

## **PART 1     GENERAL**

### **1.1           SUBMITTALS**

- .1     Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2     Shop drawings; submit drawings stamped and signed for approval by Departmental Representative.
- .3     Shop drawings to show:
  - .1       Mounting arrangements.
  - .2       Operating and maintenance clearances.
- .4     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.
- .5     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.
- .6     Closeout Submittals:
  - .1       Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
  - .2       Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .3       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.
  - .4       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.
  - .5       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.
- .6 Approvals:
  - .1 Submit draft copy of 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.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
  - .1 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 for each service.
  - .4 Make available for reference purposes and inspection.
- .9 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.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

## **1.2 QUALITY ASSURANCE**

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

### **1.3 MAINTENANCE**

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
  - .1 One set of packing for each pump.
  - .2 One casing joint gasket for each size pump.
  - .3 One head gasket set for each heat exchanger.
  - .4 One glass for each gauge glass.
  - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 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 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 All materials used on this project shall be new and CSA approved unless noted otherwise.

## **PART 3 EXECUTION**

### **3.1 PAINTING, REPAIRS AND RESTORATION**

- .1 Do painting in accordance with Section 09 91 23 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

### **3.2 CLEANING**

- .1 Clean interior and exterior of all systems.
- .2 Protect open ends of ducts, diffusers, grilles and registers during construction to prevent ingress of dust and dirt into interior of ducts. If dust or dirt is detected prior to startup, vacuum interior of all ducts and air handling units. Prior to vacuuming use video camera to record condition of ductwork. Also use video camera to record condition of ducts after cleaning.

**3.3 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
  - .1 Submit tests as specified in other sections of this specification.
- .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 - 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.4 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Contractor to 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, trouble-shooting 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.
- .5 Departmental Representative may record these demonstrations on video tape for future reference.

**3.5 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 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-11, Environmental Standard for Paints and Coatings.
- .3 National Fire Code of Canada (NFCC 2005)
- .4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1 SCAQMD Rule 1113, Architectural Coatings.
  - .2 SCAQMD Rule 1168, 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 with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

**Part 2 Products**

**2.1 MATERIAL**

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
  - .1 Primers, Paints, & Coating: in accordance with manufacturer's recommendations for surface conditions.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

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**Part 3            Execution**

**3.1                APPLICATION**

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

**3.2                CONNECTIONS TO EQUIPMENT**

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

**3.3                CLEARANCES**

- .1        Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
- .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 ball 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.

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### 3.7 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 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.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible [and as indicated].
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Install globe valves in bypass around control valves.
  - .6 Use ball valves at branch take-offs for isolating purposes except where specified.
  - .7 Install ball valves for glycol service.
- .15 Check Valves:
  - .1 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

### 3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.

- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere:
    - .1 Maintain fire rating integrity.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### **3.9 ESCUTCHEONS**

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

### **3.10 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - 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.

### **3.11 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.

### **3.12 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition 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            RELATED REQUIREMENTS**

- .1    Not Used

**1.2            REFERENCE STANDARDS**

- .1    American Society of Mechanical Engineers (ASME)
  - .1        ASME B31.1-07, Power Piping.
- .2    ASTM International
  - .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    Canada Green Building Council (CaGBC)
  - .1        Not Used
- .4    Factory Mutual (FM)
- .5    Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1        MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2        MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3        MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6    National Research Council Canada (NRC)
  - .1        National Plumbing Code of Canada 2015 (NPC).
- .7    Underwriter's Laboratories of Canada (ULC)

**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 and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3    Shop Drawings:
  - .1        Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba Province of Canada.
  - .2        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.
- .6 Sustainable Design Submittals:
  - .1 Not Used.

#### **1.4 CLOSEOUT SUBMITTALS**

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

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

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer and return of packaging materials, padding, pallets, crates, in accordance with Section 01 74 21 - Construction/Demolition 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 Performance Requirements:

- .1 Design supports, platforms, catwalks, hangers to withstand seismic events.

## 2.2 SUSTAINABLE REQUIREMENTS

- .1 Not Used

## 2.3 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.

## 2.4 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 copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed and 13 mm FM approved.
  - .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 and MSS-SP69 to MSS-SP58 FM approved.
- .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, to MSS SP69 UL listed FM approved.
  - .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 FM approved.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP69.
- .5 Shop and field-fabricated assemblies:
  - .1 Not Used.

- .6 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.
- .7 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.
- .8 Adjustable clevis: material to MSS SP69 FM approved UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: black.
  - .2 Finishes for copper, glass, brass or aluminum pipework: black , with formed portion plastic coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

## **2.5 RISER CLAMPS**

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

## **2.6 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.

## **2.7 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, and 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.

## **2.8 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. Provide certificate of calibration for each hanger.
- .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.

## **2.9 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 as indicated than equipment; rounded pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

# **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 Not Used.
- .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 Provincial Code, National Plumbing Code of Canada (NPC) authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 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 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### **3.8 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.



- .2 Waste Management: separate waste materials for recycling or reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and

**END OF SECTION**

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**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1       Heat tracing cables for pipes and tanks including controls and installation.

**1.2            REFERENCES**

- .1    Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1       Material Safety Data Sheets (MSDS).

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1       Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .3    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.
- .4    Instructions: submit manufacturer's installation instructions.
  - .1       Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**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.

**Part 2            Products**

**2.1            PIPE/TANK TRACING HEATING CABLES**

- .1    Type A: Parallel zone system, 2 conductor stranded copper bus wires covered with FEPTEFLON or fluoropolymer inner insulation. Resistance heating cable connected to bus wires. Resistance heating cable connection to alternate bus wires covered with teflon tape and overall FEP protective jacket. Heating capacity: as indicated in W/m. For use with 120 V power supply.
- .2    Type B: Copper alloy conductor with X-link polyethylene insulation copper ground braid, PVC protective jacket, cold leads factory spliced and as indicated. Heating capacity: as indicated in W/m. For use with 120 V power supply.

- .3 Type C: Mineral insulated copper conductor with stainless steel sheath and HDPE jacket factory spliced and hermetically sealed cold leads and as indicated. Heating capacity: as indicated in W/m. For use with 120 V power supply.
- .4 Type D: Self-limiting heating cable with copper ground wire, thermoplastic rubber primary and overall jackets. Heating capacity: as indicated in W/m. For use with 120 V power supply.

## **2.2 CONTROLS**

- .1 Thermostat: remote bulb type. Rating as indicated.

## **Part 3 Execution**

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

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

### **3.2 INSTALLATION**

- .1 Install Type A heating cables in accordance with manufacturer's instructions. Coordinate installation with pipe insulation application.
- .2 Install Type B, C, D heating cables in accordance with manufacturer's instructions. Distribute and fasten cable evenly on pipe or tank using pipe strap or tape at maximum spacing 0.5 m. Ensure that heating cables do not touch or cross each other at any point. Run only cold leads in conduit and ensure sensing bulb does not touch cable. Ground shield to building ground. Coordinate cable installation with insulation application. Loop additional cable at fittings, valves, and flanges.
- .3 Make power and control connections.

### **3.3 FIELD QUALITY CONTROL**

- .1 Tests:
  - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Use 500 V Megger to test cables for continuity and insulation value and record readings before, during and after installation.
- .3 Where resistance of 50 megohms or less is measured, stop work and advise Departmental Representative.
- .4 Verification requirements: Contractor's Verification to include:
  - .1 Materials and resources.
  - .2 Storage and collection of recyclables.
  - .3 Construction waste management.
  - .4 Resource reuse.
  - .5 Recycled content.

