosure rated to UL Type 12 suitable for indoor operation.
- .8 Integrated Pump Controller shall support Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.
- .9 Integrated Pump Controller shall provide a temperature controlled Fan for cooling of the heat sink in the back panel.
- .10 Integrated Pump Controller shall be rated to operate in ambient working conditions of 14°F to +113°F, up to 3300 feet above sea level.
- .11 Integrated Pump Controller shall provide 2 Analog inputs (current or voltage) and 1 current output.
- .12 Integrated Pump Controller shall provide 6 programmable Digital inputs with 2 configurable as outputs.
- .13 Integrated Pump Controller shall support 2 programmable pulse inputs
- .14 Integrated Pump Controller shall provide 2 programmable relay outputs
- .15 Integrated Pump Controller shall provide 1 RS485 communication port
- .16 Integrated Pump Controller system software shall be capable of sensorless control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.
- .17 Integrated Pump Controller Sensorless control shall operate under Quadratic Pressure Control (QPC) to ensure head reduction with reducing flow conforms to quadratic control curve.
- .18 Integrated Pump Controller shall support a minimum head of 40% of design duty head.
- .19 Integrated Pump Controller shall provide user adjustable control mode settings and minimum/maximum head set points using built-in programming interface.
- .20 Integrated Pump Controller integrated control software shall be capable of controlling pump performance for non-overloading power at every point of operation.
- .21 Integrated Pump Controller integrated control software shall be capable of maintaining flow rate data.

## 2.3

### **INLINE WET ROTOR CIRCULATOR WITH ECM MOTOR**

#### .1 General

- .1 The pumps shall be a wet rotor inline pump, in cast iron or lead free bronze body construction specifically designed for quiet operation. Suitable standard operations at 230° F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.

- .2 The pump internals shall be capable of being serviced without disturbing piping connections.
  - .3 Pump shall be equipped with a water-tight seal to prevent leakage.
  - .4 Pump volute shall be of a cast iron design for heating systems or lead free bronze for domestic water systems. The connection style on the cast iron and bronze pumps shall be flanged.
  - .5 Flange to Flange dimension shall be standard Bell & Gossett booster sizes such as 6-3/8", 8-1/2", 11-1/2", and 12". Flange dimensions shall be HVAC industry standard 2 or 4 bolts sizes.
  - .6 Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
  - .7 Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
  - .8 Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).
  - .9 Pump shall have BACnet connections built into the VFD as standard options.
  - .10 Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
  - .11 Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
  - .12 Pumps shall be UL 778 listed and bear the UL Listing Mark for USA and Canada with on-board thermal overload protection.
  - .13 Each pump shall be factory performance tested before shipment.
- .2 Operating Modes
- .1 Proportional Pressure – The differential pressure will continuously increase or decrease along a linear curve based on the flow demand.
  - .2 Constant Pressure – The pump maintains a constant differential pressure set by the user at any flow demand until the maximum speed is reached.
  - .3 Constant Speed – The pump maintains a constant speed at any flow rate
  - .4 Night Set Back – The pump will recognize a 10°C water temperature reduction and will switch to nighttime operation.
  - .5 T-Constant – This control will use a PI algorithm to vary the speed of the pump in order to maintain a constant temperature of the fluid media.
  - .6 Delta-T Constant – This control mode will use a PI algorithm to vary the speed of the pump in order to maintain a constant differential temperature between the built-in temperature sensor and external temperature sensor.
  - .7 Delta-P-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the fluid temperature.
  - .8 Delta-P-Delta-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to

the differential temperature between the built-in temperature sensor and external temperature sensor.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative .
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative .

#### **3.2 APPLICATION**

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

#### **3.3 INSTALLATION**

- .1 Install hydronic pumps to: CAN/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.

#### **3.4 START-UP**

- .1 General:

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements and supplemented as specified herein.
- .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.

### **3.5 PERFORMANCE VERIFICATION (PV)**

- .1 General:
  - .1 Verify performance in accordance with Section 01 91 13 - General Commissioning Requirements, supplemented as specified herein.
- .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 01 91 13 - General Commissioning Requirements.
  - .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 01 91 13 - General Commissioning Requirements reports supplemented as specified herein. Reports to include:
  - .1 Record of points 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 01 91 13 - General Commissioning Requirements: Report Forms and Schematics.
  - .3 Pump performance curves (family of curves).

