

.1 USE OF SYSTEMS

- .1 Use of new permanent heating and ventilation systems for supplying temporary heat or ventilation is not permitted.
- .2 Contractor is responsible for fuel used during this time.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Firestopping: Section 07 84 00
- .2 Cleaning and Start-up of Mechanical Systems: Section 23 08 02

### 1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB1.181-99, Organic Zinc-Rich Coating.

PART 2 - PRODUCTS Not Applicable.

## PART 3 - EXECUTION

### 3.1 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .4 Maintain all minimum clearances required by the NEC.
- .5 Maintain equipment and valves a maximum of 910mm above ceilings.

### 3.2 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment and components.

### 3.3 DRAINS

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

### 3.4 AIR VENTS

- .1 Install air vents at all system high points.
- .2 Install manual air vents at high points in piping systems in areas within accessible mechanical spaces.
- .3 Install automatic air vent with isolating valve at each high point in finished areas.
- .4 Install drain piping on manual air vents to floor drain and terminate where discharge is visible.

### 3.5 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape or pipe dope as recommended by manufacturer.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
  - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion.
- .14 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless otherwise indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Install globe valves in bypass around control valves.
  - .6 Use ball or butterfly valves at branch takeoffs for isolating purposes except where otherwise specified.
- .15 Check Valves:
  - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
  - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

- .16 Install pipe straight and parallel to building lines.

### 3.6 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, dry-wall partitions and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe (sheet metal acceptable for non-rated dry wall partitions).
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
  - .2 Other floors: Terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB- 1.181.
  - .4 All mechanical room walls and wet areas above ground slab.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
  - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### 3.7 ESCUTCHEONS

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

### 3.8 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00.
- .2 Uninsulated unheated pipes not subject to movement: No special preparation.
- .3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

**3.9 FLUSHING OUT OF PIPING SYSTEMS**

- .1 In accordance with Section 23 08 02.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 23 08 02 supplemented as specified in relevant sections of Division 21, 22 & 23.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

**3.10 PRESSURE TESTING OF EQUIPMENT**

- .1 Advise Departmental Representative 72 hours minimum prior to performance of pressure tests.
- .2 Pipework: All piping shall be pressure tested at either city mains pressure, or 1.5 times the normal operating pressure, whichever is greater. Also refer to testing requirements specified in relevant sections of Divisions 21, 22 and 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Divisions 21, 22 and 23.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .6 Insulate or conceal work only after review of tests by Departmental Representative.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SECTIONS INCLUDES

- .1 Electrical work to conform to Division 26 including the following:
  - .1 Supplier and installer responsibility is indicated in Division 26 on electrical drawings and related mechanical responsibility is indicated in Divisions 21, 22 and 23, and on mechanical drawings.
  - .2 Control wiring and conduit is specified in Division 26. Conduit, wiring and connections below 50V which are related to control systems specified in Divisions 21, 22 and 23 are the responsibility of Divisions 21, 22 and 23 respectively, except as indicated otherwise. Refer to Division 26 for quality of materials and workmanship.

### 1.2 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Cleaning: Section 01 74 11
- .3 Closeout Submittals: Section 01 78 00

### 1.3 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-2010, Energy Standard for Buildings except Low-Rise Residential Buildings.
- .2 National Electrical Manufacturers' Association (NEMA).

### 1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.

### 1.5 CLOSEOUT SUBMITTALS

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

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Motors: inverter duty rated premium efficiency, in accordance with local utility company standards and the requirements of ASHRAE 90.1.

### 2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.

- .2 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 1/2 HP: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .4 Motors 1/2 HP and larger: NEMA, Class B, squirrel cage induction, premium efficiency, speed as indicated, continuous duty, inverter rated, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575V, unless otherwise specified or indicated.

### 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 specified.
- .3 For motors under 10 HP: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use midposition of range for specified r/min.
- .4 For motors 10 HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave to be 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 (1) set of spare belts for each set installed in accordance with Section 23 05 00.

### 2.4 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
  - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.

- .2 Net free area of guard: not less than 80% of fan openings.
- .3 Securely fasten in place.
- .4 Removable for servicing.

### PART 3 - EXECUTION

#### 3.1 MANUFACTURER'S INSTRUCTIONS

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

#### 3.2 INSTALLATION

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

#### 3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct tests and submit report in accordance with Section 01 33 00.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as specified in Section 01 78 00.
  - .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 specified in Section 01 45 00.

#### 3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .2 Upon completion and verification of performance of installation, remove surplus.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00

### 1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate for each item as applicable:
  - .1 Manufacturer, model number, line contents, pressure and temperature rating.
  - .2 Movement handled; axial, lateral, angular and the amounts of each.
  - .3 Nominal size and dimensions including details of construction and assembly.

### 1.3 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.
- .2 Data to include:
  - .1 Servicing requirements, including any special requirements, stuffing box packing, lubrication and recommended procedures.

## PART 2 - PRODUCTS

### 2.1 ANCHORS AND GUIDES

- .1 Anchors:
  - .1 Provide as indicated/required.
  - .2 Structural steel members secured to building structure.
- .2 Alignment guides:
  - .1 Provide as indicated to accommodate specified thickness of insulation.
  - .2 Carbon steel bolted spider and outer housing.
  - .3 Copper plated spider for copper piping.

### 2.2 FLEXIBLE CONNECTIONS

- .1 Application: to suit motion.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: bronze, corrugated.
- .4 Braided wire mesh, bronze outer jacket.
- .5 Diameter and type of end connection: as indicated.

- .6 Operating conditions:
  - .1 Working pressure: 1034 kPa.
  - .2 Working temperature: 93°C.
  - .3 To match system requirements.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install pipe anchors, guides and flexible pipe connections as indicated, required and in accordance with manufacturer's instructions. Anchors to withstand 150% of axial thrust.
- .2 Ensure that a minimum of one-half of the pipe alignment spider is within the guide under all conditions.
- .3 All horizontally installed flexible loops must have 180°return bend supported.
- .4 Provide flexible connections at all pump inlet/outlets.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Mechanical General Requirements: Section 21 05 01

### 1.2 REFERENCES

- .1 ASME B40-100-2013, Pressure Gauges and Gauge Attachments.
- .2 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
- .3 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

### 1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Submit manufacturer's product data for following items:
  - .1 Thermometers.
  - .2 Pressure gauges.
  - .3 Stop cocks.
  - .4 Wells.
  - .5 Snubbers.

### 1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 33 00.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Thermometers and pressure gauges to operate at mid point of scale or range.

### 2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, aluminum case, graduated in °C and °F brass stem, liquid filled, 225 mm scale length: to CAN/CGSB 14.4.
  - .1 Acceptable Material: Trerice BX9; Weiss; Taylor; Baker; Winter's.

### 2.3 REMOTE READING THERMOMETERS

- .1 112 mm diameter mercury activated dial type: to CAN/CGSB-14.5, stainless steel bourdon tube, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.
  - .1 Acceptable Material: Trerice M80341; Weiss; Taylor; Baker; Winter's.

### 2.4 INDUSTRIAL THERMOMETER WELLS

- .1 Use copper, bronze, brass, or stainless steel to suit application, 3/4 NPT.
- .2 Provide extension to suit insulation thickness.