- .6 Local/regional materials.
- .7 Low-emitting materials.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 COMMISSIONING**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results – Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .2 Use 500 V megger to test cables for continuity and insulation value and record readings before, during and after installation.
- .3 Where resistance of 50 megohms or less is measured, stop work and advise Owner's Representative.

**END OF SECTION**

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**Part 1            General**

**1.1                REFERENCES**

- .1    Definitions:
  - .1        For purposes of this section:
    - .1            "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2            "EXPOSED" - means "not concealed" as previously defined.
    - .3            Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2        TIAC Codes:
    - .1            CRD: Code Round Ductwork,
    - .2            CRF: Code Rectangular Finish.
- .2    Reference Standards:
  - .1        American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1            ANSI/ASHRAE/IESNA 90.1-, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2        ASTM International Inc.
    - .1            ASTM B209M-, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2            ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
    - .3            ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
    - .4            ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - .5            ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.
    - .6            ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - .7            ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
    - .8            ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
    - .9            ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .3        Canadian General Standards Board (CGSB)
    - .1            CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .4        Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

- .5 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

## **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 datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
    - .2 Details of operation, servicing and maintenance.
    - .3 Recommended spare parts list.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.
- .4 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations.

## **1.3 QUALITY ASSURANCE**

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

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

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

## **Part 2 Products**

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

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

## 2.2 THERMAL INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 Code C-1: Rigid mineral fibre board to ASTM C612, without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 Code C-2: Rigid mineral fibre board to ASTM C612, with factory applied all service vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .5 Code C-3: Mineral fibre blanket to ASTM C553 faced without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C553
- .6 Code C-4: Mineral fibre blanket to ASTM C553 faced with factory applied all service vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C553.
- .7 Code C-5: Rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702.
  - .2 Maximum "k" factor: to CAN/ULC-S702.
- .8 Code C-6: Rigid moulded mineral fibre with factory applied all service vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702.
  - .2 Jacket: to CGSB 51-GP-52M.
  - .3 Maximum "k" factor: to CAN/ULC-S702.
- .9 Code C-7: Foil-faced foam sheathing board consisting of a uniform closed-cell polyisocyanurate foam core with factory applied vapour barrier.

## 2.3 JACKETS

- .1 Canvas:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.
  - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.
- .3 Aluminum:
  - .1 To ASTM B209 without moisture barrier as scheduled in PART 3 of this section.
  - .2 Thickness: 0.50 mm sheet.

- .3 Finish: Stucco embossed.
- .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.
- .4 Polyvinyl Chloride (PVC):
  - .1 One-piece cut and curled type to CAN/CGSB-51.53 with pre-formed shapes for fittings as required.
  - .2 Colour: white
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 65 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: 20 mil.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

## 2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
    - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
  - .1 220 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921
- .5 Outdoor Vapour Retarder Mastic:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
  - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>.
- .6 Tape: self-adhesive, aluminum 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
  - .1 Maximum VOC limit 50g/L to SCAQMD Rule 1168 GSES GS-36.
- .8 Canvas adhesive: washable.
  - .1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 2 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.



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

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

**3.2 PRE-INSTALLATION REQUIREMENTS**

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

**3.3 INSTALLATION**

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

**3.4 DUCTWORK INSULATION SCHEDULE**

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

Duct System	Minimum Thermal Resistance (RSI)	Insulation Type	Location of Insulation	Unit Thermal Resistance (RSI/25mm)	Insulation Thickness (mm)	Total Thermal Resistance (RSI)
<b>Temperature Difference = Over 22°C</b>						
Outdoor Air Intake / exhaust- Rectangular	0.88	C-2/C-4	Exterior	0.67	50	1.34
Outdoor Air Intake / exhaust - Round	0.88	C-4/C-6	Exterior	0.67	50	1.34

**3.5 INSULATION TYPE**

- .1 Rectangular Ductwork:
  - .1 Less than 1200 mm wide: Blanket insulation.
  - .2 Over 1200 mm wide: Rigid board insulation.
- .2 Round Ductwork:

- .1 Ductwork located in mechanical rooms: Rigid, moulded insulation.
- .2 Ductwork located in non-mechanical rooms: Blanket insulation.

### **3.6 JACKET TYPE**

- .1 Location: Indoor Mechanical Rooms:
  - .1 Rectangular Ductwork:
    - .1 Canvas jacket.
  - .2 Round Ductwork:
    - .1 PVC jacket.
- .2 Location: Indoor Non-Mechanical Rooms:
  - .1 Rectangular Ductwork:
    - .1 Canvas jacket.
  - .2 Round Ductwork:
    - .1 Canvas jacket.
- .3 Location: Outdoors:
  - .1 Rectangular Ductwork:
    - .1 Aluminum jacket.
  - .2 Round Ductwork:
    - .1 Aluminum jacket.

### **3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            SUMMARY**

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

**1.2            REFERENCES**

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

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

### **1.3 DEFINITIONS**

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

### **1.4 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) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.

### **1.5 QUALITY ASSURANCE**

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.
- .3 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 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.

## **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 Code A-1: rigid moulded fibre glass without factory applied vapour retarder jacket.
  - .1 Insulation: to CAN/ULC-S702.
  - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 Code A-2: rigid moulded mineral wool with or without factory applied jacket.
  - .1 Insulation: to ASTM C5347.
  - .2 Jacket: to CAN/ULC S102.
  - .3 Maximum "k" factor: to ASTM C518
- .5 Code A-3: rigid moulded fibre glass with factory applied all service vapour retarder jacket.
  - .1 Insulation: to CAN/ULC-S702.
  - .2 Jacket: to CGSB 51-GP-52M.
  - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 Code A-4: flexible closed-cell tubular elastomer.
  - .1 Insulation: to ASTM C534.
  - .2 Maximum "k" factor: to ASTM C534

- .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

## **2.3 INSULATION SECUREMENT**

- .1 Tape: self-adhesive, aluminum 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, 19mm wide, 0.5 mm thick.

## **2.4 CEMENT**

- .1 Thermal insulating and finishing cement:
  - .1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

## **2.5 VAPOUR RETARDER LAP ADHESIVE**

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

## **2.6 INDOOR VAPOUR RETARDER FINISH**

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

## **2.7 OUTDOOR VAPOUR RETARDER FINISH**

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

## **2.8 JACKETS**

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
  - .2 Colours: to match adjacent finish paint by Departmental Representative.
  - .3 Minimum service temperatures: -20 degrees C.
  - .4 Maximum service temperature: 65 degrees C.
  - .5 Moisture vapour transmission: 0.02 perm.
  - .6 Thickness: 20 mil.
  - .7 Fastenings:
    - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
    - .2 Tacks.
    - .3 Pressure sensitive vinyl tape of matching colour.
  - .8 Special requirements:
    - .1 Outdoor: UV rated material at least 0.5 mm thick.
- .2 Canvas:

- .1 220 and 120 gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: 0.50 mm sheet.
  - .3 Finish: corrugated.
  - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
  - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

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

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

## **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 manufacturer's 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 INSTALLATION OF ELASTOMERIC INSULATION**

- .1 Insulation to remain dry. Overlaps to manufacturer's instructions. Ensure tight joints.

- .2 Provide vapour retarder as recommended by manufacturer.

