

**Part 1        General**

**1.1            SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Shop drawings to show:
  - .1        Mounting arrangements.
  - .2        Operating and maintenance clearances.
- .3        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.
- .4        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.
- .5        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, Contract Administrator 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        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 as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .6        Approvals:

- .1 Submit 3 copies of draft Operation and Maintenance Manual to Contract Administrator for approval. Submission of individual data will not be accepted unless directed by Contract Administrator.
- .2 Make changes as required and re-submit as directed by Contract Administrator.
- .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 Contract Administrator will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .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 Contract Administrator 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 MAINTENANCE**

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
  - .1 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.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Not Applicable.

**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 including strainers. Vacuum interior of ductwork and air handling units.

**3.3 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 - 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 Contract Administrator will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, 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 Contractor will record all instructions and demonstrations on video and provide four (4) DVD copies 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 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.1-05, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
  - .3 ASME B16.3-06, Malleable Iron Threaded Fittings.
  - .4 ANSI/ASME B16.4-06, Gray-Iron Threaded Fittings.
  - .5 ASME B16.5-09, Pipe Flanges and Flanged Fittings.
  - .6 ASME B16.9-07, Factory-Made Wrought Butt Welding Fittings.
  - .7 ANSI/ASME B16.15-06, Cast Bronze Threaded Fittings.
  - .8 ANSI B16.18-2001(R2005), Cast Copper Alloy, Solder Joint Pressure Fittings.
  - .9 ANSI/ASME B16.22-2001(R2010), Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings
  - .10 ANSI/ASME B18.2.1-1996(R2005), Square and Hex Bolts and Screws (Inch Series).
  - .11 ANSI/ASME B18.2.2-1987(R2005), Square and Hex Nuts (Inch Series).
  - .12 ANSI/ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
- .2 American Society for Testing and Materials (ASTM)
  - .1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
  - .2 ASTM A307-2007, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
  - .3 ASTM A563-2007, Standard Specification for Carbons and Alloy Steel Nuts.
  - .4 ASTM B32-08, Standard Specification for Solder Metal.
  - .5 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .6 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
  - .7 ASTM B88-09, Standard Specification for Seamless Copper Water Tube.
- .3 Canadian Standards Association (CSA)
  - .1 CSA B242-05, Groove and Shoulder Type Mechanical Pipe Couplings.
  - .2 CAN/CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .4 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 14.4-M88, Thermometers, Liquid-in-Glass, Self-Indicating, Commercial/Industrial Type.
  - .2 CAN/CGSB-41.22-1993, Fibreglass-Reinforced Plastic Corrosion- Resistant Equipment.

- .5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1 MSS SP59-2009, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation
  - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.

## **1.2 SUBMITTALS**

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

## **1.3 CLOSEOUT SUBMITTALS**

- .1 Submit maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.

## **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.

## **Part 2 PRODUCTS**

### **2.1 STEEL PIPING**

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
  - .1 To NPS6: Schedule 40.
- .2 Pipe joints:
  - .1 NPS2 and under: screwed fittings with lead-free pipe dope.
  - .2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.
  - .3 Flanges: plain or raised face, weld neck.
  - .4 Orifice flanges: slip-on raised face, 2100 kPa.
  - .5 Flange gaskets: 1.5 mm thick pre-formed material to ASME Sect VIII Div 1 VA 49.1 with binder suitable for operating conditions and full face or ring type to match flanges.
  - .6 Pipe thread: taper.
  - .7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .3 Fittings:
  - .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
  - .2 Pipe flanges and flanged fittings:
    - .1 Cast iron: to ASME B16.1, Class 125.
    - .2 Steel: to ASME B16.5.
  - .3 Butt-welding fittings: steel, to ASME B16.9.
  - .4 Unions: malleable iron, to ASME B16.3.

- .4 End Connections:
  - .1 Connection into adjacent piping/tubing:
    - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.

## **2.2 COPPER PIPING**

- .1 Tubing:
  - .1 Type L hard drawn copper tubing: to ASTM B88.
- .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.
- .3 Flanges:
  - .1 Brass or bronze: threaded.
  - .2 Cast iron: threaded.
  - .3 Orifice flanges: slip-on, raised face, 2100 kPa.
- .4 Joints:
  - .1 Solder, tin-antimony, 95:5: to ASTM B32.
  - .2 Silver solder BCUP: to ANSI/AWS A5.8.
  - .3 Brazing: as indicated.
- .5 End Connections:
  - .1 Connection into adjacent piping/tubing:
    - .1 Copper tube systems: Solder ends to ANSI/ASME B16.18.
- .6 Valves:
  - .1 Connections:
    - .1 NPS 2 and smaller: ends for soldering.
    - .2 NPS 2 1/2 and larger: flanged ends.
  - .2 Ball valves:
    - .1 NPS 2 and under:
      - .1 Body and cap: cast high tensile bronze to ASTM B62.
      - .2 Pressure rating: Class 125.
      - .3 Connections: solder ends to ANSI.
      - .4 Stem: tamperproof ball drive.
      - .5 Stem packing nut: external to body.
      - .6 Ball and seat: replaceable stainless steel solid ball and teflon seats.
      - .7 Stem seal: TFE with external packing nut.
      - .8 Operator: removable lever handle.

### 2.3 PIPE HANGERS

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized after manufacture.
  - .2 Use hot dipped galvanizing process.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 NPS 2 1/2 or greater: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 NPS 2 1/2 or greater: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP58.
- .5 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .6 Pipe attachments: material to MSS SP58:
  - .1 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP58.
- .9 U-bolts: carbon steel to MSS SP58 with 2 nuts at each end to ASTM A563.

### 2.4 HANGERS AND SUPPORTS

- .1 General: all supports to have large load bearing surfaces and be as approved by pipe manufacturer.
- .2 Supports: adjustable clevis hangers sized to suit the O.D. of the pipe.
- .3 Pipe hangers and trapeze hangers: supported by mild steel rod of the correct diameter to suit the hanger, as recommended by the steel manufacturer.
- .4 Maximum load of any hanger rod:

Rod	
<u>Diameter</u>	<u>Maximum Safe Load</u>
6 mm	136 kg
9 mm	277 kg

13 mm	512 kg
16 mm	821 kg
19 mm	1229 kg

## **2.5 RISER CLAMPS**

- .1 PVC pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.
- .2 Bolts: to ASTM A307.
- .3 Nuts: to ASTM A563.

## **2.6 THERMOMETERS**

- .1 Industrial, variable angle type, liquid filled length: to CAN/CGSB14.4.
  - .1 Up to 1500 mm above finished floor: 75 mm diameter dials
  - .2 Above 1500 mm: 125 mm diameter dials.

## **2.7 PRESSURE GAUGES**

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

## **Part 3 EXECUTION**

### **3.1 GENERAL**

- .1 Provide sufficient hangers, supports, anchors, guides, vibration dampeners, flexible connectors, restraints and sway braces that will cope with the loads, moments and stresses developed in the piping system and prevent these loads and moments from being transferred to the equipment to which the piping is connected.
- .2 Connect all piping systems to equipment without springing the pipes or transferring any loads or moments to the equipment.
- .3 The use of tees in bullhead configuration is unacceptable.

### **3.2 CHANGES IN PIPE SIZES**

- .1 Install eccentric reducers at pipe size changes to ensure positive drainage or positive venting as appropriate.

### **3.3 DRAINAGE/VENTING**

- .1 Slope piping up in direction of flow 1:500.



- .2 Fit piping with drain valves at low points to facilitate complete system drainage.