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2    Underwriters' Laboratories of Canada (ULC)

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for chimneys and stacks and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Shop Drawings:
  - .1    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.
- .4    Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3                QUALITY ASSURANCE**

- .1    Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations.
- .2    Certifications:
  - .1    Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

**1.4                DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2    Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3    Storage and Handling Requirements:
  - .1    Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect chimneys and stacks from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse recycling of packaging materials padding, crates, pallets, as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 19 - Waste Management and Disposal.

## **Part 2 Products**

### **2.1 BREECHINGS**

- .1 Shop fabricated 3.5 mm thick, welded, stainless steel with sweep bends from boiler outlet to thimble or chimney.

### **2.2 BOILER VENT**

- .1 The vent shall be of the double wall, factory-built type, designed to vent category I, II, III, or IV gas fired, condensing or non condensing appliances or as specified by the appliance manufacturer.
- .2 Maximum continuous flue gas temperatures shall not exceed 550 degrees F (288 degrees C)
- .3 The vent shall be listed to a maximum positive pressure of 15"wc. (3.75kPa.) and tested to
- .4 The entire vent system from the appliance to the termination shall be supplied by the same manufacturer. All system components shall be listed to a UL or cUL standard.
- .5 The vent shall have a 1 inch space between the inner and outer tubes.
  - .1 Vent installed indoors or exposed to ambient temperatures higher than 0°C (32°F) shall have 1 inch of air space between the tubes.
  - .2 Vent exposed to ambient temperatures less than 0°C (32°F) shall have 1 inch of insulation between the tubes.
- .6 The inner tube (flue) shall be constructed of a material that meets the requirements of UL corrosion resistance standard.
  - .1 The flue shall be constructed of AL29-4C or 444 stainless steel
    - .1 Diameters of 125mm (5") through to 300mm (12") shall be constructed of a material thickness of 0.018" (28G.)
    - .2 Diameters of 350mm (14") through to 600mm (24") inches shall be constructed of a material thickness of 0.018" (28G.) or upon request 0.025" (24G.)
  - .2 The outer tube (casing) shall be constructed of 430 stainless steel
    - .1 Diameters of 125mm (5") through to 250mm (10") shall be constructed of a material thickness of 0.018" (28G.)
    - .2 Diameters of 300mm (12") through to 600mm (24") shall be constructed of a material thickness of 0.025" (24G.)

- .7 The vent shall be sealed by a factory installed high temperature silicone gasket located in the flue.
- .8 The vent shall compensate for expansion internally.
- .9 The vent shall be secured with a locking band.

### **2.3 ACCESSORIES**

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Provide drain connections as required to remove condensate drain from the system.
- .3 Barometric dampers: single acting, 70% of full size of breeching area, as applicable.
- .4 Hangers and supports: in accordance with recommendations SMACNA.
- .5 Rain cap.
- .6 Expansion sleeves with heat resistant caulking, held in place as indicated.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for chimney and stack installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 INSTALLATION - GENERAL**

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m 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.
- .6 Install rain caps and cleanouts.
- .7 Grind welds smooth to form appearance of single tube.
- .8 Seal insulating refractory at top of stack.
- .9 Pack annular space around breeching at entry tee with heat resistant caulking.
- .10 Run drain line from drain connection to closest drain.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    American Boiler Manufacturers Association (ABMA)
- .2    ASME
  - .1    ASME Boiler and Pressure Vessel Code (BPVC), Section VII-.2013.
- .3    CSA Group (CSA)
  - .1    CAN1-3.1-.77 (R2011), Industrial and Commercial Gas-Fired Package Boilers.
  - .2    CSA B51-.09., Boiler, Pressure Vessel, and Pressure Piping Code.
  - .3    CSA B139-.09., Installation Code for Oil Burning Equipment.
  - .4    CSA B140.7-.05 (R2010), Oil Burning Equipment: Steam and Hot-Water Boilers.
  - .5    ANSI Z21.13-.10. /CSA 4.9-.10., Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .4    Electrical and Electronic Manufacturers Association of Canada (EEMAC)

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's instructions, printed product literature and data sheets for heating boilers. and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Shop Drawings:
  - .1    Indicate on drawings:
    - .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.
  - .2    Engineering data to include:
    - .1    Boiler efficiency at 25%, 50%, 75%, and 100% of design capacity.
    - .2    Radiant heat loss at 100% design capacity.