### 3.5 PIPING INSULATION THICKNESSES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.  
.2 Thickness of insulation as listed in following table.

Type of System	Design Operating Temperature Range	Thermal Conductivity of Insulation		Insulation Type	Nominal Pipe Diameter				
		Conductivity Range W/m·°C)	Mean Rating Temperature (°C)		Runouts ≤ 50	≤ 25	32 to 50	63 to 100	≥ 125
					Minimum thickness of pipe insulation				
Heating Systems (Hot Water and Glycol)	> 177	0.046 - 0.049	121	A-1	38	63	63	75	88
	122 - 177	0.042 - 0.045	93	A-1	38	50	63	63	88
	94 - 121	0.039 - 0.043	65	A-1	25	38	38	50	50
	61 - 93	0.036 - 0.042	52	A-1	25	25	25	38	38
	46 - 60	0.035 - 0.040	38	A-1	25	25	25	25	38
Cooling Systems (Brine, Refrigerant)	5 - 13	0.033 - 0.039	24	A-4	25	25	25	25	25
	< 5	0.033 - 0.039	24	A-4	25	25	38	38	38
<u>Domestic Water Systems</u>									
<i>Conditioned Space</i>									
Hot Water		0.035 - 0.040	38	A-1	25	25	25	38	38
Cold Water		0.046 - 0.049	38	A-3	38	63	63	75	88
Tempered Water		0.035 - 0.040	38	A-1	25	25	25	38	38
Plumbing Vents		0.046 - 0.049	38	A-3	25	25	25	25	25

- .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.

### 3.6 FINISHES:

- .1 Location: Indoors, concealed:  
.1 Steam piping: All service jacket. If all service jacket is not available, use canvas jacket.  
.2 All other piping: All service jacket  
.2 Location: Indoors, exposed:  
.1 Steam piping: Canvas jacket  
.2 All other piping: PVC jacket  
.3 Location: Outdoors:  
.1 All piping: Aluminum jacket



**3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END END OF SECTION**

**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 electric and electronic control system for HVAC and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.2 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect electric and electronic control systems from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 THERMOSTAT (LINE VOLTAGE-HEATING AND COOLING)**

- .1 Line voltage, wall-mounted thermostat, for cooling heating-cooling with:
  - .1 Full load rating: 16 A at 120 V.
  - .2 Temperature setting range: 5 degrees C to 30 degrees C.
  - .3 Thermometer range: 5 degrees C to 30 degrees C.
  - .4 Markings in 5 degree increments.
  - .5 Differential temperature fixed at 1.1 degrees C.
- .2 Acceptable material: KControls Thermostat KJ 16110 or approved equal.

**2.2 THERMOSTAT (LOW VOLTAGE)**

- .1 Low voltage wall thermostat for radiant floor:
  - .1 For use on 24 V circuit at 1.5 A capacity.
  - .2 Temperature setting range: 5 degrees C to 25 degrees C.
- .2 Acceptable material: Honeywell AQ1000 Thermostat or approved equal.

## **2.3 SLAB TEMPERATURE (REMOTE BULB)**

- .1 Remote bulb type thermostat with:
  - .1 Sensing device: thermistor (10 kΩ @ 25°C)
  - .2 3 m copper capillary tube. Extent as required.
  - .3 Moisture and dust-resistant.
- .2 Acceptable material: Honeywell AQ12C20 Floor/Slab Temperature Sensor or approved equal.

## **2.4 THERMOSTAT GUARDS**

- .1 Thermostat guards: lockable, clear plastic. Slots for air circulation to thermostat.

## **2.5 SWITCHING RELAY**

- .1 Intermediate switching between low-voltage controllers to line-voltage device.
- .2 Acceptable material: Honeywell RA89A Switching relay or approved equal.

## **2.6 TRANSFORMER**

- .1 120 VAC – 24 VAC transformer
  - .1 Class 2
  - .2 40VA
  - .3 Electrical Ratings: Primary voltage--120 Vac; Secondary voltage--26.5 V.O.C
- .2 Acceptable material: Honeywell AT41 or approved equal.

# **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 electric and electronic control 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 INSTALLATION**

- .1 Install control devices.
- .2 On outside wall, mount thermostats on bracket or insulated pad 25 mm from exterior wall.

- .3 Install remote sensing device and capillary tube in metallic conduit. Conduit enclosing capillary tube must not touch heater or heating cable.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCES**

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
  - .1 ANSI/AWS A5.8/A5.8M-11, AMD1 Specification Filler Metals for Brazing and Braze Welding.
- .2 ASME
  - .1 ANSI/ASME B16.4-[06, Gray-Iron Threaded Fittings Classes 125 and 250.
  - .2 ANSI/ASME B16.15-11, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
  - .3 ANSI B16.18-12, Cast Copper Alloy, Solder Joint Pressure Fittings.
  - .4 ANSI/ASME B16.22-12, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 ASTM International
  - .1 ASTM B32-08, Standard Specification for Solder Metal.
  - .2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
  - .4 ASTM B88M-05(2011), Standard Specification for Seamless Copper Water Tube Metric.
  - .5 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**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 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.
  - .2 Indicate on manufacturers catalogue literature the following: valves.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

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**1.3 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual in accordance with 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 with manufacturer's written instructions.
- .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 in dry location 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.

**Part 2 Products**

**2.1 TUBING**

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

**2.2 FITTINGS**

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

**2.3 FLANGES**

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

**2.4 JOINTS**

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

**2.5 VALVES**

- .1 Connections:
  - .1 NPS 2 and smaller: ends for soldering.
- .2 Swing check valves:

- .1 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 Ball Valves:
  - .1 NPS 2 and under:
    - .1 Body and cap: cast high tensile bronze to ASTM B62.
    - .2 Pressure rating: 4140-kPa CWP, 860 kPa steam.
    - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders and solder ends to ANSI.
    - .4 Stem: tamperproof ball drive.
    - .5 Stem packing nut: external to body.
    - .6 Ball and seat: replaceable hard chrome solid ball and Teflon seats.
    - .7 Stem seal: PTFE with external packing nut.
    - .8 Operator: removable lever handle.
    - .9 Locking lever: on expansion tank valve
    - .10 No Lead Brass

### **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 HVAC fans installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative.
  - .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 PIPING INSTALLATION**

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.

- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Assemble piping using fittings manufactured to ANSI standards.

### **3.4 VALVE INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .3 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .4 Install ball valves for glycol service.

### **3.5 FLUSHING AND CLEANING**

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

### **3.6 FILLING OF SYSTEM**

- .1 Refill system with glycol.

### **3.7 FIELD QUALITY CONTROL**

- .1 Testing:
  - .1 Test system in accordance with Section 21 05 00 - Common Work Results for Mechanical.
  - .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.
- .2 Balancing:
  - .1 Balance water systems to within plus or minus 5% of design output.
- .3 Glycol Charging:
  - .1 Provide mixing tank and positive displacement pump for glycol charging.



- .2 Retest for concentration to ASTM E202 after cleaning.
- .3 Provide report to Departmental Representative

### **3.8 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCES**

- .1 ASME
  - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 ASTM International
  - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01(2011), Standard Specification for Gray 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 CSA Group
  - .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 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.

**1.3            CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: submit operation and maintenance data for wall exhaust fan and related accessory components for incorporation into manual in accordance with 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 with manufacturer's written instructions.
- .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 in dry location 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.