**3.4 HANGERS AND SUPPORTS**

- .1 Support vertical piping and risers in accordance with manufacturer's recommendations.
- .2 Support valves independently of adjacent piping.
- .3 Concentrated loads: support directly or support pipe adjacent to load.
- .4 Changes in direction: support as close to fitting as possible.
- .5 Pipe movement: as indicated.
- .6 Valves: support so as to resist operating torque.
- .7 Hanger spacing:

.1	Steel:		
	<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Max. Spacing</u>
	NPS 1-1/4 & under	10 mm	2450 mm
	NPS 1-1/2 to NPS 2	10 mm	3000 mm
	NPS 2-1/2 to NPS 3-1/2	12 mm	3650 mm
	NPS 4	16 mm	3650 mm
	NPS 6"	19 mm	3650 mm
.2	Copper:		
	<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Max. Spacing</u>
	NPS 1 & under	10 mm	1825 mm
	NPS 1-1/4 to NPS 1-1/2	10 mm	2450 mm
	NPS 2 and NPS 2-1/2	12 mm	2750 mm
.3	PVC:		
	<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Max. Spacing</u>
	NPS 1 1/2 & under	10 mm	1500 mm
	NPS 2 to NPS 3	12 mm	1800 mm
	NPS 4	12 mm	2500 mm
	NPS 6	19 mm	2800 mm
	NPS 8	19 mm	3000 mm

- .8 Alignment of piping at expansion loops and offsets: align to avoid damage by movement of piping against fixed structures.
- .9 Install hangers within 300 mm of each horizontal elbow.
- .10 Where floor or roof structural system consists of joists, support piping by means of angles spanning the top chords of adjacent joists. Determine number of spanned joists by the incident load of piping.
- .11 Hanging of piping directly from roof decking is not allowed, unless special permission is obtained from Departmental Representative.
- .12 Support groups of horizontal pipes by trapeze hangers constructed of angle iron with steel rods, conforming to the above concerning isolation of copper piping, pipe covering protection saddles and roller supports. Provide pipe covering protection saddles insulated pipe at trapeze supports.
- .13 Where desired, support several individual hanger rods from a trapeze.

- .14 Hanger rods: sufficient threaded length to allow for vertical adjustment of hangers after pipe is in place. Use two (2) nuts on each rod, one above the clevis or angle iron and one below.
- .15 Where pipe or equipment is supported from floors or walls, fabricate structural steel supports using welded joints except where provision is required for adjustment. Where details of construction are not indicated, submit drawings to Departmental Representative for approval before fabrication.
- .16 Provide vertical piping other than risers through floors with suitable supports, sway braces. Locate clamps immediately below a coupling. Brace risers up to 50 mm size at intervals not over 2100 mm.

### **3.5 PIPELINE STRAINERS**

- .1 Install strainers on the inlet side of all pumps, except for sump pumps.
- .2 Install strainers in horizontal piping with basket under pipe or in vertical piping in the down leg only.
- .3 Provide valved sediment blowoff for basket on strainers 38 mm (1 1/2") and larger.
- .4 Install in locations to allow access for removal of screen.

### **3.6 THERMOMETERS**

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

### **3.7 PRESSURE GAUGES**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.2 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.
- .3 Closeout Submittals
  - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.3 QUALITY ASSURANCE**

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

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2 Products**

**2.1 GENERAL**

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

**2.2 MOTORS**

- .1 Provide motors for mechanical equipment as specified.

- .2 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W and larger:
  - .1 EEMAC Class B, squirrel cage induction.
  - .2 Speed as indicated
  - .3 Continuous duty
  - .4 Totally Enclosed Fan Cooled (TEFC), Non Sparking
  - .5 Ball bearing,
  - .6 Maximum temperature rise 40 degrees C
  - .7 575 VAC, 3 phase, unless otherwise indicated.
  - .8 Inverter-duty rated, with insulation compliant with NEMAMG1, Part 31.
- .4 All motors driven by VFDs to have a shaft grounding ring installed.
  - .1 Current rating: 10 amps high frequency current up to 100 Mhz
  - .2 Continuous fiber ring with continuous shaft contact across all shaft speeds.
  - .3 Fiber wear: less than 0.03mm per 10,000 hours, designed for 200,000+ hours of operation.
  - .4 Maintenance Requirements: None
  - .5 Shaft grounding ring may be installed by the motor manufacturer or the fan manufacturer.
  - .6 Shaft grounding ring to be installed in accordance with manufacturer's recommendations.
  - .7 Acceptable Products:
    - .1 AEGIS® Shaft Grounding Ring kit
- .5 If delivery of specified motor will delay completion or commissioning work, install motor approved by Contract Administrator for temporary use. Work will only be accepted when specified motor is installed.

## **2.3 BELT DRIVES**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

## **2.4 DRIVE GUARDS**

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
  - .1 Fans G686-EF and G687-EF
    - .1 expanded stainless steel screen welded to stainless steel frame
    - .2 Other equipment
      - .1 Expanded metal screen welded to steel frame.
    - .3 Minimum 1.2 mm thick sheet metal tops and bottoms.
    - .4 38 mm dia holes on both shaft centres for insertion of tachometer.
    - .5 Removable for servicing.
  - .3 Provide means to permit lubrication and use of test instruments with guards in place.
  - .4 Install belt guards to allow movement of motors for adjusting belt tension.-
  - .5 Guard for flexible coupling:
    - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
    - .2 Securely fasten in place.
    - .3 Removable for servicing.
  - .6 Unprotected fan inlets or outlets:
    - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
    - .2 Net free area of guard: not less than 80% of fan openings.
    - .3 Securely fasten in place.
    - .4 Removable for servicing.

## **Part 3 Execution**

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

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

### **3.2 INSTALLATION**

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

### **3.3 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.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.15-06, Cast Bronze Threaded Fittings.
  - .3 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM A276-10, Specification for Stainless Steel Bars and Shapes.
  - .2 ASTM B61-08, Standard Specification for Steam or Valve Bronze Castings.
  - .3 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
  - .4 ASTM B283-11, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
  - .5 ASTM B505/B505M-11, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS-SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.
  - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
  - .3 MSS-SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

**1.2                SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit data for valves specified in this section.
- .3 Closeout Submittals:
  - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**Part 2            Products**

**2.1                MATERIALS**

- .1 Valves:
  - .1 Except for specialty valves, to be single manufacturer.
  - .2 All products to have CRN registration numbers.
- .2 End Connections:
  - .1 Connection into adjacent piping/tubing:
    - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
    - .2 Copper tube systems: Solder ends to ANSI/ASME B16.18.

- .3 Check Valves:
  - .1 Standard specification: MSS SP-80.
  - .2 Connections: screwed with hexagonal shoulders.
  - .3 Style: swing type, bronze disc, Class 125:
  - .4 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
  - .5 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: re-grindable.
- .4 Ball Valves:
  - .1 Full Port.
  - .2 Body and cap: cast high tensile bronze to ASTM B62.
  - .3 Pressure rating: Class125, 860 kPa steam.
  - .4 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
  - .5 Stem: tamperproof ball drive.
  - .6 Stem packing nut: external to body.
  - .7 Ball and seat: replaceable hard chrome solid ball and PTFE seats.
  - .8 Stem seal: TFE with external packing nut.
  - .9 Operator: removable lever handle.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Install rising stem valves in upright position with stem above horizontal.
- .3 Remove internal parts before soldering.
- .4 Install shut-off valves with unions or couplings on supply and return piping connections to each piece of equipment to facilitate servicing, maintenance, and equipment removal..
- .5 Install silent check valves on discharge from pumps and elsewhere as indicated.
- .6 Fit low points of all liquid filled systems with drain valves to facilitate complete drainage of systems. Install with 19 mm hose end connections or piped to hub drains.
- .7 Install shut-off valves on both sides of all pumps, size of adjacent piping and not pump connection size.

#### **3.2 CHECK VALVES**

- .1 Install check valves on the discharge of all pumps not having integral discharge check valves.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

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

**1.2                REFERENCES**

- .1    Canadian General Standards Board (CGSB)
  - .1    CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

**1.3                SUBMITTALS**

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

**1.4                QUALITY ASSURANCE**

- .1    Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

**1.5                DELIVERY, STORAGE, AND HANDLING**

- .1    Packing, shipping, handling and unloading:
  - .1    Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2    Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2            Products**

**2.1                MANUFACTURER'S EQUIPMENT NAMEPLATES**

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



**2.2 SYSTEM NAMEPLATES**

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

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20
  - .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
  - .1 Terminal cabinets, control panels: use size # 5.
  - .2 Equipment in Mechanical Rooms: use size # 9.