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

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for heating boilers. for incorporation into manual.

### **1.4 QUALITY ASSURANCE**

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial/Territorial regulations.

### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra materials:
  - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
    - .1 Special tools for burners, access opening, handholes 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.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors. and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect boiler and equipment. from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan. related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse recycling of padding, crates, pallets, packaging materials. as specified in Construction Waste Management Plan. in accordance with Section 01 74 19 - Waste Management and Disposal.

**Part 2 Products**

**2.1 GENERAL**

- .1 Start-up, instruction, on-site performance tests: 3 days per boiler.
- .2 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.
- .3 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.
- .4

**2.2 OIL FIRED BOILER**

- .1 General
  - .1 Oil fire boiler is to be assemble on site and re-certified by manufacturer during startup and commissioning.
  - .2 The hot water heating boiler shall incorporate a triple-pass cast iron heat transfer design. The boiler design shall allow for #2 fuel oil, natural gas and propane gas. Venting shall be standard Category I, non-condensing and negative draft. The control packages shall come pre-wired for the boiler/burner combination.
  - .3 Performance Criteria
    - .1 Refer to Schedule for Capacity.
    - .2 Combustion efficiency on natural gas and propane shall not be below 85%, as tested in accordance with the harmonized standard ANSI Z21.13.CSA 4.9. Combustion efficiency on #2 fuel oil shall not be below 88%.
    - .3 ASME maximum allowable working pressure (MAWP): 75 psig;
    - .4 ASME maximum water temperature (Fixed High Limit): 248°F (120°C).
    - .5 The heat exchanger filled with water shall weigh no less than 5335 lbs (2420 kg) excluding the burner, controls and jacketing. Input rate per heat exchanger surface area shall not exceed 8.6 MBH/ft<sup>2</sup> (27.2 kW/m<sup>2</sup>) for oil, and 9.0 MBH/ft<sup>2</sup> (28.2 kW/m<sup>2</sup>) for gas, based on input at full fire.
    - .6 No additional safety devices shall be required to safeguard against low flow conditions.
    - .7 The boiler shall be able to supply a temperature of up to 210°F (99°C) at 75 psig.
    - .8 Boiler minimum return water temperature shall not be below 104°F (40°C) on oil and 127°F (52.8°C) on gas.

- .9 Supply/return piping shall incorporate one of the following two methods for protecting the boiler against flue gas condensation: a 100% bypass valve or a 30% bypass pump.
- .10 A return water distribution tube shall be standard equipment, for reducing thermal stress associated with uneven water flow between sections.
- .11 The standard control options shall be able to operate independently, or integrate with building management system protocols as referenced in the control section.
- .4 Construction
  - .1 The combustion chamber and flue gas passageways shall be constructed of sectional cast iron, and shall have a triple-pass design. The grade of cast iron shall be lamellar graphite.
  - .2 The water side of the heat exchanger shall use a press-nipple design between sections to allow transportation of individual sections and reliable field assembly.
  - .3 The heat exchanger shall have a full-swing door, left- or right-hinge, to allow for easy inspection and cleaning.
  - .4 The R-value of the insulation shall be equivalent to 4" (100 mm) fiberglass with nyBACnet backing.
- .5 Certifications
  - .1 All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component. Boiler shall be CSA approved and shall be built in compliance with ASME Section IV, carrying the "H" stamp.
  - .2 The boiler shall have the following approvals and listings, or be in compliance with: CSA, CRN, ASME, I=B=R.
- .2 Burner Specifications:
  - .1 General
    - .1 The burner shall be a forced draft automatic burner designed to burn #2 fuel oil.
  - .2 Performance Criteria
    - .1 Each burner shall have a firing rate of 850 - 2700 MBH.
  - .3 Construction
    - .1 Burner Housing
      - .1 The burner housing shall be made of cast aluminum, and shall be capable of hinging open to the left or to the right.
      - .2 The burner housing shall incorporate the following features:
        - .1 A flange safety interlock switch to prevent the burner from starting when in the open position
        - .2 A self-checking differential air pressure switch
        - .3 A large sight glass for viewing the flame
        - .4 A removable cover to allow free access to serviceable components