### 2.5 PRESSURE GAUGES

- .1 112 mm dia., dial type: to ANSI/ASME B40.1, Grade A, having 1% of full scale over middle half of range accuracy unless otherwise specified. Graduated in °C and °F.
  - .1 Acceptable Material: Trerice 620B series; Weiss; Taylor, Baker; Winter's.
- .2 Provide mini ball valve and:
  - .1 Snubber for pulsating operation.
  - .2 Diaphragm for corrosive service.

## PART 3 - EXECUTION

### 3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Provide engraved lamoid nameplates as specified in Section 23 05 53, identifying medium.
- .3 Locate between equipment and first fitting or valve.

### 3.2 THERMOMETERS

- .1 Install in wells on all piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
  - .1 Water heating coils.
  - .2 3-way mixing valves.
  - .3 Heat exchangers supply and return piping.
  - .4 Supply and return piping from main heating zones.
  - .5 Supply and return from chiller and each boiler.
  - .6 Discharge from domestic hot water tanks.
- .3 Use extensions on all thermometers wells and pressure gauges to allow for insulation thickness.

### 3.3 PRESSURE GAUGES

- .1 Install in following locations:
  - .1 Domestic and fire water entrance.
  - .2 Suction and discharge of pumps over 1/2 hp.
  - .3 Upstream and downstream of control valves.
  - .4 Inlet and outlet of water side of coils: provide pressure gauge cocks and taps for balancing/commissioning.
  - .5 Inlets and outlets of all heat exchangers.
  - .6 Inlet and outlet of each boiler and chiller.
  
- .2 Use extensions on all pressure gauge connections to permit mini-ball valve complete with snubber to be clear of insulation and jacket.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Health and Safety Requirements: Section 01 35 29
- .2 Construction/Demolition Waste Management and Disposal: Section 01 74 21
- .3 Closeout Submittals: Section 01 78 00
- .4 Installation of Pipework: Section 23 05 05

### 1.2 REFERENCES

- .1 Codes and standards referenced in this section refer to the latest edition thereof.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch.)
  - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings
- .3 American Society of Testing and Materials (ASTM)
  - .1 ASTM A276-2015, Specification for Stainless Steel Bars and Shapes.
  - .2 ASTM B62-2015, Specification for Composition Bronze or Ounce Metal Castings.
  - .3 ASTM B283-2014A, Specification for Copper and Copper Alloy Die Forgings (Hot Pressed)
  - .4 ASTM B505/B505M-2014A, Specification for Copper-Base Alloy Continuous Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS SP-25-2013, Standard Marking System for Valves, Fittings, Flanges and Unions.
  - .2 MSS SP-80-2013, Bronze Gate, Globe, Angle and Check Valves.
  - .3 MSS SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

### 1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.
  - .1 Submit shop drawings and product data in accordance with Section 01 33 00.
  - .2 Submit data for valves specified this section.
- .3 Closeout Submittals
  - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00.

#### 1.4 QUALITY ASSURANCE

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

#### 1.5 DELIVERY, STORAGE AND DISPOSAL

- .1 Waste Management and Disposal.
- .2 Separate and recycle waste materials in accordance with Section 01 74 22.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

#### 1.6 MAINTENANCE

- .1 Extra Materials
  - .1 Furnish following spare parts:
    - .1 Valve seats: one (1) for every ten (10) valves each size. Minimum one (1).
    - .2 Discs: one (1) for every ten (10) valves, each size. Minimum one (1).
    - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
    - .4 Valve handles: two (2) of each size.
    - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- .1 Except for specialty valves, to be single manufacturer.
- .2 All products to have Canadian registration numbers (CRN), if required.
- .3 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 ANSI/ASME B16.18.
- .4 Lockshield Keys
  - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

#### 2.2 GATE VALVES

- .1 Requirements common to all gate valves, unless specified otherwise:
  - .1 Standard specification: MSS SP-80.
  - .2 Bonnet: with hex. shoulders.
  - .3 Connections: with hex. shoulders.
  - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
  - .5 Packing: high grade non- asbestos packing.
  - .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
  - .8 Glass 125, WP=860 kPa steam, 1.4 mPa WOG

- .9 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
  - .2 Operator: Handwheel
- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
  - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
  - .2 Operator: Handwheel
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
  - .3 Operator: Handwheel
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Operator: Handwheel
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
  - .1 Body: with long disc guides, screwed bonnet.
  - .2 Operator: Handwheel

### 2.3 GLOBE VALVES

- .1 Requirements common to all globe valves, unless specified otherwise:
  - .1 Standard specification: MSS SP-80.
  - .2 Bonnet: union with hex. shoulders.
  - .3 Connections: screwed with hex. shoulders.
  - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
  - .5 Packing: non-asbestos.
  - .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
  - .8 Glass 125, WP=860 kPa steam, 1.4 mPa WOG
- .2 NPS 2 and under, composition disc, Class 125:
  - .1 Body and bonnet: screwed bonnet.
  - .2 Disc and seat: renewable rotating PTFE disc regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
  - .3 Operator: Handwheel.
- .3 NPS 2 and under, composition disc, Class 150:
  - .1 Body and bonnet: union bonnet.
  - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
  - .3 Operator: Handwheel
- .4 NPS 2 and under, plug disc, Class 150, screwed ends:
  - .1 Body and bonnet: union bonnet.
  - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
  - .3 Operator: Handwheel

- .5 Angle valve, NPS 2 and under, composition disc, Class 150:
  - .1 Body and bonnet: union bonnet.
  - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
  - .3 Operator: Handwheel.

## 2.4 CHECK VALVES

- .1 Requirements common to all check valves, unless specified otherwise:
  - .1 Standard specification: MSS SP-80.
  - .2 Connections: with hex agonal shoulders.
  - .3 Class 125, WP=860 kPa steam, 1.4 mPa WOG
  - .4 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG
  - .5 Class 200 1.4 mPa CWP
- .2 NPS 2 and under, swing type, bronze disc, Class 125:
  - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
  - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .3 NPS 2 and under, swing type, bronze disc:
  - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
  - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 NPS 2 and under, swing type, composition disc, Class 200:
  - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex. head.
  - .2 Disc: renewable rotating disc, of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
- .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
  - .1 Body: with integral seat, union bonnet ring with hex. shoulders, cap.
  - .2 Disc: renewable PTFE for steam, #6 composition rotating disc for water, oil or gas service in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
  - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

## 2.5 SILENT CHECK VALVES

- .1 NPS 2 and under:
  - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
  - .2 Pressure rating: Class 125.
  - .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
  - .4 Disc and seat: renewable rotating disc.
  - .5 Stainless steel spring, heavy duty.
  - .6 Seat: regrindable.

## 2.6 BALL VALVES

- .1 NPS 2 and under:
  - .1 Body and cap: cast high tensile bronze to ASTM B62.

- .2 Pressure rating: Class 125, 860 MPa steam.
- .3 Connections: Screwed ends to ANSI B1.20.1 and with hex. shoulders.
- .4 Stem: tamperproof ball drive.
- .5 Stem packing nut: external to body.
- .6 Ball and seat: replaceable stainless steel or hard chrome solid ball and teflon seats.
- .7 Stem seal: TFE with external packing nut.
- .8 Operator: removable lever handle with extension for insulated pipe.