**2.3 EXISTING IDENTIFICATION SYSTEMS**

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Contract Administrator.

**2.4 IDENTIFICATION OF PIPING SYSTEMS**

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
  - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

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

Background colour:	Legend, arrows:
Light Green	BLACK
Light Purple	BLACK
Dark Green	WHITE
Dark Purple	WHITE

.3 Background colour marking and legends for piping systems:		
Contents	Background colour marking	Legend
Hot water heating supply	Dark green to match existing colours	HOT WATER SUPPLY
Hot water heating return	Light green to match existing colours	HOT WATER RETURN
Glycol heating supply	Dark purple to match existing colours	GLYCOL HEATING SUPPLY
Glycol heating return	Light purple to match existing colours	GLYCOL HEATING RETURN

**2.5 IDENTIFICATION DUCTWORK SYSTEMS**

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

**2.6 VALVES, CONTROLLERS**

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

## **2.7 CONTROLS COMPONENTS IDENTIFICATION**

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

## **2.8 LANGUAGE**

- .1 Identification in English.

## **Part 3 Execution**

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

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

### **3.2 TIMING**

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

### **3.3 NAMEPLATES**

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

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

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### **3.5 VALVES, CONTROLLERS**

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

### **3.6 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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

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

**1.2 QUALIFICATIONS OF TAB PERSONNEL**

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

**1.3 PURPOSE OF TAB**

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

- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

#### **1.4 EXCEPTIONS**

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

#### **1.5 CO-ORDINATION**

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

#### **1.6 PRE-TAB REVIEW**

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

#### **1.7 START-UP**

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

#### **1.8 OPERATION OF SYSTEMS DURING TAB**

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

#### **1.9 START OF TAB**

- .1 Notify Contract Administrator 3 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.

- .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
- .4 Correct fan rotation.
- .5 Fire, smoke, volume control dampers installed and open.
- .6 Coil fins combed, clean.
- .7 Access doors, installed, closed.
- .8 Outlets installed, volume control dampers open.

**1.10 APPLICATION TOLERANCES**

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

**1.11 ACCURACY TOLERANCES**

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

**1.12 INSTRUMENTS**

- .1 Prior to TAB, submit to Contract Administrator list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Contract Administrator.

**1.13 SUBMITTALS**

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

**1.14 PRELIMINARY TAB REPORT**

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

**1.15 TAB REPORT**

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

**1.16 VERIFICATION**

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

**1.17 SETTINGS**

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

**1.18 COMPLETION OF TAB**

- .1 TAB considered complete when final TAB Report received and approved by Contract Administrator.

**1.19 AIR SYSTEMS**

- .1 Standard: TAB to most stringent of TAB standards of AABC and SMACNA.
- .2 Do TAB of following systems, equipment, components, controls:
  - .1 Fan.
  - .2 Grilles.
  - .3 Dampers.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

**1.20 FLUID SYSTEMS**

- .1 Prepare and submit to the Contract Administrator a system balance report with data showing compliance with the design and that quantities at each piece of equipment with 5% (five percent) of design figure. Include specified and measured data on pump performance including horsepower, load amperage, speed, and pressure (suction and discharge).
- .2 Balancing: performed by trained personnel with records kept on each trial balance, for supervision and approval.



- .3 Balancing of flows - Each outlet shall be Bell & Gossett circuit setters on each unit.
- .4 Upon completion of balance and submittal of the balance report, provide, if called upon, a spot check of the system with the Contract Administrator's representative. If actual quantities do not agree with the balancing report data, rebalance the system until satisfactory to the Contract Administrator.
- .5 Pre-TAB verification:
  - .1 System completely filled.
  - .2 System cleaned.
  - .3 System free of air.
  - .4 System service valves open.
  - .5 System strainers provided with clean sleeves having proper perforations.
  - .6 Three-way valves properly piped.
  - .7 System coils correctly piped.
  - .8 Coil fins straight and clean.
  - .9 Proper balancing devices in place and correctly located:
    - .1 Meters
    - .2 Pressure taps
    - .3 Thermometer wells
    - .4 Balancing valves
  - .10 Automatic temperature control system in operation.
  - .11 Adequate pressure to completely fill the system.
- .6 Measure the amperes of pump motors before hydronic balancing is started and take proper steps to correct and report any overloads.
- .7 Measure flow quantities, temperatures and pressures according to the AABC National Standards.
- .8 Report conditions that will not permit proper balancing.
- .9 At completion of balancing: at least one terminal unit balancing valve in each piping branch fully open and at least one branch pipe balancing valve fully open.
- .10 Clearly mark final position of each balancing valve. Set memory devices to permit closing and reopening the valve to its balanced setting.
- .11 Verify that automatic controllers operate the correct control valves.
- .12 Measure fluid flow quantities using the installed meters.
- .13 Apply any necessary correction factor to the indicated value to account for the density of the fluid flowing in the system.
- .14 Include initial and final readings of meters on the AABC Report Form. List pertinent information regarding each meter, such as:
  - .1 Designation of terminal
  - .2 Manufacturer
  - .3 Type
  - .4 Size
  - .5 Rating
    - .1 GPM

.2 Pressure differential

**1.21 OPERATIONAL TESTING FIRE/SMOKE DAMPERS**

- .1 Provide for the operational testing of each fire or smoke damper in conformance with NFPA Code 90.
- .2 Operate each damper by removing the fusible link and manually stroking the damper to check for binding.
- .3 Install a remote release pin and release the damper from an open position to verify operation and full closure.
- .4 Report dampers that fail to close completely, balk or bind to the installing contractor for repair and then retested.
- .5 Prepare a signed report detailing each damper by location or number, size, type and verifying that the tests were positive. List the name of the technician performing the tests.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not used.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Definitions:
  - .1 For purposes of this section:
    - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2 "EXPOSED" - means "not concealed" as previously defined.
    - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2 TIAC Codes:
    - .1 CRD: Code Round Ductwork,
    - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
  - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1 ANSI/ASHRAE/IESNA 90.1-07, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .2 ASTM International Inc.
    - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2 ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - .3 ASTM C553-08, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - .4 ASTM C612-10, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
    - .5 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .3 Canadian General Standards Board (CGSB)
    - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
  - .5 Underwriters Laboratories of Canada (ULC)
    - .1 CAN/ULC-S102-07, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
    - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 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.
- .3 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

### **1.3 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, 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 INSULATION**

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

### **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.
- .3 Aluminum:
  - .1 To ASTM B209 as scheduled in PART 3 of this section.
  - .2 Thickness:0.50 mm sheet.
  - .3 Finish: Smooth.
  - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
    - .1 Stainless steel:

.2 Type: 304.

**2.4 ACCESSORIES**

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick-setting
- .3 Canvas adhesive: washable.
- .4 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 manufacturers instructions and as indicated.
- .3 Hangers and supports in accordance with Section 23 31 14 - Metal Ducts - Low Pressure to 500 Pa.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .4 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

**3.4 DUCTWORK INSULATION SCHEDULE**

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Supply and return ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	50
Exhaust duct between dampers and louvres	C-1	no	50
Exhaust stacks	C-1	no	50

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.

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

**END OF SECTION**

**Part 1        General**

**1.1            REFERENCES**

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 90.1-10, 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 C335-10(E2011), Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .2 ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .3 ASTM C547-11(E2012), Mineral Fiber Pipe Insulation.
  - .4 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701-11, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .3 CAN/ULC-S702-09, Thermal Insulation, Mineral Fibre, for Buildings

**1.2            DEFINITIONS**

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

### **1.3 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 shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.

### **1.4 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 of TIAC.

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

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
  - .1 Protect from weather, construction traffic.
  - .2 Protect against damage.
  - .3 Store at temperatures and conditions required by manufacturer.

## **Part 2 Products**

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

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



## **2.2 INSULATION**

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702.
  - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULC-S702.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to CAN/ULC-S702.

## **2.3 INSULATION SECUREMENT**

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

## **2.4 CEMENT**

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

## **2.5 VAPOUR RETARDER LAP ADHESIVE**

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

## **2.6 INDOOR VAPOUR RETARDER FINISH**

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

## **2.7 JACKETS**

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

- .2 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.