## **Part 2 Products**

### **2.1 DIAPHRAGM TYPE EXPANSION TANK**

- .1 Vertical steel pressurized diaphragm type expansion tank.
- .2 Capacity: 30 L.
- .3 Size: 318 mm long x 356 mm diameter.
- .4 Diaphragm sealed in [elastomer] [EPDM] suitable for 115 degrees C operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification 520 kPa.
- .6 Air precharged to 84 kPa (initial fill pressure of system).
- .7 Base mount for vertical installation.
- .8 Supports: provide supports with hold down bolts and installation templates

### **2.2 AUTOMATIC AIR VENT**

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 310 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.

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

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

### **2.4 PIPE LINE STRAINER**

- .1 NPS 1/2 to 2: bronze body to ASTM B62, solder end connections, Y pattern.
- .2 Blowdown connection: NPS 1.
- .3 Screen: stainless steel with 1.19 mm perforations.
- .4 Working pressure: 860 kPa.

### **2.5 GLYCOL FILL STATION**

- .1 25 litre (6.6 U.S. gallon) storage/mixing tank with molded-in level gauge
- .2 125 mm (5") fill/access opening and cover;
- .3 Pump suction hose
- .4 Inlet strainer w/ check valve;

- .5 Pressure pump with fuse protection;
- .6 Low fluid level pump cut-out float switch
- .7 UL listed and fused power supply adapter with LED power indicator light,
- .8 115/60/1 to 24 VDC 50 watts AC, supplied loose for field installation.
- .9 Feeder shall be compatible with glycol solutions of up to 50% concentration.
- .10 Option Low level Alarm Panel c/w Remote Monitoring Dry Contacts and Selectable Audible Alarm
- .11 Basis of design: Axiom Industries Ltd. model mf200 or approved equivalent.

### **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 to glycol tank
- .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.

**3.5 AIR VENTS**

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

**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 glycol tank.

**3.8 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1    Not Used

**1.2            REFERENCE STANDARDS**

- .1    ASME
  - .1    ASME B16.22-12, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
  - .2    ASME B16.24-11, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.
  - .3    ASME B16.26-11, Cast Copper Alloy Fittings for Flared Copper Tubes.
  - .4    ASME B31.5-10, Refrigeration Piping and Heat Transfer Components.
- .2    ASTM International
  - .1    ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.
  - .2    ASTM B280-08, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3    CSA Group
  - .1    CSA B52-05 (R2009), B52 Package, Mechanical Refrigeration Code.
- .4    Environment Canada (EC)
  - .1    EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

**1.3            ADMINISTRATIVE REQUIREMENTS**

- .1    Pre-installation Meetings:
  - .1    Convene pre-installation meeting 1 week prior to beginning work of this Section with Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
    - .1    Verify project requirements.
    - .2    Review installation and substrate conditions.
    - .3    Co-ordination with other building construction sub-trades.
    - .4    Review manufacturer's written installation instructions and warranty requirements.

**1.4            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 refrigerant piping, fittings and equipment, and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 43 - Environmental Procedures and 01 35 29.06 - Health and Safety Requirements. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Sustainable Design Submittals:
  - .1 Not Used

## **1.5 CLOSEOUT SUBMITTALS**

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

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .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 in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect refrigerant piping, fittings and equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **Part 2 Products**

### **2.1 TUBING**

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

### **2.2 FITTINGS**

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.

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

### **2.3 PIPE SLEEVES**

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

### **2.4 VALVES**

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

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for refrigerant piping 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 GENERAL**

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05 - Installation of Pipework.

### **3.4 BRAZING PROCEDURES**

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

### **3.5 PIPING INSTALLATION**

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

### **3.6 PRESSURE AND LEAK TESTING**

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

### **3.7 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.

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

### **3.8 DEMONSTRATION**

- .1 Instructions:

- .1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

### **3.9 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition 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            REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
  - .1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
  - .3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - .3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
  - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

**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 metal ducts and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products****2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	[C]
250	[C]
125	[C]

- .2 Seal classification:
  - .1 Class C: transverse joints and connections made air tight with sealant] [tape] [or combination thereof.

**2.2 SEALANT**

- .1 Sustainability Characteristics:
  - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
  - .2 Adhesives and sealants: VOC limit 30 g/L maximum to SCAQMD Rule 1168 GS-36.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

**2.3 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
  - .1 Rectangular: standard radius or short radius with single thickness turning vanes centreline radius: 1.0 times width of duct.
  - .2 Round: smooth radius five piece, centreline radius: 1.0 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.

- .4 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .5 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

## 2.4 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA

## 2.5 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Strap hangers: of same material as duct [but next sheet metal thickness heavier than duct].
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to SMACNA.
  - .3 Hangers: galvanized steel angle with galvanized steel rods SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp steel plate washer.
  - .3 For steel beams: manufactured beam clamps:

## 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 HVAC fans installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative.

- .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 Do work in accordance with NFPA 90A, NFPA 90B, & SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
  - .1 Insulate strap hangers 100 mm beyond insulated duct Ensure diffuser is fully seated.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

### 3.3 HANGERS

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

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500

### 3.4 WATERTIGHT DUCT

- .1 Provide watertight duct for:
  - .1 Fresh air intake.
  - .2 As indicated.

### 3.5 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

### 3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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

**END OF SECTION**



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**Part 1 General**

**1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 – Submittal Requirements.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature and data sheets for motorized backdraft damper and actuator include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Installation Instructions:
  - .1 Submit manufacturer's installation instructions.

**1.2 CLOSEOUT SUBMITTALS**

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

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect dampers and actuator 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 in accordance with section 01 74 21 – Construction/Demolition Waste Management and Disposal.

**Part 2 Products**

**2.1 MOTORIZED BACKDRAFT DAMPER AND ACCESSORIES**

- .1 Extruded aluminum interlocking blades with extruded silicone, aluminum and galvanized linkage, blade edge seals, extruded aluminum frame.
  - .1 Positive seal with leakage less than 1%.
  - .2 Pressure fit self-lubricated bronze bearings.
  - .3 Inward mount, flange on outside.
  - .4 Bird and insect screen.
  - .5 Size to coordinate with wall exhaust fan.
- .2 Insulated aluminum dampers:

- .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
- .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.
- .3 Acceptable material: Tamco 9000 SC Motorized Backdraft Damper or approved equal.
- .4 Actuator:
  - .1 Electric.
  - .2 120V, 60Hz.
  - .3 Operation: Two position – spring return.
    - .1 Actuator will power to either the open or the closed position. When power supply is removed or turned off, the actuator will fail to the initial position by means of a spring.
  - .4 End switch.
  - .5 External kit for mounting of actuator outside the airstream.
  - .6 Provide extended linkage to allow placement outside of the cold air trap: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
  - .7 Acceptable material: Bellimo LF120-S or approved equal complete with external kit mounting, extended linkage and end switch.
- .5 Insulated cold air trap: as indicated.
- .6 Weather Hood:
  - .1 1.21mm (18 gauge) galvanized metal, factory assembled, with rust-proof bird and insect screen, exterior mount, concealed fastening, size to suit.
- .7 Interconnection to wall exhaust fan thermostatically controlled Section 23 34 00 – HVAC Fans.
- .8 Provide all components and accessories to ensure a fully functioning exhaust/make-up air system.

## **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 damper 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 Departmental Representative.

### **3.2 INSTALLATION**

- .1 Install where indicated in prepared opening.