## 2.7 ACCEPTABLE PRODUCT

- .1 Acceptable Product: Jenkins, Crane, Watts, Wilkins, Newman Hattersley, Milwaukee, Conbraco, Kitz, Red White, M.A. Stewart, Nibco.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
- .4 Up to and including NPS 2 use line size ball valves for isolation of all equipment and every pipe branch circuit. Gate or ball valves are acceptable for sizes over NPS 2.
- .5 Provide discrete but noticeable markers on ceiling systems for all equipment located above ceiling tiles.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Health and Safety Requirements: Section 01 35 29
- .3 Construction/Demolition Waste Management Disposal: Section 01 74 22
- .4 Closeout Submittals: Section 01 78 00
- .5 Installation of Pipework: Section 23 05 05
- .6 Valves – Bronze: Section 23 05 23

### 1.2 REFERENCES

- .1 Codes and standards referenced in this section refer to the latest edition thereof.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
- .3 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A49-2012, Specification for Heat-Treated Carbon Steel Joint Bars.
  - .2 ASTM A126-04(2014), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
  - .3 ASTM B61-08, Specification for Steam or Valve Bronze Castings.
  - .4 ASTM B62-2015, Specification for Composition Bronze or Ounce Metal Castings.
  - .5 ASTM B85/B85M-2014, Specification for Aluminum-Alloy Die Castings.
  - .6 ASTM B209-2014, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS SP-70-2011, Cast Iron Gate Valves, Flanged and Threaded Ends.
  - .2 MSS SP-71-2011, Grey Iron Swing Check Valves, Flanged and Threaded Ends
  - .3 MSS SP-85-2011, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

### 1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.
  - .1 Submit shop drawings and product data in accordance with Section 01 33 00.
  - .2 Submit data for valves specified this section.
- .3 Closeout Submittals
  - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00.

#### 1.4 QUALITY ASSURANCE

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

#### 1.5 DELIVERY, STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
  - .1 Separate and recycle waste materials in accordance with Section 01 74 22.
  - .2 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

#### 1.6 MAINTENANCE

- .1 Extra Materials
  - .1 Furnish following spare parts:
    - .1 Valve seats: one (1) for every ten (10) valves each size. Minimum one (1).
    - .2 Discs: one (1) for every ten (10) valves, each size. Minimum one (1).
    - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
    - .4 Valve handles: two (2) of each size.
    - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.

### PART 2 - PRODUCTS

#### 2.1 MATERIAL

- .1 Except for specialty valves, to be of single manufacturer.
- .2 Standard specifications:
  - .1 Gate valves: MSS SP-70.
  - .2 Globe valves: MSS SP-85.
  - .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
  - .1 Body, bonnet: cast iron to ASTM B209 Class B.
  - .2 Connections: flanged ends, plain face, to ANSI B16.1.
  - .3 Bonnet gasket: non-asbestos.
  - .4 Stem: to have precision- machined Acme or 60°V threads, top screwed for handwheel nut.
  - .5 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
  - .6 Gland packing: non-asbestos.
  - .7 Handwheel: Die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
  - .8 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have Canadian Registration Numbers (CRN).
- .5 Bronze trim for steam, water, air or glycol service, iron trim for oil, gas or gasoline.
- .6 Acceptable Product: Crane, Jenkins, Milwaukee, Newman Hattersley, Kitz, M.A. Stewart, NIBCO, Watts, Wilkins.

## 2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze or iron trim, solid wedge disc:
  - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
  - .2 Bronze Trim:
    - .1 Disc: Solid offset taper wedge, bronze to ASTM B62.
    - .2 Seat rings: renewable bronze to ASTM B62, screwed into body.
    - .3 Stem: bronze to ASTM B62.
  - .3 Iron Trim:
    - .1 Disc: Solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
    - .2 Seat: Integral with body.
    - .3 Stem: wrought steel.
    - .4 Operator: Handwheel
  
- .2 NPS 10 - 24, non rising stem, inside crew, bronze or iron trim, solid wedge disc:
  - .1 Body and multiple-bolted bonnet: cast iron to ASTM A126 Class B for sizes up to NPS 14, Class C for sizes NPS 16 and over, with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re- assembly, body tie ribs between bonnet and end flanges.
  - .2 Pressure ratings: Class 125.
  - .3 Bronze Trim:
    - .1 Disc: Solid offset taper wedge, with bronze rings to ASTM B62 rolled into cast iron disc, secured to stem.
    - .2 Seat rings: renewable bronze to ASTM B62 screwed into body.
    - .3 Stem: bronze to ASTM B62.
    - .4 Iron Trim:
      - .1 Disc: Solid offset taper wedge, cast iron secured to stem.
      - .2 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
      - .3 Stem: wrought steel.
      - .4 Operator: Handwheel
  
- .3 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze or iron trim, solid wedge disc:
  - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut, Class 125.
  - .2 Bronze Trim:
    - .1 Disc: Solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
    - .2 Seat rings: renewable bronze screwed into body.
    - .3 Stem: manganese- bronze.
  - .3 Iron Trim:
    - .1 Disc: Solid offset taper all-cast iron, secured to stem through integral forged T-head disc- stem connection.
    - .2 Seat rings: integral with body.
    - .3 Stem: nickel-plated steel for iron trim.
    - .4 Pressure-lubricated operating mechanism.
    - .5 Operator: Handwheel.
  - .4 NPS 10 - 24, outside screw and yoke (OS&Y), bronze or iron trim, solid wedge disc:
    - .1 Body and multiple-bolted bonnet: NPS 10 - 14: cast iron to ASTM A126 Class B; NPS 16 - 24: cast iron to ASTM A126 Class C. With bosses in body and bonnet for taps

and drains, full length disc guides designed to ensure correct re- assembly, body tie ribs between bonnet and end flanges, yoke, yoke hub, yoke sleeve and nut.

- .2 Pressure ratings: Class 125.
  - .1 NPS 10-12: WP = 1.4 MPa CWP
  - .2 NPS 14-24: WP = 1.03 MPa CWP
- .3 Bronze Trim
  - .1 Disc: Solid offset taper wedge, bronze disc rings to ASTM B62 rolled into cast iron disc, secured to stem through integral forged T-head disc-stem connection.
  - .2 Seat rings: renewable bronze to ASTM B62 screwed into body.
  - .3 Stem: manganese- bronze.
- .4 Iron Trim:
  - .1 Disc: Solid offset taper all-cast iron, secured to stem through integral forged T-head disc- stem connection.
  - .2 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
  - .3 Stem: nickel-plated steel.
- .5 Pressure-lubricated operating mechanism.
- .6 Operator: Handwheel.