### **Part 3 Execution**

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

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

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

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

#### **3.3 INSTALLATION**

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

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

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

#### **3.5 PIPING INSULATION SCHEDULES**

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
  - .1 Securements: Tape at 300 mm on centre.
  - .2 Seals: lap seal adhesive, lagging adhesive.

- .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
  - .1 Securements: Tape at 300 mm on centre.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation as listed in following table.
  - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
  - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Applica- tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38
Glycol Heating	60 - 94	A-1	25	38	38	38	38	38
Glycol Heating	up to 59	A-1	25	25	25	25	38	38
Glycol	below 4	A-3	25	25	38	38	38	38

- .5 Finishes:
  - .1 Exposed in mechanical rooms: canvas jacket.
  - .2 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
  - .3 Installation: to appropriate TIAC code CRF/1 through CPF/5.

### 3.6 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.

### 3.7 PAINTING

- .1 Paint thermal insulation in accordance with Section 09 91 23 – Painting.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM E202-09, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.2 SUBMITTALS**

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

**1.3 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 CLEANING SOLUTIONS**

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

**2.2 POT FEEDER**

- .1 Welded steel, pressure rating 1200 kPa. Temperature rating: 90 degrees C.
- .2 Micron filter for each pot feeder:
  - .1 Capacity 2% of pump recirculating rate at operating pressure.
  - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

**2.3 CLEANING OF FLUID SYSTEMS**

- .1 Supply necessary auxiliary equipment and chemicals required to perform piping systems cleaning, de-greasing and chemical treatment as described under Execution.

**2.4 GLYCOL**

- .1 Fluid: 50% by volume solution of heat transfer fluid premixed by the manufacturer with the correct ratio of distilled water, to ASTM D1384, delivered to the site by tank or in drums.
- .2 Inhibitor: phosphate-based and copper corrosion inhibitors, dyed to facilitate leak protection.
- .3 Acceptable material: Dowfrost HD or approved equal in accordance with B6.

**Part 3 EXECUTION**

**3.1 CLEANING HYDRONIC SYSTEMS**

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

- .7 Hydronic Systems (Water):
  - .1 Fill system with water, ensure air is vented from system.
  - .2 Use water metre to record volume of water in system to +/- 0.5%.
  - .3 Add chemicals under direct supervision of chemical treatment supplier.
  - .4 Circulate system cleaner for at least 12 h. Drain as quickly as possible.
  - .5 Flush the system until pH of the water in the system is back to pH of the make-up water. After cleaning and flushing, introduce corrosion inhibitor.
  - .6 Conduct pH test before, during and after cleaning, and report the procedures followed and pH readings to the Contract Administrator in writing.
- .8 Glycol Systems:
  - .1 In addition to procedures specified above perform specified procedures.
  - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.
  - .3 Provide a refractometer used to measure the freezing point in degrees Celsius of the inhibited glycol/water solution in the system.

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

- .1 After cleaning is completed and system is filled:
  - .1 Establish circulation and expansion tank level, set pressure controls.
  - .2 Ensure air is removed.
  - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
  - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
  - .5 Clean out strainers repeatedly until system is clean.
  - .6 Repeat with water at design temperature.
  - .7 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
  - .8 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing (TAB) for Mechanical Systems.
  - .9 Adjust pipe supports, hangers, springs as necessary.
  - .10 Monitor pipe movement, performance of guides, anchors.
  - .11 Re-tighten bolts, etc. using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
  - .12 Check operation of drain valves.
  - .13 Adjust valve stem packings as systems settle down.
  - .14 Fully open all balancing valves (except those that are factory-set).
  - .15 Check operation of over-temperature protection devices on circulating pumps.
  - .16 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation procedures for control of liquid and air flow rates.

**1.2 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .2 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
  - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM A276-10, Specification for Stainless Steel Bars and Shapes.
  - .2 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
  - .3 ASTM B283-11, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
  - .4 ASTM B505/B505M-11, Specification for Copper-Base Alloy Continuous Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS-SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.
  - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
- .5 MSS-SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.



**Part 2 Products**

**2.1 VALVES – 2-WAY AND 3-WAY CONTROL**

- .1 Pressure rating: as indicated.
- .2 Valve operators:
  - .1 Requirements:
    - .1 Direct mount proportional type.
    - .2 Spring return type for "fail-safe" in Normally Open or Normally Closed position as indicated.
    - .3 Valve actuator to drive valve from full open to full closed in less than 150 seconds.
    - .4 Spring return to drive damper from full open to full closed in less than 25 seconds at normal room temperature.
    - .5 Electrical Connection: Terminals in integral housing
    - .6 Overload protection: Required.
    - .7 Auxiliary Switches: Not required.
    - .8 Position Feedback: Not required
    - .9 Operating range: 4-20 mA.
    - .10 Operating Temperature: -15 °C to 50 °C.
    - .11 Housing: NEMA 1 or IP54 or better.
    - .12 CSA approval or equivalent.
  - .2 Acceptable products:
    - .1 Siemens SKD Electronic Actuators
    - .2 or approved equal in accordance with B6.
- .3 Water valves:
  - .1 Two-way: single seated, linear.
  - .2 Three-way mixing: linear characteristics.
  - .3 Three-way diverting: linear characteristics as indicated.
  - .4 Flow rate and maximum pressure drop: as indicated.
  - .5 Acceptable materials:
    - .1 Siemens Flowrite VF 599 Series
    - .2 or approved equal in accordance with B6.

**2.2 DAMPERS**

- .1 Operating type dampers are specified in Section 23 33 15 - Dampers-Operating.
- .2 Smoke type dampers are specified in Section 23 33 16 - Dampers - Fire and Smoke.

**2.3 DAMPER OPERATORS – ON/OFF**

- .1 Requirements:
  - .1 Direct mount on-off type.
  - .2 Spring return type for "fail-safe" in Normally Open or Normally Closed position as indicated.

- .3 Size operators to control dampers against maximum pressure or dynamic closing pressure, whichever is greater.
- .4 Damper actuator to drive damper from full open to full closed in less than 90 seconds.
- .5 Spring return to drive damper from full open to full closed in less than 60 seconds at normal room temperature.
- .6 Angle of Rotation: 90° minimum, adjustable with mechanical stops.
- .7 Direction of Rotation: Configurable via switch mounted on the actuator.
- .8 Shaft Diameter: 8.0mm to 16.0mm (3/8" to 1/2").
- .9 Electrical Connection: 0.9 meter (3 ft), 18 AWG, plenum rated cable.
- .10 Overload protection: Required.
- .11 Auxiliary Switches: Two SPDT, adjustable operation between 0 and 95°, integral to actuator.
- .12 Operating Temperature: -30 °C to 50 °C.
- .13 Housing: NEMA 2 or IP54 or better.
- .14 CSA approval or equivalent.
- .2 Acceptable products:
  - .1 Siemens GMA or GCA as indicated
  - .2 or approved equal in accordance with B6.

## **2.4 DAMPER OPERATORS – MODULATING**

- .1 Requirements:
  - .1 Direct mount proportional type.
  - .2 Spring return type for "fail-safe" in Normally Open or Normally Closed position as indicated.
  - .3 Size operators to control dampers against maximum pressure or dynamic closing pressure, whichever is greater.
  - .4 Damper actuator to drive damper from full open to full closed in less than 150 seconds.
  - .5 Spring return to drive damper from full open to full closed in less than 25 seconds at normal room temperature.
  - .6 Angle of Rotation: 90° minimum, adjustable with mechanical stops.
  - .7 Direction of Rotation: Configurable via switch mounted on the actuator.
  - .8 Shaft Diameter: 8.0mm to 16.0mm (3/8" to 5/8").
  - .9 Electrical Connection: 0.9 meter (3 ft), 18 AWG, plenum rated cable.
  - .10 Overload protection: Required.
  - .11 Auxiliary Switches: Not required.
  - .12 Position Feedback: Required, 4-20 mA or 0-10V output.
  - .13 Operating range: 4-20 mA, 0-10 or 2-10 VDC.
  - .14 Operating Temperature: -30 °C to 50 °C.
  - .15 Housing: NEMA 2 or IP54 or better.
  - .16 CSA listing or equivalent.
- .2 Acceptable products:

- .1 Siemens GMA or GCA as indicated
- .2 or approved equal in accordance with B6.