- .2 Fan
  - .1 The blower wheel shall be statically and dynamically balanced.
- .3 Air Intake
  - .1 The air intake shall consist of multiple aluminum air intake vanes on the suction side for combustion air regulation. Air louvers shall be controlled by a dedicated stepper motor having 900 settable increments from 90 angular degrees (open) to 0 angular degrees (closed). Air louvers shall be driven to the fully closed position during the "off" cycle to minimize draft losses. The air intake shall include sound attenuating material, and a screen to reduce the likelihood of foreign material entering the blower.
- .4 Combustion Head
  - .1 The flame tube and diffuser assembly shall be made of stainless steel alloy, and shall have a temperature rating of 1470°F. The diffuser, nozzle assembly and all serviceable components shall be accessible without need for burner removal. The combustion head shall be adjustable such that the pressure drop across the diffuser can be optimized to match the maximum firing rate of the burner.
- .5 Burner Management System
  - .1 The burner management system shall integrate fuel/air ratio control, flame safeguard functions, load control and communications into one control system. The burner management system shall have four levels of password protection.
  - .2 The fuel/air ratio control system shall be free of linkages which connect fuel control and air control functions into a common servomotor or actuator. Fuel and air control components shall be individually controlled by dedicated stepper motors programmable via the keypad. The fuel/air ratio shall be infinitely adjustable throughout the firing range.
  - .3 The burner shall have independent ignition position (independent of any other firing position).
  - .4 All functions including burner history, commissioned values, operating parameters and pressure/temperature settings shall be accessible/adjustable without the need for a laptop computer or other special tools.
  - .5 Both the programming pad and the main control module shall hold programmed data with capability of uploading/downloading from one to the other.
  - .6 The flame safeguard system shall be integrated into the control system and shall include sensor electrode (standard) or QRI infrared flicker detector (option). The combustion control system shall include built-in PID pressure/temperature control and time/temperature adjustable cold start function to protect the boiler from thermal shock.

- .7 The control system shall have selectable operating modes to allow for the following:
  - .1 Direct modulation via the building automation system using either a 4-20 mA, 2-10V or floating type operating signal.
  - .2 Set-point adjustment via the building automation system using either a 4-20 mA, 2-10V or floating type operating signal.
- .8 The burner control system shall be capable of providing the following functions and data signals via a BACnet interface:
  - .1 Burner ON/OFF
  - .2 Load signal
  - .3 Set-point and process value
  - .4 Operating information
  - .5 Actual load position of burner
  - .6 Lock-out with failure code
  - .7 Actual position (on/off) of air pressure switch, valves, fan, gas pressure, flame supervision
  - .8 Start-up counter
  - .9 Actual operating hours
- .9 The control system shall incorporate a 4-line, 64 character LCD display (ABE). The ABE display shall be capable of being mounted either on the burner or in a remote control panel. ABE shall be easy to remove from its mounting while remaining connected to the wiring harness enabling a technician to have "handheld" adjustment capability.
- .6 Motor
  - .1 The burner shall have a three-phase (or single-phase) TEFC blower motor fully compatible for use with variable frequency drive.
- .4 Certifications
  - .1 All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component.
  - .2 The minimum standards for #2 fuel oil burners are:
    - .1 CAN/CSA B139 Installation Code For Oil Burning Equipment (for Canada)
    - .2 CSA C22.1 Canadian Electrical Code and/or local electrical codes (for Canada)
    - .3 NFPA 31 Standard for the Installation of Oil Burning Equipment (for U.S.)
    - .4 ANSI/NFPA 70 National Electrical Code (for U.S.)
- .3 Control

.1 General

.1 The control unit shall provide control for a single boiler with one high temperature heating circuit. Temperature control of the heating circuit shall be from internal set point control, optional 0-10VDC interface input into boiler control, dry contact 143/146 demand inputs or optional BACnet communication card. The control shall operate either a single-stage, two-stage or modulating burner as a function of set point boiler water temperature.

.2 General Requirements

.1 The controller shall have the following features.