### 2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 14, OS&Y:
  - .1 Approvals: UL and FM approved for fire service.
  - .2 UL and FM Label: on valve yoke.
  - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B).
  - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
  - .5 Packing gland: bronze.
  - .6 Stem: manganese bronze. Diameter to ULC C-262 (B).
  - .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
  - .8 Bosses for bypass valve, drain: on NPS 4 and over.
  - .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
  - .10 Disc seat ring: self- aligning, Milwood undercut on NPS 3 - 12.
  - .11 Pressure rating:
    - .1 NPS 2-1/2 - 12: 1.7 MPa CWP
    - .2 NPS 14:1.2 MPa CWP
  - .12 Operator: Handwheel.

### 2.4 GLOBE VALVES

- .1 NPS 2½ - 10, OSY:
  - .1 Body: with multiple-bolted bonnet.
  - .2 WP: 860 kPa steam, 1.4 MPa CWP
  - .3 Bonnet-yolk gasket: non- asbestos.
  - .4 Disc: bronze to ASTM B 62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
  - .5 Seat ring: renewable, regrindable, screwed into body.
  - .6 Stem: bronze to ASTM B 62.
  - .7 Operator: handwheel.

## 2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves: spindle uprights or parallel position.
- .3 Size of bypass valve:
  - .1 Main valve up to NPS 8: NPS 3/4.
  - .2 Main valve NPS 10 and over: NPS 1.
- .4 Type of bypass valves:
  - .1 On gate valve: globe, with composition disc, trim, to Section 23 05 23. Pressure rating to match main valve.
  - .2 On globe valve: globe, with composition disc, bronze trim, to Section 23 05 23. Pressure rating to match main valve.

## 2.6 VALVE OPERATORS

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

## 2.7 CHECK VALVES

- .1 Swing check valves, Class 125:
  - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
    - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
    - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
  - .2 Ratings:
    - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
    - .2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.
    - .3 NPS 18 and over: 1.03 MPa CWP.
  - .3 Bronze Trim
    - .1 Disc: Rotating for extended life.
      - .1 Up to NPS 6: bronze to ASTM B 62.
      - .2 NPS 8 and over: bronze-faced cast iron.
    - .2 Seat rings: renewable bronze to ASTM B62 screwed into body.
    - .3 Hinge pin, bushings: renewable bronze to ASTM B62.
  - .4 Iron Trim
    - .1 Disc: A126 Class B, secured to stem, rotating for extended life.
    - .2 Seat: cast iron, integral with body.
    - .3 Hinge pin: exelloy; bushings: malleable iron.
  - .5 Identification tag: fastened to cover.
  - .6 Hinge: galvanized malleable iron.
- .2 Swing check valves, NPS 2 1/2 - 8 Class 250:
  - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
  - .2 Flanged ends: 2 mm raised face with serrated finish.
  - .3 Rating: 1.7 mPa steam; 3.4 mPa CWP.
  - .4 Disc: Rotating for extended life.

- .1 Up to NPS 3: bronze to ASTM B61.
- .2 NPS 4 - 8: Iron faced with ASTM B61 bronze.
- .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
- .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
- .7 Hinge: galvanized malleable iron.
- .8 Identification tag: fastened to cover.

## 2.8 SILENT CHECK VALVES

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

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal. Ensure sufficient room for valve stem in fully open position.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00
- .3 Valves - Bronze: Section 23 05 23

### 1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME B16.5-2013, Pipe Flanges and Flanged Fittings.
  - .2 ANSI/ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
  - .3 ANSI/ASME B16.25-2012, Butt-welding Ends.
  - .4 ANSI/ASME B16.34-2013, Valves Flanged, Threaded and Welding End.
- .2 American Petroleum Institute (API)
  - .1 API 598-2009, Valve Inspection and Testing.
- .3 American Society for Testing and Materials (ASTM)
  - .1 ASTM A36-2014, Carbon Structural Steel.
  - .2 ASTM A49-2012, Specification for Heat-Treated Carbon Steel Joint Bars.
  - .3 ASTM A193M-2015, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
  - .4 ASTM A194M-2014, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service.
  - .5 ASTM A216-2014, Specification for Steel Castings, Carbon Suitable for Fusion Welding for High Temperature Service.
  - .6 ASTM B85-2014, Specification for Aluminum Alloy Die Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
  - .1 MSS SP25-2013, Standard Marking System for Valves, Fittings, Flanges and Unions.
  - .2 MSS SP61-2013, Pressure Testing of Steel Valves.
- .5 Province of Nova Scotia
  - .1 Boiler Pressure Vessel and Compressed Gas Regulations.

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Submit data for valves specified this section.

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 EXTRA MATERIALS

- .1 Furnish following spare parts:
  - .1 Valve seats: one (1) for every ten (10) valves each size, minimum one (1).
  - .2 Discs: one (1) for every ten (10) valves each size, minimum one (1).
  - .3 Stem packing: one (1) for every ten (10) valves, each size. Minimum one (1).
  - .4 Valve handles: two (2) of each size.
  - .5 Gaskets for flanges: one (1) for every ten (10) flanged joints.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- .1 Except for specialty valves, to be of single manufacturer.
  - .1 Acceptable manufacturers:
    - .1 Crane
    - .2 Jenkins
    - .3 Milwaukee
    - .4 Newman Hattersley
    - .5 Kitz
    - .6 M.A. Stewart
    - .7 NIBCO
- .2 Valves to be individually tested.
- .3 Requirements common to valves, unless specified otherwise:
  - .1 Pressure-temperature ratings: to ANSI B16.34.
  - .2 Inspections and tests: to API 598.
  - .3 Pressure Testing: to MSS SP-61.
  - .4 Flanged valves:
    - .1 Face-to-face dimensions: to ANSI B16.10.
    - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face
  - .5 Butt-weld valves:
    - .1 End-to-end dimensions: to ANSI B16.10.
    - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
  - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B 85 or malleable iron to ASTM A 49.
  - .7 Markings: to MSS SP-25.
  - .8 Identification:
    - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
    - .2 Body markings: manufacturer, size, primary service rating, material symbol.
  - .9 Canadian registration number (CRN) required for all products.

#### 2.2 GATE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS&Y, solid flexible wedge disc, flanged butt-weld ends, Class150 300:
  - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A 216 WCB, with full length disc guides designed to ensure correct re-assembly.
  - .2 Body/bonnet joint: Flat face with corrugated metallic gasket, malefemale on Class 300.
  - .3 Bonnet studs: to ASTM A 193 Type B7.
  - .4 Bonnet nuts: to ASTM A 194 Type 2H.

- .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
- .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
- .7 Yoke sleeve: Ni-Resist, minimum melting point above 954°C.
- .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
- .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
  - .1 NPS 2 1/2 - 6: Solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
  - .2 NPS 8 and larger: Carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.
- .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60° V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: see elsewhere this section.

### 2.3 GLOBE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS&Y, flanged butt-weld ends, Class150 to 300:
  - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A 216 WCB.
  - .2 Body/bonnet joint: Flat Male-female face with corrugated metallic gasket.
  - .3 Bonnet studs: to ASTM A 193 Type B7.
  - .4 Bonnet nuts: to ASTM A 194 Type 2H.
  - .5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.
  - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
  - .7 Yoke bushing: Ni-Resist, minimum melting point above 954°C.
  - .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
  - .9 Disc: Plug type with 15° taper seat and bottom guide.
  - .10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.
  - .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60° V threads, top screwed for handwheel nut.
  - .12 Operator: see 2.4 below.