## **2.5 DAMPER OPERATORS – PNEUMATIC**

- .1 Requirements:
  - .1 Direct mount on-off type.
  - .2 Spring return type for "fail-safe" in Normally Open or Normally Closed position as indicated.
  - .3 Size operators to control dampers against maximum pressure or dynamic closing pressure, whichever is greater.
  - .4 Damper actuator to drive damper from full open to full closed in less than 10 seconds.
  - .5 Spring return to drive damper from full open to full closed in less than 10 seconds at normal room temperature.
  - .6 Angle of Rotation: 90° minimum, adjustable with mechanical stops.
  - .7 Limit Switches:
    - .1 Electrical Classification: Class I, Zone 2
    - .2 Type: Mechanical
    - .3 Voltage Rating: 120 VAC
    - .4 Current Rating: 5 A
    - .5 Approvals: CSA or equivalent
    - .6 Housing: NEMA 4X or better.
    - .7 Direct mount to actuator
    - .8 Spare terminals for solenoid wiring in electrical housing.
  - .8 Solenoid:
    - .1 Electrical Classification: Class I, Zone 2
    - .2 Configuration: 3 way
    - .3 Voltage: 120 VAC
    - .4 Approvals: CSA or equivalent
    - .5 Direct-mount to actuator
  - .9 Operating Temperature: 0 °C to 40 °C.
  - .10 Acceptable Products:
    - .1 Metso Jamesbury VPVL100SR6B with Metso Neles Quartz QX2S
    - .2 or approved equal in accordance with B6.

## **2.6 IDENTIFICATION**

- .1 Provide in accordance with Section 23 05 54 - Mechanical Identification.

**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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation of low-pressure metallic ductwork, stacks, joints and accessories.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM A480/A480M-10, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-09, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
  - .3 ASTM A653/A653M-09, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
  - .4 ASTM A368-95a, Standard Specification for Stainless Steel Wire Strand
- .3 CSA International
  - .1 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition 2005.

**1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

Pressure Range (Pa)	SMACNA Seal Class
500 to 750	B
250 to 500	C
125 to 250	C
- .1 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with tape.
- .3 Class C: transverse joints and connections made air tight with tape. Longitudinal seams unsealed.
- .4 Unsealed seams and joints.

## **2.2 SEALANT**

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

## **2.3 TAPE**

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

## **2.4 FITTINGS**

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
  - .1 Round: five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct.
  - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:
  - .1 Diverging: 20 degrees maximum included angle.
  - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
  - .1 Short radiused elbows as indicated.

## **2.5 FIRE STOPPING**

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

## **2.6 GALVANIZED STEEL**

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

**2.7 STAINLESS STEEL DUCTWORK - WET WELL**

- .1 Lock forming quality: to ASTM A480/A 480M, Type 316L.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.
- .4 Welded joints:
  - .1 All rectangular ductwork in the wet well and from the wet well to the motorized damper to be welded.
  - .2 Continuously weld joints using Inert Gas Metal Arc process without burning parent metal, using filler rods type ER316L as specified in CSA W48. Grind smooth and polish joints.
- .5 Flanged Joints:
  - .1 A limited number of T-24a flanged connections are permitted in the wet well. Contractor to confirm duct design and connections at shop drawing stage with approval from the Contract Administrator.

**2.8 EXHAUST STACK**

- .1 Stack Material:
  - .1 Round duct, 316L stainless steel, 18 gauge.
- .2 Construction:
  - .1 Prefabricated sections, welded on site or at factory.
  - .2 All joints and seams welded.
- .3 Welding:
  - .1 To full thickness.
- .4 Supports:
  - .1 Guy wire roof supports
    - .1 Epoxy coated, urethane insulated, hollow steel support, 10 mm x 305 mm x 305 mm base plate, appropriate fasteners to mount to structural steel as indicated, 0.79 mm stainless steel flashing, bituminous painted deck flange.
    - .2 Strength: suitable for 6.9 kN at a 45° angle.
    - .3 Warrantee: Provide 20 year warrantee against leaks and defects in materials.
    - .4 Acceptable material: Thaler ARS-301 T3 or approved equal in accordance with B6.
  - .2 Guy wires and clamps:
    - .1 Stainless steel cable and clamps.
    - .2 Minimum cable breaking strength: 6.9 kN.
- .5 Dimensions: as indicated.

**2.9 FASTENERS**

- .1 Nuts: Stainless steel, 316L to ASTM A194.
- .2 Bolts: Stainless steel, 316L to ASTM A193.
- .3 Sheet Metal Screws: 316L; only permitted on round duct in wet well.

## **2.10 HANGERS AND SUPPORTS**

- .1 Trapeze angles: size and spacing to SMACNA.
- .2 Unistut: sized per manufacturer's specifications. Spacing to SMACNA.
- .3 All duct supports and accessories in the Wet Well: 316 stainless steel.
- .4 Metal supports in contact with stainless steel outside the Wet Well: galvanically isolated from the stainless steel.
- .5 Hanger configuration: to SMACNA.

Hangers: (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

- .6 Upper hanger attachments:
  - .1 For concrete: manufactured stainless steel concrete inserts.
  - .2 For steel joist: manufactured joist clamp.
  - .3 For steel beams: manufactured beam clamps:

## **Part 3 Execution**

### **3.1 GENERAL**

- .1 Do work in accordance with SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

### **3.2 DUCTWORK**

- .1 Stainless Steel:
  - .1 Wet Well: Joints and Seams: welded.
  - .2 Wet Well Mechanical Room: joint and seams to SMACNA.
  - .3 Exhaust Fan Discharge: Class A seal classification.

### **3.3 HANGERS**

- .1 Angle hangers and Unistrut: complete with locking nuts and washers.
- .2 Hanger spacing: in accordance with SMACNA as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000



**3.4 SEALING AND TAPING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2006.

**1.2 SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.
- .3 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**Part 2 Products**

**2.1 GENERAL**

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

**2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: 316 stainless steel, 75 mm thick, fabric attached by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m<sup>2</sup>.

**2.3 ACCESS DOORS IN DUCTS**

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
  - .1 Up to 300 x 300 mm: two sash locks.

**2.4 TURNING VANES**

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

**2.5 INSTRUMENT TEST**

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

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 200 x 200 mm for viewing; where space is available.
  - .2 Locations:
    - .1 Fire Dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Heating coils.
    - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.

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

### **3.3 CLEANING**

- .1 Perform cleaning operations as specified in Section 01 74 11 - Cleaning and in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1            General**

**1.1                SUMMARY**

- .1 Section Includes:
  - .1 Balancing dampers for wet well supply air system.

**1.2                SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate the following:
    - .1 Performance data.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.3                DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2            Products**

**2.1                GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2                MULTI-BLADED DAMPERS**

- .1 Material: 316 stainless steel, factory manufactured.
- .2 Opposed blade: double skin airfoil design, 1.6 mm thick 316 stainless steel to 1200 mm length, 2 mm thick to 1500 mm length.
- .3 Maximum blade height: 100 mm.
- .4 Bearings: stainless steel sleeve pressed into cast housing bolted to the damper frame.

- .5 Linkage: located in jamb out of airstream and constructed of minimum 3.5 mm stainless steel double clevis arms with 4.8 x 19 stainless steel tie bars pivoting on 9.5 mm diameter stainless steel pivot pins with lock type retainers.
- .6 Blade Seals: silicone blade seals mechanically attached to blade.
- .7 Jamb seals: flexible stainless steel located between blade edge and jamb for maximum sealing compression.
- .8 Channel frame: minimum 200 mm deep x 50 mm flanged, 2.8 mm 316 stainless steel.
- .9 Maximum leakage : 0.22% at 250 Pa.
- .10 Acceptable Materials: Ruskin CD80AF3, Greenheck HCD230 or approved equal in accordance with B6.