- .1 Compatible with single-stage, two-stage and modulating burners.
- .2 EPROM memory is maintained without main power.
- .3 Control algorithms are PID-based.
- .4 BACnet ready with the addition of BACnet communication module.
- .5 Quick connect plug & play system for low voltage controls.
- .6 Communication with other protocols such as BACnet , BacNet and Ethernet/IP shall be available.

.2 The controller shall be factory tested and approved by CSA as part of a package with the compatible boilers.

.3 The controller shall be able to support the following output devices:

- .1 (1) Boiler Pump.
- .2 (1) Shunt pump for boiler return water temperature elevation.
- .3 (1) Operation with Single Stage, Two Stage or modulating Burner.
- .4 (1) Motorized modulating valve output for boiler isolation or return temperature elevation.

.2 Construction

.1 Control Interface

.1 The control interface shall be menu driven with an alpha-numeric display (°F or °C) and shall have the following features:

- .1 Able to display all system temperatures and set points.
- .2 Displays unique fault message during and alarm.
- .3 A program selection function.
- .4 Domestic hot water temperature set point adjustment function.
- .5 Information indicator with confirmation function.
- .6 Boiler operating hours display.
- .7 Number of burner starts display.

- .8 Operating status check function.
- .9 Emission test switch.
- .10 Boiler supply water temperature set point adjustment function.
- .2 Additional Features
  - .1 The controller shall have the following additional features:
    - .1 On/Off switch.
    - .2 Default factory settings reset function.
    - .3 Operating status indication light.
    - .4 Tamper-proof adjustable high limit.
    - .5 Manual override switch.
    - .6 TUV service switch (overrides AHL).
    - .7 Manual reset fixed high limit.
    - .8 Fault Indicator light.
    - .9 Integration of individual combustion air dampers or blowers using the Combustion Air Device Adapter.
    - .10 Operating condition scans.
    - .11 Maintenance requirement status.
    - .12 Relay test function.
    - .13 Option to incorporate a flue gas temperature sensor.
    - .14 Ability to restore the control to factory defaults.
  - .2 The fixed high limit shall have the following tamper-proof features:
    - .1 A locking mechanism which allows for lower temperature adjustments only. Once a lower temperature setting is adjusted, the limit cannot revert back to a higher temperature setting.
- .3 Fault Management
  - .1 If a fault occurs on a boiler, the fault code shall be indicated in the display window and by the flashing red fault lamp. A compiled failure alarm contact shall close in order to signal the alarm condition to a Building Automation System (BAS). If a BACNET card is installed, the message shall also be broadcasted on the BACNET communication bus. The error history shall be saved to memory. An optional Output Module connected to the BACNET bus shall close a set of potential-free contacts for each of the following conditions: burner status, burner failure, high boiler temperature and low water cut-off alarm.
- .4 Auxiliary Inputs
  - .1 The following dry contact inputs shall be available to be wired to each boiler to control the following functions:
    - .1 Boiler disable.
    - .2 Change between modulating to staged burner control.

- .3 External heat demand.
- .5 Building Management System Interface
  - .1 The controller shall use the BACNET communication protocol and shall be able to be fully integrated into a building automation system running on the BACNET protocol without having to use a gateway.
  - .2 The controller shall have the ability, through the use of an Input Module, to accept a 0-10V signal from a Building Management System for the purpose of allowing remote control of the boiler supply water temperature set point.
  - .3 The controller shall be able to fully integrate with Building Management Systems running on the BacNet or N2 communication protocols via a gateway.
- .6 Remote Communication Interface
  - .1 The controller shall have the ability to be connected to a phone dialer, enabling remote control of any of the functions listed in the Auxiliary inputs section.
  - .2 The controller shall have the ability to be connected to an Internet server interface, which shall allow access to all programming and operating parameters over the World Wide Web.
- .3 Certifications
  - .1 All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component.
  - .2 All electrical wiring is to be done in accordance with the latest editions of:
    - .1 CSA C22.1 Canadian Electrical Code and/or local electrical codes (for Canada)
    - .2 ANSI/NFPA 70 National Electrical Code (for U.S.)
- .4 Gateway
  - .1 General
    - .1 Provide communication gateway that allows for data transfer between the BACNET System, used with equipment, and a Building Management System or Building Automation System using either BACnet or BACnet communication protocols.
    - .2 The gateway shall offer a combination of both readable and readable/writable points available from the equipment within the system.
    - .3 The gateway shall be capable of communicating with up to 1 cascade control, and up to 8 boilers within a single system.
    - .4 The gateway shall be capable of communicating with up to 4 systems.
    - .5 The gateway shall be offered in 2 versions, one version complete with an enclosure for remote mounting applications, the other as a DIN rail mountable version for installation into select equipment junction boxes.