### 2.4 VALVE OPERATORS

- .1 Handwheel: on all valves except as specified.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.
- .3 Ball valves: NPS 36 lever handle, NPS 812 gear operator.

### 2.5 BYPASSES FOR VALVES GATE AND GLOBE

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

## 2.6 CHECK VALVES

- .1 NPS 2 1/2 and over, flanged butt-weld ends, Class 150 or 300: swing check.
  - .1 Body and multiple-bolted cap: cast steel to ASTM A 216 WCB.
  - .2 Cap studs: to ASTM A 193 Type B7.
  - .3 Cap nuts: to ASTM A 194 Type 2H.
  - .4 Body/cap joint: male-female face with corrugated metallic gasket.
  - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
  - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
  - .7 Hinge: ASTM A 216 WCB.
  - .8 Hinge pin: 410 Stainless Steel.

## 2.7 BALL VALVES

- .1 NPS 3 and larger, flanged ends. Class 150 or 300 regular port.
  - .1 One piece body: cast carbon steel to ASTM A216 WCB.
  - .2 Ball: Type 304 stainless steel.
  - .3 Blow out proof stem
  - .4 Stem: type 304 stainless steel
  - .5 Antistatic device
  - .6 Seats: glass filled PTFE.
  - .7 Body gasket: PTFE.
  - .8 Cap /screws: ASTM A193.
  - .9 Packing: graph oil
  - .10 Gland: carbon steel C1018 cadmium plated.
  - .11 Gland Flange: to ASTM A36.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

### 3.2 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00
- .3 Cast-in-Place Concrete: Section 03 30 00
- .4 Structural Steel for Buildings: Section 05 12 23
- .5 Metal Fabrications: Section 05 50 00

### 1.2 REFERENCES

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-2012, Power Piping, (SI Edition).
  - .2 ANSI/ASME B31.3-2014, Process Piping.
  - .3 ANSI/ASME B31.5-2013, Refrigeration Piping and Heat Transfer Components.
  - .4 ANSI/ASME B31.9-2014, Building Services Piping.
- .2 American Society for Testing and Materials (ASTM)
  - .1 ASTM A125-96(R2013), Specification for Steel Springs, Helical, Heat Treated.
  - .2 ASTM A307-2012, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563/ASTM A563M-07(R2014), Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2009, Pipe Hangers and Supports Materials, Design and Manufacture.
- .5 Underwriter's Laboratories of Canada (ULC).

### 1.3 DESIGN REQUIREMENTS

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 , B31.3, B31.5, B31.9 or MSS SP58.
- .3 Confirm supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment to be in accordance with MSS SP58.

#### 1.4 PERFORMANCE REQUIREMENTS

- .1 Design supports, platforms, catwalks, hangers to withstand seismic events for location as per the National Building Code.
- .2 Submit shop drawings and product data in accordance with Section 01 33 00.
- .3 Submit shop drawings and product data for following items:
  - .1 Bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

#### 1.5 CLOSEOUT SUBMITTALS

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

### PART 2 - PRODUCTS

#### 2.1 GENERAL

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

#### 2.2 PIPE HANGERS

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized painted with zincrich paint after manufacture.
  - .2 Use electroplating galvanizing process or hot dipped galvanizing process.
  - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: Suspension from lower flange of I-Beam.
  - .1 Cold piping NPS 2 maximum: Malleable iron Cclamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed, 13 mm FM approved.
    - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed ,FM approved where required to MSS SP58.
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
  - .1 Cold piping NPS 2 maximum: Ductile iron top of beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved where required to MSS SP58.
  - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top of beam jaw clamp with hooked rod, spring washer, plain washer and nut UL listed, FM approved where required.
- .4 Upper attachment to concrete.
  - .1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weld-less forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved where required to MSS SP58.

- .5 Shop and field fabricated assemblies.
  - .1 Trapeze hanger assemblies: MSS SP58.
  - .2 Steel brackets: MSS SP58.
  - .3 Sway braces for seismic restraint systems: to MSS SP89.
- .6 Hanger rods: threaded rod material to MSS SP58.
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
  - .3 Do not use 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP58.
  - .1 Attachments for steel piping: carbon steel galvanized.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation saddles for hot pipework.
  - .4 Oversize pipe hangers and supports for insulated pipes.
- .8 Adjustable clevis: material to MSS SP69, UL listed FM approved, where required 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.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP58.
- .10 Ubolts: carbon steel to MSS SP58 with two (2) nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: galvanized.
  - .2 Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP58.

### 2.3 RISER CLAMPS

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

### 2.4 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP58, galvanized sheet carbon steel. Length designed for maximum 3m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP58.

### 2.5 CONSTANT SUPPORT SPRING 2%.6 HANGERS

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

### 2.6 VARIABLE SUPPORT SPRING HANGERS

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

### 2.7 EQUIPMENT SUPPORTS

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

### 2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

### 2.9 HOUSEKEEPING PADS

- .1 For base-mounted equipment: Concrete, at least 100 mm high, 50 mm larger all around than equipment, and with chamfered edges.
- .2 Concrete: to Section 03 30 00.

### 2.10 OTHER EQUIPMENT SUPPORTS

- .1 From structural grade steel meeting requirements of Section 05 12 23.
- .2 Submit structural calculations with shop drawings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers and elsewhere as indicated.
- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt tightening torques to be to industry standards.
  - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: Install below joint.
- .4 Clevis plates:
  - .1 Attach to concrete with four (4) minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
  - .1 vertical movement of pipework is 13 mm or more.
  - .2 transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
  - .1 transfer of load to adjacent piping or to connected equipment is not critical.
  - .2 variation in supporting effect does not exceed 25 % of total load.

#### 3.2 HANGER SPACING

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code
- .2 Fire protection: to applicable fire code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Hydronic, steam, condensate, rigid, and flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

Maximum Pipe Size Copper Size: <u>NPS</u>	NPS Maximum Spacing:	Steel Maximum Spacing:
up to 1-1/4	2.2 m	1.8 m
1-1/2	2.1 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.1 m	3.0 m
3	3.1 m	3.0 m
3-1/2	3.1 m	3.3 m
4	4.1 m	3.6 m
5	4.1 m	
6	5.1 m	
8	5.1 m	
10	6.6 m	
12	6.9 m	

- .5 Within 300 mm of each elbow.
- .6 Pipework greater than NPS 12: to MSS SP58.

### 3.3 HANGER INSTALLATION

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

### 3.4 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

### 3.5 FINAL ADJUSTMENT

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

- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Cast-in-Place Concrete: Section 03 30 00

### 1.2 REFERENCES

- .1 National Fire Protection Association (NFPA)
  - .1 NFPA 13-2013, Installation of Sprinkler Systems.
- .2 National Building Code of Canada (NBC) 2010.

### 1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Provide separate shop drawings for each isolated system shop drawings complete with performance and product data.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation to be as indicated.
- .2 Acceptable product: Korfund, Mason, Vibron, Vibro-Acoustics.