### **Part 3 Execution**

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

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

#### **3.2 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .4 Dampers: vibration free.
- .5 Ensure damper operators are observable and accessible.
- .6 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .7 Corrections and adjustments as directed by Contract Administrator.

#### **3.3 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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

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

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate the following:
    - .1 Performance data.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.3 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2 Products**

**2.1 MULTI-LEAF DAMPERS**

- .1 Parallel blade type.
- .2 Stainless steel, type 316, factory manufactured 1.6 mm thick 316 stainless steel to 1200 mm length, 2 mm thick 316 stainless steel to 1500 mm length complete with silicone blade seals mechanically attached to blade. Jamb seals shall be flexible stainless steel located between blade edge and jamb for maximum sealing compression.
- .3 Axle: minimum 19 mm diameter stainless rod.
- .4 Bearings: stainless steel sleeve pressed into cast housing bolted to the damper frame.

- .5 Linkage: located in jamb out of airstream and constructed of minimum 3.5 mm stainless steel double clevis arms with 4.8 x 19 stainless steel tie bars pivoting on 9.5 mm diameter stainless steel pivot pins with lock type retainers.
- .6 Channel frame: minimum 200 mm deep x 50 mm flanged, 2.8 mm 316 stainless steel.
- .7 Performance:
  - .1 Leakage: in closed position less than 15.2 l/s/m<sup>2</sup> of rated air flow at 250 Pa differential across damper.
  - .2 Pressure drop: at full open position less than 7 Pa differential across damper at 5.08 m/s.
- .8 Acceptable materials: Greenheck, Nailor, Ruskin, or approved equal in accordance with B6.

## **2.2 BACK DRAFT DAMPERS**

- .1 Parallel blade type.
- .2 Blades: 1.8 mm extruded aluminum.
- .3 Linkage: heavy duty with counterbalance weights.
- .4 Channel frame: 2 mm galvanized steel channel with 203 mm depth.
- .5 Acceptable materials: Greenheck, Nailor, Ruskin, or approved equal in accordance with B6

## **Part 3 Execution**

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

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

### **3.2 INSTALLATION**

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

### **3.3 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
  - .1 ANSI/NFPA 90A-2009, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
  - .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
  - .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
  - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate the following:
    - .1 Fire dampers.
    - .2 Fusible links.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.3 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Provide following:
    - .1 Six (6) fusible links of each type.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

## **Part 2 Products**

### **2.1 FIRE DAMPERS FOR WET WELL SUPPLY AND WET WELL EXHAUST DUCTS**

- .1 Fire dampers: dynamic, multiple blade, listed and bear label of ULC, meet requirements of ANSI/NFPA 90A, and authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112
- .2 Stainless steel Type 316, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
  - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
  - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected
- .3 Frame and blades: 16 gauge, 316 stainless steel.
- .4 Sleeve: minimum 20 gauge, 316 stainless steel.
- .5 Fusible link: actuated at 74°C (165°F),
- .6 Retaining angle: minimum 40 mm x 40 mm, 316 stainless steel, on full perimeter of fire damper, on side of fire separation being pierced.
- .7 Retaining angle sealant: use only sealant approved by the fire damper manufacturer to maintain the ULC rating of the fire damper. Sealant must also be approved for use in moist environments containing H<sub>2</sub>S.
- .8 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.
- .9 Design and construct dampers to maximize air transfer opening cross-sectional area.
- .10 Acceptable materials: Ruskin DFD35SS, Greenheck SEDFD-210, Nailor D1201SS or approved equal in accordance with B6

### **2.2 FIRE DAMPERS**

- .1 Fire dampers: dynamic, "out-of-wall" arrangement, type B style or otherwise with the curtain out of the airstream except where shown on the drawings as "in-the-wall," type A, listed and bear label of ULC, meet requirements of ANSI/NFPA 90A, and authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.
- .2 Galvanized steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
  - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
  - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset, square; interlocking type; guillotine type; sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow. All fire dampers to have 71°C (160°F) fusible links.

- .5 40 x 40 mm retaining angle iron frame, on full perimeter of fire damper, on side of fire separation being pierced.
- .6 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .7 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .8 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.
- .9 Acceptable materials: Greenheck, Nailor, or approved equal in accordance with B6.

### **Part 3 Execution**

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

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

#### **3.2 INSTALLATION**

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

#### **3.3 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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

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

**1.2 REFERENCES**

- .1 Air Conditioning and Mechanical Contractors (AMCA)
  - .1 AMCA Publication 99-2003, Standards Handbook.
  - .2 AMCA 300-2008, Reverberant Room Method for Sound Testing of Fans.
  - .3 AMCA 301-2006, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/AMCA 210-2007, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

**1.3 SYSTEM DESCRIPTION**

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

**1.4 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Provide :
  - .1 Fan performance curves showing point of operation, kW and efficiency.

- .2 Sound rating data at point of operation.
- .4 Indicate:
  - .1 Motors, sheaves, bearings, shaft details.
  - .2 Minimum performance achievable with variable speed controllers.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .6 Closeout Submittals:
  - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

## **1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
    - .1 Spare parts to include:
      - .1 Matched sets of belts.
    - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
      - .1 Bearings and seals.
      - .2 Addresses of suppliers.
      - .3 List of specialized tools necessary for adjusting, repairing or replacing.

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

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

## **Part 2 Products**

### **2.1 FANS GENERAL**

- .1 Motors:
  - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
  - .2 For use with variable speed controllers.
  - .3 Sizes as indicated.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .5 Vibration isolation: hanging spring isolators
- .6 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

## **2.2 TUBULAR IN-LINE CENTRIFUGAL FANS (WET WELL EXHAUST)**

- .1 Casings: fibre reinforced plastic, resin rich smooth interior and exterior, lifting lugs.
- .2 Blade and Hub material: fibre reinforced plastic, resin rich smooth surface.
- .3 Spark resistance rating: Type B.
- .4 Corrosion resistance: Components compatible with moist H<sub>2</sub>S in the airstream.
- .5 Supports:
  - .1 Duct mounted units: inlet and outlet flanges.
  - .2 Ceiling suspended units: support brackets attached to side of casing. Extend grease lubrication facilities to outside of casing.
- .6 Bearings: ball or roller with extension tubes to outside of casing.
- .7 Belt drive:
  - .1 Drive fixed blades by externally mounted motors through V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.
- .8 Acceptable material: MK Plastics, Plasticair, or approved equal in accordance with B6.

## **2.3 IN-LINE CENTRIFUGAL FANS**

- .1 Fan wheels:
  - .1 Welded steel or aluminum construction.
  - .2 Maximum operating speed of centrifugal fans not more than 50 % of first critical speed.
  - .3 Forward curved blades, as indicated.
- .2 Bearings: split pillow-block grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 h.
- .3 Housings:
  - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, steel or aluminum for smaller wheels, braced, and with welded supports.
  - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
- .4 Provide latched airtight access doors with handles. Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, V-belt drive and guard outside casing.
- .5 Fabricate casing of zinc coated or phosphate treated steel of 1.21 mm thickness reinforced and braced for rigidity. Provide removable panels for access to interior. Uncoated, steel parts shall be painted over with corrosion resistant paint to CGSB 1-GP-181M. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 12 mm thick rigid acoustic insulation.

- .6 Acceptable material: Greenheck BSQ, Loren Cook SQN, or approved equal in accordance with B6.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 FAN INSTALLATION**

- .1 Install fans as indicated, complete with spring isolators, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

**3.3 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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.

**1.2 SYSTEM DESCRIPTION**

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

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate following:
    - .1 Capacity.
    - .2 Throw and terminal velocity.
    - .3 Noise criteria.
    - .4 Pressure drop.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Include:
    - .1 Keys for volume control adjustment.
    - .2 Keys for air flow pattern adjustment.



**Part 2 Products**

**2.1 GENERAL**

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level as indicated.
- .2 Frames:
  - .1 Full perimeter gaskets.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as directed by Contract Administrator.