.2 General Requirements

.1 The gateway shall have the following features:

- .1 Communication with up to 1 cascade control and 8 boilers in a single system.
- .2 Enclosure for remote mounting or wall mounting.
- .3 Shipped complete with 24VDC Power Supply Unit.
- .4 USB configuration back-up port.
- .5 LAN connection port for communication with PC/Laptop, BACnet IP, or BACnet TC/IP
- .6 RS485 port for communication using BACnet MS/TP or BACnet 485.
- .7 Two BACNET communication ports for integration into the BACNET system.
- .8 The gateway shall be factory tested and approved by CSA as part of a package with the compatible series of boilers.

.3 Construction

.1 Control Interface

- .1 The control interface shall be web browser driven, capable of displaying both metric and imperial units, and shall have a language selection menu. Menu driven selection functions, providing access to (but are not limited to) the following operating points:
  - .1 Able to display all system temperatures and set points.
  - .2 Displays unique fault message during an alarm.
  - .3 A program selection mode.
  - .4 Domestic hot water temperature set point adjustment.
  - .5 Operating status check.
  - .6 Slope and shift adjustment for heating curve.

.4 Fault Management

- .1 If a fault occurs within the system, the fault code shall be transmitted to the Building Management System or Building Automation System. Any fault will be displayed as a unique fault code relative to the fault generated.

.5 Certifications

- .1 All individual components shall be accepted as part of the system under the governing body having jurisdiction. Field approval shall not be required for any component.
- .2 The gateway shall be CSA Certified for U.S. and Canada.
- .3 All electrical wiring is to be done in accordance with the latest editions of:
  - .1 CSA C22.1 Canadian Electrical Code and/or local electrical codes (for Canada)
  - .2 ANSI/NFPA 70 National Electrical Code (for U.S.)

## 2.3 ELECTRIC BOILER

- .1 General
  - .1 Description
    - .1 Each unit shall be a complete boiler with automatic controls. The boiler, with all piping and wiring, shall be a factory package. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 160 PSIG.
    - .2 Pressure Vessel:
      - .1 Vertical carbon steel with welded heads and flanged element insertion openings.
      - .2 The boiler shall have one supply connection and one return water connection. The supply and return connections shall be positioned so that water flow cannot short circuit heating elements.
    - .3 Casing:
      - .1 Jacket: 18 gauge metal wrapped casing.
      - .2 Control compartment enclosures: NEMA 250, Type 1A.
      - .3 Finish: Enamel.
      - .4 Insulation: Minimum two (2) inch thick, mineral-fiber insulation having minimum 1-1/2 lb/ft<sup>3</sup> density surrounding the heat exchanger. Radiation and convection losses shall not exceed 0.5% of total boiler output.
  - .2 Heating Elements
    - .1 The heating elements shall be individually field replaceable with standard tools.
      - .1 Heating elements shall be mounted on circular flanges for convenient inspection.
      - .2 Heating elements shall be secured using torqued ferrule fittings.
    - .2 The heating elements watt density shall not exceed 75 watts per square inch.
    - .3 The heating elements shall be Incoloy 800 sheathed.
    - .4 The heating elements length shall not exceed 36 inches.
  - .3 Trim
    - .1 Safety valve(s) shall be ASME Section IV approved side outlet type. Size shall be in accordance with code requirements.
    - .2 Combined temperature-pressure gauge shall be mounted on the return connection.
    - .3 Solid state low water cut-off probe control with manual reset and test switch.
    - .4 Status lights for power on, high temperature cutoff, low water cutoff, step status for each step.
      - .1 .Automatic. air vent
      - .2 Auxiliary low water cutoff
      - .3 Alarm horn (electronic sounder)