- 
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
  - .3 Ensure dampers are observable and accessible for ease of maintenance.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/AMCA Standard 99-2010, Standards Handbook.
  - .2 ANSI/AMCA Standard 210-2007 / (ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .3 ANSI/AMCA Standard 300-2008, Reverberant Room Method for Sound Testing of Fans.
  - .4 ANSI/AMCA Standard 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual .
    - .1 MPI #18, Primer, Zinc Rich, Organic.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Installation Instructions:
  - .1 Submit manufacturer's installation instructions.
- .4 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.
  - .2 Provide:
    - .1 Fan performance curves showing point of operation, bhp and efficiency.
    - .2 Sound rating data at point of operation.
  - .3 Indicate:
    - .1 Motors, sheaves, bearings, shaft details
    - .2 Performance

**1.3            CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data: submit operation and maintenance data for wall exhaust fan and related accessory components for incorporation into manual in accordance with Section 01 78 00 – Closeout Submittals.

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**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .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 in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC fans from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 SYSTEM DESCRIPTION**

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

**2.2 WALL EXHAUST FAN**

- .1 Packaged Wall Fan
- .2 Direct drive.
- .3 Aluminum Propeller
- .4 Motor totally enclosed and thermally protected.
- .5 Steel welded box housing, powder coat finish.
- .6 Aluminium louvre shutters supported by nylon bushings.
- .7 Guards, heavy wire chrome plated OSHA type on intake side of fan.
- .8 Fans to be fully factory assembled.
- .9 Dimensions 500mm x500mm maximum outer dimensions
- .10 RPM: 1075
- .11 HP: 1/6.

- .12 Litres per second: 353 (748 CFM).
- .13 115V, 1 Phase. 73 watts
- .14 Weight: 28 kg.
- .15 dB(A): 55.
- .16 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .17 Acceptable material: Loren Cook 12XP26D103 or approved equal.

## **2.3 ACCESSORIES AND CONTROLS**

- .1 Weather Hood:
  - .1 1.21mm (18 gauge) galvanized metal, factory assembled, with rust-proof bird and insect screen, exterior mount, concealed fastening, size to suit.
- .2 Thermostatically controlled.
  - .1 Thermostat.
    - .1 Line voltage thermostat.
    - .2 Moisture proof box.
    - .3 Weatherproof and corrosion proof with polycarbonate thermoplastic construction and stainless steel capillary sensor.
    - .4 16 Amp rating at 120V.
    - .5 Acceptable material: KKontrols Thermostat KJ 16110 or approved equal.
- .3 Interconnection to make-up air motorized damper Section 23 33 15 – Dampers - Operating.

## **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 HVAC fans installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 FAN INSTALLATION**

- .1 Install in accordance with exhaust fan manufacturer's instructions.
- .2 Ensure fan components requiring servicing are easily accessible.
- .3 Install in prepared wall opening of size indicated.
- .4 Secure fan using factory mounting holes with fasteners as recommended by fan manufacturer to suit substrate.

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.5 Electrical connections by electrical.

.6 Install accessory components.

### **3.3 ANCHOR BOLTS AND TEMPLATES**

.1 Size anchor bolts to withstand seismic acceleration and velocity forces.

### **3.4 CLEANING**

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.

.3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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

**END OF SECTION**

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**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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2    Indicate following:
    - .1    Capacity.
    - .2    Throw and terminal velocity.
    - .3    Noise criteria.
    - .4    Pressure drop.
    - .5    Neck velocity.

**1.2            CLOSEOUT SUBMITTALS**

- .1    Operation and Maintenance Data: submit operation and maintenance data for wall exhaust fan and related accessory components for incorporation into manual in accordance with Section 01 78 00 – Closeout Submittals.

**1.3            DELIVERY, STORAGE AND HANDLING**

- .1    Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2    Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.
  - .3    Replace defective or damaged materials with new.

**Part 2           Products**

**2.1            SYSTEM DESCRIPTION**

- .1    Performance Requirements:
  - .1    Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.



## **2.2 GENERAL**

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- .2 Frames:
  - .1 Full perimeter gaskets.
  - .2 Plaster frames where set into plaster or gypsum board and as specified.
  - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as directed by Departmental Representative

## **2.3 MANUFACTURED UNITS**

- .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

## **2.4 REGISTERS, GRILLES, DIFFUSERS**

- .1 Sidewall and ceiling return air and transfer air grilles (standard duty).
  - .1 C70 LA B15 curved face border, 45° deflection, 50 mm spaced 19 mm blades in short dimension, screw fastened, aluminum finish.

# **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 diffuser, register and grille 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**

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere as indicated.

## **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
  - .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
    - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCES**

- .1       American Boiler Manufacturers Association (ABMA)
- .2       ASME
  - .1       ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .3       CSA Group
  - .1       CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.
- .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       Installation Instructions:
  - .1       Submit manufacturer's installation instructions.

**1.3            CLOSEOUT SUBMITTALS**

- .1       Operation and Maintenance Data: submit operation and maintenance data for wall exhaust fan and related accessory components for incorporation into manual in accordance with 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 with manufacturer's written instructions.
- .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 in dry location 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.

**Part 2           Products**

**2.1            GENERAL**

- .1       Packaged boiler:

- .1 Complete with necessary accessories and controls.
- .2 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7 & CAN1-3.1.
- .3 Ready for attachment to piping, electrical power, controls.
- .4 Designed and constructed to ASME Boiler and Pressure vessel Code.
- .5 CRN (Canadian Registration Number), to CSA B51.
- .6 Boiler/burner package to bear ULC label.
- .2 Electrical:
  - .1 Power: 208 V, phase, 60 Hz.
  - .2 Controls: 120 V, 1 phase, 60 Hz.
  - .3 Electrical components: CSA approved.
- .3 Controls: factory wired. Enclosed in EEMAC 1 steel cabinet.
- .4 Mounting:
  - .1 Structural steel base, lifting lugs.
- .5 Start-up, instruction, on-site performance tests: 0.5 days per boiler.
- .6 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.
- .7 Temporary use by contractor:
  - .1 Contractor may use boilers only after written approval from Departmental Representative.
  - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
  - .3 Refurbish to as-new condition before final inspection and acceptance.

## **2.2 ELECTRIC BOILER**

- .1 Immersion resistance type heating elements, wired to obtain 1 step of 2.25 kW each and replaceable without special tools.
- .2 Boiler assembly to include:
  - .1 Control cabinet.
  - .2 Terminal blocks.
  - .3 Fuses: High Rupture Capacity (HRC) form 1:
    - .1 Heating elements.
    - .2 Primary of control circuit transformer.
  - .4 Pilot light for low water or high pressure/temperature.
  - .5 Manual on-off control circuit switch and "power on" pilot light.
- .3 Controls:

- .1 Water temperature regulated by sequencing step controller with sensors operating between two adjustable set points operates magnetic contactors to energize heating elements.
- .2 High limit control to de-energize heating elements at 99 degrees C & 207 kPa.

## **2.3 AUXILIARIES**

- .1 Provide auxiliaries for each boiler and to meet ASME requirements.
- .2 Hot water boilers:
  - .1 Relief valve: ASME rated, set at 207 kPa, to release entire boiler capacity.
  - .2 Pressure gauge: 90 mm diameter complete with shut-off cock.
  - .3 Thermometer: 115 mm diameter range 10 to 190 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

## **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 HVAC fans installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative.
  - .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 glycol tank.
- .6 Pipe blowdown/drain to blowdown tank.