**2.2 MANUFACTURED UNITS**

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

**2.3 GRILLES AND REGISTERS**

- .1 General: with opposed blade dampers operable from register face, same material as register.
- .2 Type RA-1
  - .1 Model: return air
  - .2 Material: steel
  - .3 Border: steel, 32 mm.
  - .4 Blades: single deflection, 45 degrees, horizontal face bars.
  - .5 Finish: White powder coat.
  - .6 Acceptable materials: Price 530D, Nailor, Titus, Tuttle and Bailey or acceptable equal in accordance with B6.
- .3 Type SA-1
  - .1 Model: supply air
  - .2 Material: 316 stainless steel
  - .3 Border: steel, 32 mm.
  - .4 Blades: single deflection, 19 mm on center, 45 degrees, horizontal face bars.
  - .5 Acceptable materials: Price 720SS/N/L/A or acceptable equal in accordance with B6.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Type RA-1:
  - .1 Fasteners: oval head cadmium plated screws in countersunk holes where fastenings are visible.

- .3 Type SA-1:
  - .1 Fasteners: stainless steel screws in countersunk holes.

**3.3 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.

**END OF SECTION**

**Part 1        General**

**1.1            REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-115.18- M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.
- .3 Underwriters' Laboratories of Canada
  - .1 ULC -S111- 07, "Fire Tests for Air Filter Units".

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawing and product data in accordance with Section 01 33 00 - Submittal Procedures.

**1.3            CLOSEOUT SUBMITTALS**

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

**1.4            MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

**1.5            EXTRA MATERIALS**

- .1 Spare filters: in addition to filters to be installed immediately prior to acceptance by Contract Administrator, supply 1 complete set of filters for each filter unit or filter bank in accordance with section 01 78 00 - Closeout Submittals.

**Part 2        Products**

**2.1            GENERAL**

- .1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 50 degrees C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.

## **2.2 ACCESSORIES**

- .1 Holding frames: permanent channel section construction of extruded aluminum, 1.6 mm thick, except where specified otherwise.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side.

## **2.3 COTTON PANEL FILTERS**

- .1 Disposable pleated reinforced cotton dry media: to CAN/CGSB 115.18.
- .2 Holding frame: galvanized steel, or slide in channel for side access.
- .3 Performance:
  - .1 MERV 8 to ASHRAE 52.2.
- .4 Fire Rated: to ULC -S111.
- .5 Nominal thickness: 50 mm.
- .6 Acceptable material: Camfil Farr 30/30 or approved equal in accordance with B6.

## **2.4 FILTER GAUGES - DIAL TYPE**

- .1 Diaphragm actuated, direct reading.
- .2 Range: 0 to 2 times initial pressure.
- .3 Acceptable material: Dwyer Magnehelic, or approved equal in accordance with B6.

## **Part 3 Execution**

### **3.1 INSTALLATION GENERAL**

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

### **3.2 REPLACEMENT MEDIA**

- .1 Replace all media with new upon acceptance.
- .2 Filter media to be new and clean, as indicated by pressure gauge, at time of acceptance.

### **3.3 FILTER GAUGES**

- .1 Install type as indicated across each filter bank in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

**END OF SECTION**

**Part 1 GENERAL**

**1.1 REFERENCES**

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society of Mechanical Engineers (ASME)
  - .1 ASME Boiler and Pressure Vessel Code, 2010.
- .3 ASTM International Inc.
  - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M-01(2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-84(2009), Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .4 Canadian Standards Association (CSA International)
  - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA-B214-07, Installation Code for Hydronic Heating Systems.
- .5 Electrical Equipment Manufacturers Advisory Council (EEMAC)
- .6 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2009, Motors and Generators.

**1.2 SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
    - .1 Indicate manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.

- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.

### **1.3 CLOSEOUT SUBMITTALS**

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

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

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

## **Part 2 PRODUCTS**

### **2.1 PLATE HEAT EXCHANGER**

- .1 Water to glycol.
  - .1 Designed, constructed and tested in with accordance CSA B51 and provincial pressure vessel regulations.
- .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- .3 Plates: type 304 stainless steel.
- .4 Gaskets: nitrile rubber.
- .5 Nozzles: 1035 kPa, ASA rubber rated flange type.
- .6 Supports: as indicated.
- .7 Piping connections: as indicated.
- .8 Capacity: as indicated.
- .9 Dimensions: as indicated.
- .10 Acceptable materials: Bell and Gossett, Armstrong, Alfa Laval, Taco, SPX-APV or approved equal in accordance with B6.

**2.2 SHELL AND TUBE EXCHANGER**

- .1 Flushing water to glycol
  - .1 Designed, constructed and tested in with accordance CSA B51 and provincial pressure vessel regulations.
- .2 Heads: cast iron.
- .3 Tube Sheets: brass
- .4 Shell Ends: brass
- .5 Tubes: 9.5 mm copper
- .6 Supports: as indicated.
- .7 Piping connections: as indicated.
- .8 Capacity: as indicated.
- .9 Dimensions: as indicated.
- .10 Insulation: as indicated in Section 23 07 20.
- .11 Acceptable materials: Bell and Gossett CHX or approved equal in accordance with B6.

**2.3 AUTOMATIC AIR VENT**

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

**2.4 AIR SEPARATOR - IN-LINE**

- .1 Centrifugal type, inlet and outlet connections tangential to shell.
- .2 Connections: NPT or flanged, equivalent or next size up to piping size.
- .3 Working pressure: 862 kPa at 177°C.
- .4 Acceptable Materials: Armstrong, Bell & Gossett, Amtrol, or approved equal in accordance with B6.

**2.5 DIAPHRAGM TYPE EXPANSION TANK**

- .1 Vertical steel pressurized diaphragm type expansion tank.
- .2 Capacity: 30.3 L.
- .3 Size: 495 mm long x 305 mm diameter.
- .4 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification.
- .6 Air precharged to 84 kPa (initial fill pressure of system).
- .7 Base mount for vertical installation.
- .8 Acceptable material: Armstrong, Bell & Gossett, Expanflex, Taco or approved equal in accordance with B6.

**2.6 GLYCOL FEED UNIT**

- .1 Packaged hydronic system feed unit, integral mix tank, diaphragm pump, accumulator tank, purge valve, flex connection hoses.
- .2 Storage capacity: 65 litres (17 gallon).
- .3 Acceptable material: Axiom Model MF300 complete with Model R1A10 alarm panel or approved equal in accordance with B6.

**2.7 VERTICAL IN-LINE CIRCULATORS**

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with flanged suction and discharge connections.
- .2 Impeller: bronze.
- .3 Shaft: carbon steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: rigid self-aligning.
- .6 Motor: as per Section 26 05 13.
- .7 Capacity: as indicated.
- .8 Design pressure: 1200 kPa.
- .9 Acceptable materials: Armstrong, Bell & Gossett, Taco or approved equal in accordance with B6.

**2.8 SUCTION DIFFUSER**

- .1 Body: cast iron, angle type.
- .2 Internal components: strainer with built-in, disposable 1.19 mm mesh, low pressure drop screen and 25mm blowdown connection, permanent magnet particle trap, full length straightening vanes, pressure gauge tappings.
- .3 Acceptable materials: Armstrong, Bell & Gossett, Taco or approved equal in accordance with B6.

**2.9 HEATING COILS**

- .1 General:
  - .1 Cleanable tube type: steel headers and straight tubes.
  - .2 Plate fin type: tubes mechanically bonded to fins.
  - .3 Spiral wound fin type: mechanically bonded to tubes.
  - .4 Non-ferrous tubes and headers: brazed assembly.
  - .5 Factory tested with air under water.
- .2 Capacities: as indicated.
- .3 Ratings: Certified by manufacturer. Submit with shop drawings actual heating fluid entering and leaving conditions for stated air side requirements.
- .4 Coil casings:



- .1 Mounting: as indicated.
  - .2 Steel: die formed 1.6 mm thick galvanized steel sheet.
  - .3 Tube supports: allow for expansion and contraction.
  - .4 Supports: steel channel or double angle frames or other approved support. Provide brass supports for copper coils.
  - .5 Blank-off plates: of similar material as casing to prevent air bypass. Seal openings where pipes pass through casing using methods recommended by SMACNA.
- .5 Glycol heating coils: cleanable fins.
- .1 Tubes: copper.
  - .2 Fins: aluminum.
  - .3 Headers: steel.
  - .4 Pressure tests: 1.7 MPa.
- .6 Construction: custom built to sizes schedule but confirmed by site measurement, drainable header arrangement.
- .7 Acceptable materials: Engineered Air, Greenheck, McQuay, JCI/York, Vapac or approved equal in accordance with B6.