- .4 Controls
  - .1 All controls to be panel mounted and located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to UL and CSA requirements.
  - .2 When multiple boilers are to be installed together, a system integration control shall be provided to stage up to four (4) boilers using a separate boiler lead-lag panel.
    - .1 The control shall include automatic selection of needed boilers based on load demand. The control shall monitor supply water heater temperature, return water temperature to each boiler, and shall communicate to boilers using a 4-20mA analog signal.
  - .3 Boilers controls shall communicate with BACnet building management system utilizing a protocol translator for requirements other than the native BACnet RTU.
    - .1 Protocol translator mounted in a NEMA 1 panel with power supply and terminals.
    - .2 Protocol translator shipped loose for installation in boiler control panel with required power supply.
  - .4 The boiler controls shall include provisions for remote setpoint.
  - .5 Include provisions for shutting down the boiler on loss of system pump signal.
  - .6 Include a flow switch and provisions for shutting down the boiler on loss of flow.
    - .1 Mount flow switch to the boiler return nozzle
  - .7 Step control capabilities shall include:
    - .1 1-Step: (1) On/Off temperature switch.
    - .2 2-Steps: (2) On/Off temperature switch.
    - .3 3-Steps+: (1) solid state electronic proportional temperature control with progressive step control, adjustable span, and interstage time delay.
      - .1 Temperature and set-point temperature shall be displayed at all times. A supply water temperature transmitter shall be provided and wired to the PID process controller.
      - .2 Control shall be equipped with a touchscreen display for set up, trouble shooting, and operational display, and shall include BACnet communication capability.
      - .3 Control shall include the programming to control of up to two heating demand loops.
      - .4 Set-points and configurations shall be factory pre-configured. Parameter settings are to be established to suit jobsite conditions and to be configured at the time of initial jobsite operation.
      - .5 Boiler shall have capability to have 24/7 remote monitor without connections to a BMS through an encrypted secure channel. The remote interface shall have the following features and capabilities
        - .1 Display real time boiler system operation, runs hours, inlet/outlet water temps, alarms, and more.

- .2 View data on mobile app and customizable online dashboard
  - .3 Multiple user authorization with different levels of access
  - .4 Multiple site integration to allow user to see all boiler plants and control individual plants
  - .5 Email and text alerts
  - .6 Data trending
  - .7 Silicon controlled rectifier (SCR) control
- .5 Electrical Power
- .1 Electrical power supply shall be per electrical drawings
  - .2 Main lugs for supply circuits.
    - .1 Mechanical lugs bolted to copper bus bars or distributions blocks with pressure connectors.
    - .2 Panel electrical short circuit current rating (SCCR) shall be 10,000 amps interrupting current.
  - .3 Fused 120V control circuit transformer.
  - .4 Supplemental internal branch circuit fuses, current limiting, non-renewable, rated at 200,000 amps interrupting capacity.
  - .5 Magnetic contactors rated at 500,000 cycles, 50A resistive up to 600V.
  - .6 Housed in NEMA 250, Type 1A enclosure with louvers.
  - .7 Wiring shall be numbered and color coded to match a wiring diagram.
    - .1 Install factory wiring outside of an enclosure in a metal raceway or conduit.
    - .2 Minimum heating element wire size shall be #8 AWG.
    - .3 Minimum control circuit wire size shall be #16 AWG.
- .6 Quality Control
- .1 Hydrostatic Test: Factory to perform a functional controls test for all safety devices; perform hydrostatic test; and continuity test for contactors and relays.
  - .2 Test and inspect factory-assembled boilers, before shipping, according to most current ASME Boiler and Pressure Vessel Code.
  - .3 All wiring shall be in compliance with the National Electric Code.

## 2.4 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ASME requirements.
- .2 Hot water boilers:
  - .1 Relief valve.s.: ASME rated, 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 .1. set of cleaning tools.
- .3 Pot type chemical feeder.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for heating boiler installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative. of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

#### **3.2 MANUFACTURER'S INSTRUCTIONS**

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

#### **3.3 INSTALLATION**

- .1 Install in accordance with ASME Boiler and Pressure Vessels Code, regulations of Province. having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 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.
- .4 Mount unit level
- .5 .Pipe hot water relief valves full size to nearest drain.
- .6 .Pipe blowdown/drain to blowdown tank/floor drain.
- .7 Oil fired installations - in accordance with CSA B139.

#### **3.4 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.
- .2 Blowdown valves:
  - .1 Run discharge to terminate as indicated.

### **3.5 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.

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for recycling. in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**