### **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 glycol tank.
- .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 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CSA C22.2 No.46, Electric Air-Heaters.
- .2 Underwriters' Laboratories (UL)
  - .1 UL 1042, Standard for Electric Baseboard Heating Equipment.

**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 convectors and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.

**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 convectors for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect convectors from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

**Part 2 Products**

**2.1 BASEBOARD CONVECTORS**

- .1 Heaters: to CSA C22.2 No.46, UL 1042 standard wattage density as indicated with connection box one ends.

- .1 Element through-type stainless steel fitted with aluminum convector vanes and resistor wire enclosed in mineral insulation in copper sheath.
- .2 Element: locked to cabinet and supported at additional points throughout length to allow for linear expansion with non-metallic supports.
- .3 Cabinet: to CSA C22.2 No.46, UL 1042, pre-drilled back for securing to wall. Integral air diffusion reflector with wireway at bottom and built-in clamps.
  - .1 Bottom inlet/front outlet.
  - .2 Panel: steel metal thickness, bottom 1 mm, front 1 mm thick.
  - .3 Finish: phosphatized and finished with powder coated finish, White colour.

## **2.2 CONTROLS**

- .1 Integral thermostats 1 pole to control load 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 convectors 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**

- .1 Install baseboard convector heaters, blank sections and controls.
- .2 When wireway is used, remove knock-outs and insert insulating bushing between units.
- .3 Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.
- .4 Make power and control connections.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Ensure heaters and controls operate correctly.

### **3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - 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 11 - Cleaning.
- .3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.5 PROTECTION**

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

**END OF SECTION**

PART 1 - GENERAL

1.1 ACTION AND  
INFORMATIONAL  
SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's product submittal data for all components, including pressure and temperature rating, oxygen-barrier performance, and fire-performance characteristics.
  - .2 Provide manufacturer's product data for pump.
  - .3 Provide manufacturer's product data for thermostat.
  - .4 Provide manufacturer's product data for remote slab sensor monitoring device assembly components.
  - .5 Submit manufacturer's installation instructions.
  - .6 Submit manufacturer's underfloor heating system start-up instructions.
    - .1 Submit manufacturer's start-up pressure testing instructions.
    - .2 Submit manufacturer's slab sensor testing instructions.
- .3 Shop Drawings:
  - .1 Submit the following piping layouts, calculations and reports.
    - .1 Piping layout scale: 1:100.
    - .2 Submit manufacturer's detailed drawings showing layouts, fixing details and piping details of all areas where hydronic radiant systems are indicated.
    - .3 Submit a cross-referenced manifold schedule indicating loop lengths, tubing diameter, flow rate, operating water temperatures, fluid and loop pressure drop and manifold pressure drop to meet the required heating performance indicated along with product and performance data for each component.
    - .4 Submit a valve and pump schedule to suit. Indicate number, type, size, model and service. Provide supporting product data.
    - .5 Ideal performance to maintain temperatures above +5°C.
    - .6 Provide calculations that support the heating performance requirements of the hydronic radiant system. Calculations must show the required flow rate, operating temperatures and pressure drops through the system for heating.
    - .7 Submit manifold details, including all connections, fittings, valves and mounting requirements.
    - .8 Provide drawings showing piping manifold and pump locations and installation details.
    - .9 Provide control sequences and requirements for control hardware devices. Indicate compliance and coordination requirements.
    - .10 Provide piping sample with complete print stream indicating certification of properties.
    - .11 Provide the following documents: water supply summary, radiant panel schedule and details, heating system

summary, heating system details.

## 1.2 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data:
  - .1 Submit operation and maintenance data for valves, manifolds, pumps, sensors and controls.
- .3 Close-out Documentation:
  - .1 Submit manufacturer's report detailing that the hydronic radiant system has been installed in accordance with the contract documents and the manufacturer's specified instructions. Provide manufacturer's instructions. Note any exceptions.
  - .2 Submit start-up report demonstrating that system meets required capacity, is fully functional and commissioned to the satisfaction of system manufacturer.
  - .3 Provide final as-built drawings indicating tubing layout, manifold locations, zoning and manifold schedules with details required for installation of the system.
  - .4 Provide documentation indicating that the installer is trained to install the manufacturer's products.
  - .5 Warranty documents specified herein.
- .4

## 1.3 SPARE PARTS

- .1 For maintenance purposes, provide two (2) spare cartridges for the hydronic circulator pumps.
- .2 Deliver to site in manufacturer's packaging complete with typewritten label affixed identifying: "SPARE CARTRIDGE FOR RADIANT FLOOR HEATING SYSTEM HYDRONIC CIRCULATOR PUMP".
- .3 Locate as directed by Departmental Representative.

## 1.4 WARRANTY

- .1 Submit manufacturer's standard executed warranty.
  - .1 Warranty Period for PEX Tubing: 30-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of installation.
  - .2 Warranty Period for Manifolds and Fittings: 5-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of installation.
  - .3 Installer must be certified by the manufacturer as part of warranty conditions.

## 1.5 QUALITY ASSURANCE

- .1 Installer Qualifications:
  - .1 Installer shall have five years demonstrated experience on projects with documentation proving successful completion of hydronic radiant system installation and training by the PEX tubing manufacturer.
  - .2 Installer must receive training and certification by the radiant

heating system manufacturer.

- .2 Installation Qualifications:
  - .1 Installation must be by skilled tradesmen holding a trade qualification license or apprentices under the supervision of a licensed tradesman.
- .3 Manufacturer:
  - .1 Hydronic radiant system manufacturer shall have proven successful track record for fifteen years minimum, successfully completing installations of similar type and scope.
  - .2 Manufacturer shall provide a representative for field support during the installation and commissioning of the hydronic radiant system.
- .4 Pre-installation Meetings:
  - .1 Verify project requirements, substrate conditions, manufacturer's installation instructions and warranty requirements.
  - .2 Review project construction timeline to ensure compliance or discuss modifications as required.
  - .3 Interface with work of other Specification sections.
  - .4 Establish the frequency for site visits by the Departmental Representative and inspections by the PEX tubing manufacturer's representative.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .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 off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area. Do not expose products to direct sunlight.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section. Packaging Waste Management: Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

#### 1.7 OBSERVED MOCK-UP

- .1 Construct mock-up in presence of Departmental Representative and in accordance with Section 01 45 00 – Quality Control.
- .2 Make arrangements for radiant floor heating manufacturer's representative to be present.
- .3 Mock-up to be performed at the first freezer installation (Walk-in

Freezer No.1) installation as follows:

- .1 Prior to mock-up:
  - .1 Perimeter steel angle in place.
  - .2 Concrete floor substrate cleaned.
  - .3 Radiant floor heating system fully installed with exception of over-pour.
  - .4 System pre-tested and found to be fully functional.
- .2 Mock-up:
  - .1 Step 1: Contractor to demonstrate radiant floor heating system function to the satisfaction of the Departmental Representative and the radiant floor heating manufacturer's representative.
  - .2 Step 2: Observed installation of over-pour.
- .4 Have on site for review at mock-up location:
  - .1 Complete set of drawings and specifications.
  - .2 All materials and accessories with original wrapping/containers identifying product.
  - .3 Reviewed shop drawings/product data.
  - .4 Radiant floor heating manufacturer's detailed installation instructions.
- .5 Construct mock-up in accordance with manufacturer's written instructions.
- .6 Provide 72-hour notice of start time and date of mock-up installation.