**2.10 VALVES**

- .1 Valves: as far as possible from a single manufacturer (see Section 23 05 22).
- .2 Drain valves up to and including 19 mm: compression stops or hose bibbs, rough brass, with garden hose thread outlet.

**2.11 STRAINERS (WATER SERVICE)**

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern, 20 mesh screen. Acceptable material: Sarco Figure 16.
- .2 NPS 2 1/2 to 12: cast iron body to ASTM A278/A278M, Class 30 flanged connections, 3 mm perforations. Acceptable material: Sarco Figure CI-125
- .3 Blowdown connection: NPS 1.
- .4 Screen: stainless steel.
- .5 Working pressure: 860 kPa.

**2.12 CIRCUIT BALANCING VALVES (CBV)**

- .1 General:
  - .1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connected to differential pressure meter.
  - .2 Accuracy:
    - .1 Readout to be within plus or minus 2% of actual flow at design flow rate.
- .2 Construction: cast iron, 1.2 MPa, 121 degrees C, screwed ends, Teflon disc, screw-in bonnet.

- .1 Flow control: at least four full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
- .3 Drain connection:
  - .1 NPS3/4 valved and capped, suitable for hose socket.
  - .2 Incorporated into valve body or provided as separate item.
- .4 Acceptable materials: Armstrong, Bell & Gossett or approved equal in accordance with B6.

## **2.13 SIDEARM FILTERS**

- .1 Cast iron and steel filter housing complete with flow indicators.
- .2 Provide adequate filters to complete initial system cleaning and provide The City with six spare filters at time of system turnover to The City.

## **Part 3 EXECUTION**

### **3.1 APPLICATION**

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

### **3.2 GENERAL**

- .1 Maintain adequate clearance to permit service and maintenance.
- .2 Should deviations beyond allowable clearances arise, request and follow Contract Administrator's directive.
- .3 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

### **3.3 HEAT EXCHANGER**

- .1 Examination
  - .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for heat exchanger 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.
  - .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative
- .2 Installation
  - .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

- .2 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.
- .3 Plate exchangers: install in accordance with manufacturer's recommendations.
- .3 Appurtenances
  - .1 Install with safety relief valve piped to drain, vacuum breaker, hose bib drain valve.
  - .2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.
- .4 System Start-up
  - .1 Check heater for cleanliness on primary and secondary sides.
  - .2 Check water treatment system is complete, operational and correct treatment is being applied.
  - .3 Check installation, settings, operation of relief valves and safety valves.
  - .4 Check installation, location, settings and operation of operating, limit and safety controls.
  - .5 Check supports systems.
  - .6 Timing: only after TAB of hydronic systems have been successfully completed.
  - .7 Primary side:
    - .1 Measure flow rate, pressure drop, and water temperature at heater inlet and outlet.
    - .2 Control valve: verify proper operation without binding, slack in components. Measure pressure drop across inlet to common, bypass to common, inlet to bypass.
  - .8 Secondary side:
    - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
    - .2 Verify installation and operation of air elimination devices.
  - .9 Verify settings, operation, safe discharge from safety valves and relief valves.
  - .10 Verify settings, operation of operating, limit and safety controls and alarms.

### **3.4 PUMP MOUNTING**

- .1 Ensure that pump body does not support piping or equipment.
  - .1 Provide stanchions or hangers for this purpose.
  - .2 Refer to manufacturer's installation instructions for details.
- .2 Elbows on pump suction and discharge: long sweep type.
- .3 Check rotation prior to start-up.
- .4 Install pressure gauge test cocks.

### **3.5 PROTECTION OF FINNED ELEMENTS**

- .1 Protect of heating coils from damage during the period of construction.

- .2 Comb out all fins damaged during construction to the satisfaction of the Contract Administrator. Replace units that cannot be properly repaired.

### **3.6 INSTALLATION OF PIPING**

- .1 Cut pipe accurately to measurements taken at site and install without springing or forcing. Changes in direction: with fittings.
- .2 Connected equipment, valves, etc., using unions up to 50 mm and flanges in sizes 63 mm and over.
- .3 Slip on flanges: forged carbon steel welding flanges. Flange connections: made with a full complement of nuts and bolts.
- .4 Weld flanges to the pipe at the neck of flange and also back welded at end of the pipe at inside face of flange. Ground back weld at flange face clean after welding is completed.
- .5 Grade liquid piping upward in direction of flow. Minimum grade: .25% 75 mm/31 m (3"/100 ft).
- .6 Screwed valves installed in copper lines: copper male thread adapters with joint compound applied.
- .7 Install piping parallel to walls whenever possible.
- .8 Install drain valves on each pump and at low points in the mechanical system to provide complete drainage. Run drain lines and blow off connections to terminate above nearest drain.
- .9 Remove valve working parts prior to brazing or soldering operations.
- .10 Provide shut off valves and unions or flanges at connections to each piece of equipment.
- .11 Install strainers upstream of flow control equipment.
- .12 Make reductions in pipe size using eccentric reducers or eccentric reducing couplings.
- .13 Where change in direction of piping is shown as being used to take up expansion of the piping, such as at expansion loops or swing connections, spring piping cold when it is being installed.
- .14 Blow out equipment with compressed air prior to making final piping connections.
- .15 Butt welding joints in 63 mm piping and above to be made using backing rings, which to be installed fully in accordance with the manufacturer's recommendations. All nubs to be removed on completion of joints.
- .16 Copper piping up to 25 mm in size: soldered joints with 95-5 solder. Copper piping over 25 mm: silver brazed joints.
- .17 Install di-electric insulating couplings or isolating flanges between pipes or apparatus constructed of dissimilar metals.
- .18 Install air vents at high points in water systems where air might be trapped. Install gate valve on automatic air vent inlet. Run discharge to nearest drain.
- .19 Bull head connections are not acceptable.

### **3.7 PIPELINE STRAINERS**

- .1 Install strainers on the inlet side of all pumps, except for sump pumps.
- .2 Install strainers in horizontal piping with basket under pipe or in vertical piping in the down leg only.
- .3 Provide valved sediment blowoff for basket on strainers 38 mm and larger.
- .4 Install in locations to allow access for removal of screen.

### **3.8 VALVE INSTALLATION**

- .1 Install check valves on pump discharges and install shut-off valves in suction and discharge piping at each pump located to allow servicing.
- .2 Arrange for maximum effectiveness or as directed.

### **3.9 EXPANSION COMPENSATION**

- .1 Make proper provision for expansion and contraction of all piping. Use swing connections and loops where shown or necessary.
- .2 Install hot water piping with expansion loops or joints where shown, and anchor to the building structure by rigid anchors at the points indicated, in order to control expansion.
- .3 If not otherwise indicated on the drawings, install 1200 mm X 1200 mm expansion loops on all copper hot water heating piping, having a straight run in excess of 12m. Centre expansion loop in the straight run, with alignment guides on each side of the loop and anchors at the extreme ends of the pipe run. Install similar loops on straight runs of steel glycol heating piping which exceed 18m in length.
- .4 Alignment Guides
  - .1 Provide alignment guides, on each side of expansion loops.
  - .2 Support guides on structural brackets braced to building support.
- .5 Anchors
  - .1 Provide pipe anchors where shown on the drawings. Construction: fabricated from channels and angles to suit the location and braced to the building's structure.
- .6 Anchors and guides in contact with copper pipe: copper or copper plated.

### **3.10 EXPANSION TANKS**

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

### **3.11 PRESSURE SAFETY RELIEF VALVES**

- .1 For water piping, run discharge pipe to terminate above nearest drain.
- .2 For glycol piping, run discharge pipe to glycol make-up tank.

### **3.12 SUCTION DIFFUSERS**

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

**END OF SECTION**