### 2.2 ELASTROMERIC PADS

- .1 Type EP1 neoprene waffle or ribbed; 9mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Type EP2 rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .3 Type EP3 neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.
- .4 Type EP4 rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

### 2.3 ELASTROMERIC MOUNTS

- .1 Type M1 colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two (2) bolt-down holes; ribbed top and bottom surfaces.

## 2.4 SPRINGS

- .1 Design stable springs so that ratio of lateral to axial stiffness is equal to or greater than 1.2 times the ratio of static deflection to working height. Select for 50% travel beyond rated load. Units to be complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring to be between 0.8 to 1.0.
- .3 Cadmium plate for outdoor, 100% relative humidity.
- .4 Colour code springs.

## 2.5 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 stable open spring: support on bonded 6mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Acceptable manufacturer: Korfund, Mason, Vibron, Vibro-Acoustics.

## 2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degree arc without metal to metal contact.
- .2 Type H1 neoprene in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

## 2.7 ACOUSTIC BARRIERS FOR ANCHOR AND GUIDES

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

## 2.8 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9

mm.

- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

### 2.9 STRUCTURAL BASES

- .1 Type B1 Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; predrilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .2 Type B2 Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and predrilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.
- .4 Acceptable manufacturer: Korfund, Masdom, Vibron, Vibro Acoustics.

### 2.10 INERTIA BASE

- .1 Type B3 full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
- .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.
- .3 Concrete: to Section 03 30 00.
- .4 Acceptable manufacturer: Korfund, Mason, Vibron, Vibro-Acoustics.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Painting: Section 09 91 00

### 1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB1.60-97, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB24.3-92, Identification of Piping Systems.
- .2 National Fire Protection Association
  - .1 NFPA 13-2013, Installation of Sprinkler Systems.
  - .2 NFPA 14-2013, Standpipe and Hose Systems.

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Product data to include paint colour chips, other products specified in this section.

### 1.4 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00.
- .2 Samples to include nameplates, labels, tags, lists of proposed legends.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers to be 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.
- .4 Include required listings (ie. CSA, ULC, etc.).

## 2.2 SYSTEM NAMEPLATES

- .1 Colours:
- .1 Hazardous: red letters, white background.
  - .2 Elsewhere: white letters, black background (except where required otherwise by applicable codes).
- .2 Construction:
- .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
- .1 Conform to following table:
- | # | mm       | Lines | Letters (mm) |
|---|----------|-------|--------------|
| 1 | 10 x 50  | 1     | 3            |
| 2 | 13 x 7   | 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 Room: Use size # 9.
  - .3 Use maximum of 25 letters/numbers per line.

## 2.3 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
  - .1 Sprinklers: to NFPA 13.
  - .2 Standpipe and hose systems: to NFPA 14.
  - .3 Propane: to CSA B149.

## 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, to 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 All other pipes: Pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.
- .7 Colours and Legends:
- .1 Where not listed, obtain direction from Departmental Representative.
  - .2 Colours for legends, arrows, to following table:

<u>Background colour</u>	<u>Legend, arrows</u>
Yellow	BLACK
Green	WHITE
Red	WHITE

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

<u>Contents</u>	<u>Background colour</u>	<u>Legend</u>
Ethanol supply	Green	GWS
Ethanol return	Green	GWR
Domestic cold water supply	Green	DCW
Domestic hot water supply	Green	DHW
Sanitary	Green	SAN.S.
Plumbing vent	Green	SAN. VENT
Hot water heating supply	Green	HWS
Hot water heating return	Green	HWR
Chilled water supply	Green	CWS
Chilled water return	Green	CWR
Propane	Yellow	PROPANE
Sprinklers	Red	SPRINKLER
Conduit for low voltage Control wiring	To Section 25 00 00	

## 2.5 DUCTWORK IDENTIFICATION

- .1 50 mm high stencilled letters and directional arrows 150mm long x 50 mm high.
- .2 Colours: Black, or coordinated with base colour to ensure strong contrast.
- .3 Identify system: e.g. Supply HRV- 1, Exhaust EF-1, etc.

## 2.6 VALVES, CONTROLLERS

- .1 Brass tags 75mm diameter with 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.

- .3 Use the same abbreviations as noted for the pipe labelling.

## 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) failsafe position, component ID name.

## 2.8 LANGUAGE

- .1 Identification to be in English.
- .2 Use one (1) nameplate, label for each language.

## PART 3 - EXECUTION

### 3.1 TIMING

- .1 Provide identification only after all painting specified in Section 09 91 00, has been completed.

### 3.2 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB 24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.

### 3.3 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in Mechanical room and Sprinkler Room: 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, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.

- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be 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.

#### 3.4 VALVES, CONTROLLERS

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

#### 3.5 MECHANICAL EQUIPMENT

- .1 Mechanical equipment located above T-bar ceilings or access doors (such as valves, balancing dampers, fan coil units, drains, etc.) install circular 19mm diameter self-adhesive identification discs on the underside of the ceiling, as close as possible to the location of the equipment.
- .2 Major mechanical equipment (such as fan coil units, mixing valves, fans, etc.) require laminated plastic plates.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 GENERAL

- .1 Ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment to be pressure tested for leaks.

### 1.2 TIMING

- .1 Test ducts before installation of insulation or any other form of concealments.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, gaskets, etc.

### 1.3 REFERENCES

- .1 SMACNA 1966-2006, HVAC Air Duct Leakage Test Manual.

### 1.4 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested to be consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
  - .1 Fittings, branch ducts, tapins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on Reference Standard.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

### 1.5 TEST INSTRUMENTS

- .1 Provide instruments for tests.
- .2 Test apparatus to include:
  - .1 Fan capable of producing required static pressure.
  - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
  - .3 Flow measuring instrument compatible with the orifice plate.
  - .4 Calibration curves for orifice plates used.
  - .5 Flexible duct for connecting to ductwork under test.
- .3 Smoke bombs for visual inspections.
- .4 Test apparatus to be accurate to within +/3% of flow rate and pressure.
- .5 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.

- .6 Test instruments to be calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .7 Instruments to be recalibrated every six (6) months thereafter.

#### 1.6 SYSTEM LEAKAGE TOLERANCES

- .1 System leakage tolerances specified herein are stated as a percentage of total flow rate handled by the system. Therefore, when testing sections of ductwork this acceptable leakage shall be prorated to entire system. Leakage for sections of duct systems shall not exceed the total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
  - .1 Small duct systems up to 250 Pa: Leakage 2 %.
  - .2 Fan coil and duct on downstream side of Fan coil: Leakage 2 %.
  - .3 Large low pressure duct systems up to 500 Pa: Leakage 2 %.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

#### 1.7 EQUIPMENT LEAKAGE TOLERANCES

- .1 Equipment and system components such as Fan coils, duct heating leakage: 2%.

#### 1.8 REPORT FORMS

- .1 Submit proposed report form and test report format to Departmental Representative for approval. Do not start tests until approval received in writing from Departmental Representative.

#### 1.9 PRESSURE TEST REPORTS

- .1 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
  - .1 Schematic of entire system.
  - .2 Schematic of section under test showing test site.
  - .3 Required and achieved static pressures.
  - .4 Orifice differential pressure at test sites.
  - .5 Permissible and actual leakage flow rate (L/s) for test sites.
  - .6 Witnessed certification of results.
- .2 Include test reports in final TAB report for Commissioning Manual.

#### PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 GENERAL

- .1 Pressure test the entire exhaust system and all supply duct systems on the fan side of terminal units. Ductwork downstream of supply terminal units need not be tested.

**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.
- .3 Have the TAB agency present to assist the commissioning authority during the commissioning of HVAC systems. TAB agency will be responsible for measuring entering and leaving air temperature at all coils to calibrate EMCS and for setting the DHW balancing valves.

### 1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel certified to AABC or NEBB to perform TAB to Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience. TAB contractor must have a minimum of five (5) years experience to AABC, NEBB or SMACNA.
- .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.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
- .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 the 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 SMACNA), 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 so as 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 be 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 so as to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

#### 1.6 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing all 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 other Divisions.

#### 1.8 OPERATION OF SYSTEMS DURING TAB

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

#### 1.9 START OF TAB

- .1 Notify Departmental Representative seven (7) days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
  - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
  - .2 Application of weatherstripping, sealing, caulking.

- .3 All pressure, leakage, other tests specified elsewhere in other Divisions.
- .4 All provisions for TAB installed and operational.
- .3 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 Other HVAC systems: plus 5%, minus 5%.

#### 1.11 ACCURACY TOLERANCES

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

#### 1.12 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative list of instruments to be 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 three (3) months of TAB. Provide certificate of calibration to Departmental Representative.

#### 1.13 SUBMITTALS

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

#### 1.14 PRELIMINARY TAB REPORT

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

### 1.15 TAB REPORT

- .1 Format to be 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 three (3) copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

### 1.16 VERIFICATION

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

### 1.17 SETTINGS

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

### 1.18 COMPLETION OF TAB

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

### 1.19 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.
- .2 Do TAB of systems, equipment, components, controls specified in other Divisions.
- .3 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
- .4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .5 Measurements: to include, but not limited to, following 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, amperage and volts for each stage of electrical heating coils.
- .6 Locations of equipment measurements to include, but not be limited to, the following as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.

- .2 At controllers, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, the following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

#### 1.20 LIQUID SYSTEMS

- .1 Balance all water systems after all systems have been pre-cleaned. Balancing of water systems to take place only after the successful balancing of the air system.
- .2 Include the following in the balancing report for heating and cooling systems:
  - .1 Record and report, installation data, manufacturer, model and size of each pump. List specified and actual flow and head of each pump. Include the actual current drawn by the pumps.
  - .2 Design and actual flows through all coils. Record the coil water pressure drop and water entering and leaving temperatures and the air-side entering and leaving temperatures. Pressure drops to be measured for full flow through coils.
  - .3 Inlet and outlet pressure for each pump.
  - .4 Pressure drop across each heat exchanger.
  - .5 Design and actual flow rates through all heating water loops on each floor. Perimeter heating systems to be balanced with all two-way control valves in the open position.
  - .6 Provide schematics with required and actual flow rates.
  - .7 Permissible deviation from design water quantities shall be 0% to 10%.
  - .8 The Departmental Representative reserves the right to ask the balancing company to take flow readings in the presence of the Departmental Representative after completion of the balancing report. If inconsistencies are found between the values recorded in the balancing report and the spot reading, the Contractor shall rebalance the entire system again, in the presence of the Departmental Representative.
  - .9 Following recheck and acceptance of report, permanently mark settings of all balancing valves.

PART 2 - PRODUCTS Not applicable.

PART 3 - EXECUTION Not applicable

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Bases, Hangers and Supports: Section 23 05 29

### 1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM B209M-2014, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
  - .2 ASTM C335-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .3 ASTM C449/C449M-07(R2013), Standard Specification for Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement.
  - .4 ASTM C553-2013, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .5 ASTM C612-2014, Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .6 ASTM C921-10, Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 51GP52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC S102-2010, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC S701-11, Thermal Insulation Polystyrene, Boards and Pipe Covering.

### 1.3 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" will mean "not concealed" as defined herein.
  - .3 Insulation systems insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
  - .1 CRD: Commercial Round Ductwork,
  - .2 CRF: Commercial Rectangular Finish.
  - .3 CEF: Commercial Rigid Insulation External Application.

### 1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

### 1.5 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

### 1.6 MANUFACTURERS' INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with Section 01 33 00.
- .2 Installation instructions to include procedures used and installation standards achieved.

### 1.7 QUALIFICATIONS

- .1 Installer: specialist in performing work of this section, and have at least five (5) years successful experience in this size and type of project, qualified to standards of TIAC.

### 1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions recommended 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: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51GP52Ma (as scheduled in PART 3 of this Section); 25mm thick.
- .4 TIAC Code C2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51GP52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.

- .2 Jacket: to CGSB 51GP52Ma.
- .3 Maximum "k" factor: to ASTM C553.
- .4 Thickness: 25mm.

### 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.
- .2 Aluminum:
  - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
  - .2 Thickness: 0.40 mm sheet.
  - .3 Finish: Stucco embossed or corrugated.
  - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
- .3 Self-adhesive weather barrier membrane:
  - .1 Flexible SBS modified membrane impermeable to air, moisture vapour and water. UV light resistant, flame free adhesion.

### 2.4 ACCESSORIES

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

PART 3 - EXECUTION

3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of ductwork systems complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

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

3.3 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses: Conform to following Table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts (exposed)	C1	Yes	50
Round cold and dual temperature supply air ducts (concealed)	C2	Yes	50
Rectangular warm air ducts (exposed)	C1	No	25
Round warm air ducts (exposed)	C1	No	25
Rectangular cold and dual temperature supply air ducts (concealed)	C2	Yes	25
Round cold and dual temperature supply air ducts (exposed)	C1	Yes	50

Rectangular warm air ducts (concealed)	C2	No	25
Round warm air ducts (concealed)	C2	No	25
Intake and exhaust plenums	C1	Yes	50
Exhaust duct between dampers and louvers	C1	No	50

- .2 Jackets: Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:  
.1 Use TIAC code C1 insulation, scored to suit diameter of duct.  
.2 Finishes: Conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	None	None
Indoor, exposed within mechanical room	CRF/ Canvas	CRD/ Canvas
Indoor, exposed elsewhere	CRF/ Aluminum	CRD/ Aluminum

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

### 1.2 REFERENCE

- .1 American Society for Testing and Materials (ASTM International)
  - .1 ASTM B209M-2014, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
  - .2 ASTM C335/ASTM C335M-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .3 ASTM C449/C449M-07(R2013), Specification for Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement.
  - .4 ASTM C533-2013, Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - .5 ASTM C534/ASTM C534M-2014, Standard Specification for Preformed Flexible Cellular Thermal Insulation In Sheet And Tubular Form.
  - .6 ASTM C547-12, Specification for Mineral Fiber Pipe Insulation.
  - .7 ASTM C553-2013, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .8 ASTM C612-2014, Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .9 ASTM C921-10, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 51GP52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Thermal Insulation Association of Canada (TIAC)
  - .1 National Insulation Standards.
- .4 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC S102-10, Surface Burning Characteristics of Building Materials and Assemblies.