## PART 2 - PRODUCTS

### 2.1 SYSTEM - GENERAL

- .1 Hydronic radiant heating system, complete with all components and accessories required for a fully functioning system meeting intent and description of operations. The installation is to be on existing concrete floor, below the floor panels of each of two new Walk-in Freezers.
  - .1 Overall thickness of system as indicated.
- .2 Description of operations:
  - .1 Intent:
    - .1 To prevent long-term freezing condition below the insulated Walk-in Freezer floor panels while not providing excessive heat underfloor that would affect the proper functioning of the freezer.
  - .2 The system is to be self-regulating.
  - .3 The circulating pump to turn on and off based on a call for floor heatings.
  - .4 Liquid (food grade glycol) in the radiant floor heating system to receive heat through an electric boiler.
  - .5 An audible alarm is tied to the system triggered by a flow switch and aquastat on the return, announcing that flow has been interrupted and/or that temperature is outside of the required range.
  - .6 A removable/replaceable slab sensor is installed within the hydronic heating system overpour to monitor and display slab temperature. A warning flashing indicator light is tied to the system announcing the temperature is out of set-point range.

- .3 Each Walk-in Freezer is to have a completely independent hydronic radiant heating system tied to one common boiler, each with its own equipment (pump, pipe accessories, and manifold) and controls.
- .4 Design parameters:
  - .1 Maintain temperatures under each Walk-in Freezer at approximately, but not below +5°C, when freezer is in operation.
- .5 Manufacturer-supported system start-up and commissioning phase support is a requirement.
- .6 System compatibility:
  - .1 To ensure system compatibility consistency, all products, manifolds and components specified herein must be manufactured by and/or available from the PEX tubing manufacturer.
  - .2 Acceptable manufacturer: Uponor or approved equal.
- .7 System components:
  - .1 Tubing complete with fittings:
    - .1 Each freezer to have its own independent underfloor radiant heating system with heat source originating from that particular freezer's refrigeration system.
      - .1 Walk-in Freezer No.1: two loops/circuits.
      - .2 Walk-in Freezer No.2: two loops/circuits.
  - .2 Fluid type: food grade glycol minimum 30% concentration.
  - .3 Controls: (separate controls are required for each of the two radiant floor heating systems)
    - .1 Thermostats.
      - .1 As recommended by radiant floor heating system manufacturer.
    - .2 Control modules.
    - .3 Pump relays.
    - .4 Audible alarms triggered by flow switches and aquastats at 10 degrees C.
    - .5 Flow switches and aquastats on return.
  - .4 Manifolds.
  - .5 Hydronic circulator pumps.
  - .6 Glycol tanks.
  - .7 Electric boiler heat exchangers by-pass and thermostatic valves.
    - .1 Refer to Section 23 52 00 Heating Boilers.
  - .8 Slab sensor system to monitor and display slab temperature. A warning flashing indicator light is tied to the system announcing the temperature is out of set-point range.
  - .9 Lamacoid signage.

2.2 CROSS-LINKED  
POLYETHELENE (PEX) TUBING  
AND FITTINGS

- .1 Tubing:
  - .1 Material: Engel-method crosslinked polyethylene (PEX-a).
  - .2 Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877 and tested for compliance by an independent third-party agency.
  - .3 Pressure Ratings: Standard Grade hydrostatic design and pressure ratings as issued by the Plastics Pipe Institute (PPI), a division of the Society of the Plastics Industry (SPI):

- .1 23 degrees C at 1102 kPa.
- .4 Minimum Bend Radius (Cold Bending): Six times the outside diameter.
- .5 Barrier tubing type:
  - .1 Tubing shall have an oxygen-diffusion barrier that does not exceed an oxygen diffusion rate of 0.10 grams per cubic meter per day at 40 degrees C water temperature in accordance with German DIN 4726.
  - .2 Nominal inside diameter:
    - .1 Provide tubing with nominal inside diameter in accordance with ASTM F876, as indicated in the system design.
    - .2 Tube size: 8mm.
    - .3 Tube spacing: 305mm.
- .6 Acceptable material: Wirsbo hePEX or approved equal.
- .2 Insulation:
  - .1 All tubing outside of the overpour area is to be factory pre-insulated with 25mm polyethylene foam insulation.
- .3 Fittings:
  - .1 ASTM F1960 cold-expansion fitting manufactured from the following material types:
    - .1 UNS No. C69300 Lead-free (LF) Brass.
    - .2 20% glass-filled polysulfone as specified in ASTM D6394.
    - .3 Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D6394.
    - .4 Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D6394.
    - .5 Blend of polyphenylsulfone 55-80% and unreinforced polysulfone (rem.) as specified in ASTM D6394.
    - .6 Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-a piping manufacturer and marked F1960.

### 2.3 DISTRIBUTION MANIFOLD

- .1 Stainless steel manifold:
  - .1 Stainless steel manifold assembly shall be constructed of 304L stainless steel, with minimum 25 mm barrel, sized for flow rates required on submitted manifold schedule.
  - .2 Manifold assembly to be furnished and installed with:
    - .1 Flow meter.
    - .2 Supply and return filter ball valves with NPT threads.
    - .3 Supply and return temperature gauges.
    - .4 Loop balancing and isolation valves.
    - .5 End cap with vent and drain.
    - .6 Durable mounting bracket to suit substrate.
    - .7 Manual balancing valves with visual flow indicators.
    - .8 ASTM F1960 fitting assemblies.
    - .9 Individual loop actuators with adapter rings, as required.
  - .3 Install flow setter on the return leg from the manifold to provide flow balancing between manifolds.
  - .4 Manifold support 8 mm PEX tubing.

- .5 Manifold location should have the ability to vent air manually from the system.
- .6 Provide manifold elbows and offsets, as required.

#### 2.4 HYDRONIC CIRCULATOR PUMP

- .1 In-line, single stage, self-lubricating hydronic circulator pump.
  - .1 Stainless steel, standard flange.
  - .2 Ceramic shaft, EPDM O-ring and gaskets.
  - .3 Overall dimensions: 178 mm x 144 mm.
  - .4 Performance data:
    - .1 Maximum flow: 2.27 l/s (36 GPM).
    - .2 Maximum working pressure: 8.6 Bar (125 psi).
    - .3 Minimum fluid temp: 4 degrees C.
    - .4 Maximum fluid tem: 110 degrees C.
  - .5 Electrical: 115V, 60Hz, single phase, 0.76 A, 29.44 watts (1/25 HP).
  - .6 Acceptable material: Taco 009-SF5 or approved equal.

#### 2.5 PIPING SPECIALTIES AND ACCESSORIES

- .1 Pre-formed knob mat: suitable for overpour installation
  - .1 Black pre-formed knobbed mat with self-adhesive backing, 12.5 mm thick.
  - .2 Suitable for 8 mm radiant floor heating tubing, tube spacing 305mm.
  - .3 Knobs on mat to include holes to allow levelling compound to spread evenly and bond firmly with sub-floor.
  - .4 Panels to interlock ensuring proper alignment of tubing installation.
  - .5 Acceptable material: Uponor Fast Trak 0.5 or approved equal.
- .2 Hot dipped galvanized steel perimeter edge angle to prevent overpour from seeping under panels: refer to Structural for supply and install.
  - .1 Coordinate with Structural.
- .3 Overpour:
  - .1 Concrete:
    - .1 To suit application and as approved by radiant floor heating manufacturer, supplied and installed by Structural.
    - .2 Must provide a flat durable concrete surface as required by Section 11 41 00 – Walk-in Freezers. Coordinate with this Section for requirements.
    - .3 Do not install levelling compound on the concrete overpour.
    - .4 Vibrate concrete to ensure flow around tubing.
  - .2 Minimum coverage over tubing: 38 mm.
    - .1 Refer to Structural.

#### 2.6 ACCESSORIES AND CONTROLS

- .1 Controls: (separate controls are required for each of the two radiant floor heating systems)
  - .1 Thermostats.
    - .1 As recommended by radiant floor heating system manufacturer.



- .2 Control modules.
- .3 Pump relays.
- .4 Audible alarms triggered by flow switches and aquastats at 10 degrees C.
- .2 Slab sensor system to monitor and display slab temperature complete with warning flashing indicator light is tied to the system announcing the temperature is out of set-point range.
  - .1 Slab sensor:
    - .1 Type intended for concrete slab temperature sensing in floor heating applications.
    - .2 Removable for inspection and replacement.
    - .3 Water resistant.
    - .4 Sensor material: high density polyethylene sleeve and high density polyethylene jacketed wire of length to suit.
    - .5 Dimensions: 10mm OD x 38mm.
    - .6 CSA Approved.
    - .7 Operating range: -51 to 60 degrees C.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- .1 Verification of Conditions:
  - .1 Verify that conditions of substrate are acceptable for installation in accordance with manufacturer's written instructions.
  - .2 Visually inspect substrate in presence of Departmental Representative.
  - .3 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .4 Proceed with installation only after unacceptable conditions have been remedied.

#### 3.2 INSTALLATION

- .1 Manufacturer's Instructions:
  - .1 Install radiant heating system in accordance with manufacturer's instructions and reviewed shop drawings.
  - .2 Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings.
- .2 Ensure system is freeze-proof should ambient temperature drop below 0 degrees C and the system is not yet under full operation.
- .3 Clean concrete floor substrate free of dirt, dust, oil, wax and other deleterious material.
- .4 Coordinate the installation by Structural of the hot dipped galvanized steel perimeter edge angle, bolted to floor at full perimeter to contain overpour, preventing it from seeping under panels and to protect the surrounding structure from moisture damage and expansion forces.
- .5 Adhere adhesive-backed preformed knobbed panels directly to concrete subfloor and snap the tubing between the knobs in accordance with reviewed shop drawings, manufacturer's instructions

and under the supervision of manufacturer's representative.

- .6 Mount manifolds.
  - .1 Install the supply-and-return piping to the manifold in a reverse-return configuration to ensure self-balancing.
- .7 Install pumps, valves and all related fittings, controls and accessories.
- .8 Install slab sensors in conduit sleeve at location indicated. Install within concrete overpour, 25mm below slab surface and halfway between PEX tubing.
- .9 Electric boiler supplied and installed by Section 23 52 00 Heating Boilers.
- .10 Connect PEX tubing to the manifold and to heat exchangers.
- .11 Ensure all radiant floor lines outside of the overpour area are insulated.
- .12 Do not install overpour until system has been pressure tested in the presence of Departmental Representative and the radiant floor heating manufacturer's representative. Refer to Part 1 – Observed Mock-up.
- .13 Pressure testing the system:
  - .1 Test pressure applied to the system must meet manufacturer's pressure testing requirements. Manufacturer to provide values for the following system requirements:
    - .1 Operating pressure.
    - .2 Test pressure.
    - .3 Conditioning pressure.
  - .2 Pressure test the system before the tubing is covered in accordance with manufacturer's instructions for system start-up – pressure testing. Pressurize the system to manufacturer's parameters which must be maintained for minimum of 24 hours.
  - .3 Use appropriate end caps or plugs to seal the system as necessary.
  - .4 Maintain pressure on the system during placement of overpour in order to simplify leak detection if the tubing is damaged during the pour or installation.
  - .5 Take all measures such as installing a pressure relief valve to protect the pressurized tubing and the overpour during the curing process.
- .14 Concrete overpour to be put in place by Structural.
  - .1 Coordinate placement in accordance with radiant floor heating manufacturer's instructions and as indicated, creating a level surface for installation of Walk-in Freezer floor panels. Coordinate vibration of concrete overpour to ensure flow around tubing.
    - .1 Minimum coverage of overpour over tubing: 38 mm.
    - .2 Overpour to be level to 6mm over entire floor plate.
    - .3 Refer also to Structural.

### 3.3 ADJUSTING

- .1 Test and adjust operating equipment.
- .2 Balancing Loops Across the Manifold:

- .1 Balance all loops across each manifold to the flow rates specified on the approved manifold schedule.
- .2 Balancing is unnecessary when all loop lengths across the manifold are within 3% of each other in length.
- .3 Install the supply-and-return piping to the manifold in a reverse-return configuration to ensure self-balancing.

#### 3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
  - .2 Clean equipment and apparatus.
  - .3 Re-finish damaged coatings and finishes.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

#### 3.5 PROTECTION

- .1 Protect installed products and components from damage during construction.

#### 3.6 COMMISSIONING

- .1 Commissioning of the radiant floor heating system is required in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements, Section 01 91 31 – Commissioning (Cx) Plan and Section 01 91 33 – Commissioning Forms.
- .2 Manufacturer shall provide a representative for field support during the commissioning.
- .3 Commissioning shall be performed in the presence of the General Contractor. Departmental Representative may be present for part of the proceedings.
- .4 Start-up system in accordance with radiant floor heating manufacturer's written instructions. Note that the system must be thoroughly checked before and after installation of the concrete overpour.
- .5 Submit a start-up/testing schedule and list of procedures for review and approval.
  - .1 Start-up to include in accordance with radiant floor heating manufacturer's instructions:
    - .1 Pressure testing of the system in accordance with radiant floor heating pressure testing instructions.
    - .2 Filling the system.
    - .3 Purging air from the system.
    - .4 Initial balancing of the manifold loops.
    - .5 Fine balancing of the manifold loops.

- .2 Test the slab sensor in accordance with slab sensor manufacturer's testing instructions.
- .3 Submit for review, a report signed by the manufacturer's representative outlining procedures followed, testing results and balancing details.
  - .1 Indicate any system deficiencies. If deficiencies are found, indicate procedures and schedule for rectifying deficiencies. Indicate further testing required.
  - .2 When deficiencies are rectified, submit a follow-up report for review.

### 3.7 DEMONSTRATION AND TRAINING

- .1 System to be fully tested and adjusted prior to scheduling demonstration and training. There shall be no outstanding deficiencies.
- .2 Demonstrate operation, operating components, adjustment features, controls and maintenance requirements to Owner in accordance with Section 01 79 00 – Demonstration and Training.
  - .1 Refer to Section 01 79 00 – Demonstration and Training for submittal requirements prior to scheduling the session.
- .3 Demonstration and training to be conducted by competent representative(s) of the supplier and installer.
- .4 Arrange with the manufacturer's representative equipment to be present at the demonstration.
- .5 Coordinate with the General Contractor for a suitable date and time for the demonstration. It shall be the responsibility of this contractor to ensure that all manufacturers are advised of this time.
- .6 Provide a written report, in triplicate, to the General Contractor, following the demonstration, listing all those persons who were in attendance for the demonstration and include a report describing all activities and indicating any malfunctions of the equipment and/or deficiencies outstanding encountered during demonstration.