### 1.3 PRODUCT DATA

- .1 Submit samples in accordance with Section 01 33 00.

### 1.4 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00.
- 2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

### 1.5 MANUFACTURER'S INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with Section 01 33 00.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

## 1.6 QUALIFICATIONS

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

## 1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions recommended 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 Acceptable product: Manson, Knauf, Owens Corning

### 2.2 INSULATION

- .1 Mineral fibre: includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A1: Rigid moulded mineral fibre without factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C547.
  - .2 Maximum "k" factor: ASTM C547.
- .4 TIAC Code A2: Rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
  - .1 Insulation: ASTM C533.
  - .2 Maximum "k" factor: ASTM C533.
  - .3 Design to permit periodic removal and reinstallation.
- .5 TIAC Code A3: Rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C547.
  - .2 Jacket: to CGSB 51GP52Ma.
  - .3 Maximum "k" factor: ASTM C547.
- .6 TIAC Code A6: Flexible unicellular tubular elastomer.
  - .1 Insulation: with vapour retarder jacket to ASTM C534.
  - .2 Jacket: to CGSB 51GP52Ma.
  - .3 Maximum "k" factor: C534.

- .4 Certified by manufacturer free of potential stress corrosion cracking corrodants.
- .5 Flame spread index less than 25, and smoke developed index less than 50.
  
- .7 TIAC Code C1: Rigid mineral fibre board, unfaced.
  - .1 Mineral fibre: ASTM C612.
  - .2 Maximum "k" factor: ASTM C612.
  
- .8 TIAC Code C2: Mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: ASTM C553.
  - .2 Jacket: to CGSB 51GP52Ma.
  - .3 Maximum "k" factor: ASTM C553.
  
- .9 TIAC Code C4: Rigid mineral fibre board faced with factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C612.
  - .2 Jacket: to CGSB 51GP52Ma.
  - .3 Maximum "k" factor: ASTM C612.
  
- .10 Provide removable pre-fabricated insulation pads for valves.

### 2.3 CEMENT

- .1 Thermal insulating and finish
  - .1 To: ASTM C449/C449M.
  - .2 Hydraulic setting or air drying on mineral wool, to ASTM C449.

### 2.4 JACKETS

- .1 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.
  
- .2 Aluminum:
  - .1 To ASTM B 209.
  - .2 Thickness: 0.40 mm sheet.
  - .3 Finish: Stucco embossed or corrugated.
  - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
  - .5 Fittings: 0.25 mm thick die-shaped fitting covers with factory attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

### 2.5 INSULATION SECUREMENTS

- .1 Tape: Self-adhesive, aluminum, reinforced, 50 mm wide minimum.
  
- .2 Contact adhesive: Quick setting.
  
- .3 Canvas adhesive: Washable.
  
- .4 Tie wire: 1.5 mm diameter stainless steel.
  
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

- .6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation.
- .7 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips. Length of pin to suit thickness of insulation.

## 2.6 VAPOUR RETARDER LAP ADHESIVE

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

## 2.7 INDOOR RETARDER FINISH

- .1 Type A6 to manufacturer's recommendation.

## PART 3 - EXECUTION

### 3.1 PRE-INSULATION REQUIREMENTS

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

### 3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards
  - .1 Hot equipment: To TIAC code 1503-H.
  - .2 Cold equipment: to TIAC code 1503-C or 1503CA.
- .2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .3 Provide vapour retarder as recommended by manufacturer.
- .4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers, supports outside vapour retarder jacket.
- .7 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### 3.3 REMOVABLE, PRE- FABRICATED INSULATION AND ENCLOSURES

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

damage to adjacent insulation.

### 3.4 EQUIPMENT INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Hot Equipment:
  - .1 TIAC code A1 or C1 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
- .3 Thicknesses:
  - .1 Domestic hot water storage tanks 50 mm
  - .2 Buffer tanks: 50mm.
- .4 Finishes:
  - .1 Equipment in mechanical rooms: TIAC code CEF/1 with jacket.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Joint Sealants: Section 07 92 10

### 1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
  - .1 ASTM B209M-2014, Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
  - .2 ASTM C335-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation
  - .3 ASTM C449/C449M-07(R2013), Standard Specification for Mineral Fibre Hydraulic Setting Thermal Insulating and Finishing Cement.
  - .4 ASTM C533-2013, Standard specification for Calcium Silicate Insulation Block and Pipe.
  - .5 ASTM C534-2014, Standard Specification for Preformed Elastomeric Cellular Thermal Insulation in Sheet And Tubular Form.
  - .6 ASTM C547-12, Standard Specification for Mineral Fibre Pipe Insulation.
  - .7 ASTM C921-10, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2 CAN/CGSB 51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .3 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 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

### 1.3 DEFINITIONS

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

### 1.4 SHOP DRAWINGS

- .1 Shop drawings in accordance with Section 01 33 00.

- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

### 1.5 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00.

### 1.6 MANUFACTURER'S INSTRUCTIONS

- .1 Submit manufacturers' installation instructions in accordance with Section 01 33 00.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

### 1.7 QUALIFICATIONS

- .1 Installer to be specialist in performing work of this Section, and have at least five (5) years successful experience in this size and type of project, qualified to standards of TIAC.

### 1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

## PART 2 - PRODUCTS

### 2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULCS102.
  - .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°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A3: Rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to CAN/ULCS702 and ASTM C547.
  - .2 Jacket: to CGSB 51GP52Ma.
  - .3 Maximum "k" factor: to CAN/ULCS702.

- .4 TIAC Code C2: Mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to CAN/ULCS702.
  - .2 Jacket: to CGSB 51GP52Ma.
  - .3 Maximum "k" factor: to CAN/ULCS702.
- .5 Acceptable product: Manson, Knauf, Owens Corning

### 2.3 INSULATION SECRETMENT

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

### 2.4 CEMENT

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

### 2.5 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.
- .2 For Type A6 insulation to manufacturer's recommendation.

### 2.6 INDOOR VAPOUR RETARDER FINISH

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

### 2.7 OUTDOOR VAPOUR RETARDER FINISH

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

### 2.8 JACKETS

- .1 Canvas:
  - .1 220gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: Compatible with insulation.
- .2 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: 0.40mm sheet.

- .3 Finish: Stucco embossed or corrugated.
  - .4 Joining: Longitudinal and circumferential slip joints with 50mm laps.
  - .5 Fittings: 0.5mm thick die shaped fitting covers with factory attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
- .3 Self-adhesive weather barrier membrane:
- .1 Flexible SBS modified membrane impermeable to air, moisture vapour and water. UV light resistant, flame free adhesion.
  - .2 Bakor Foilskin, or approved equivalent.

## 2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking: to Section 07 92 10.

## PART 3 - EXECUTION

### 3.1 PRE-INSTALLATION REQUIREMENT

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

### 3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two (2) 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 Hangers, supports to be 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.

### 3.3 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

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

**3.4 INSTALLATION OF ELASTOMERIC INSULATION**

- .1 Insulation to remain dry at all times. Overlaps to manufacturer's instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

**3.5 PIPING INSTALLATION SCHEDULES**

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A3.
  - .1 Securements: Tape at 300 mm oc.
  - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
  - .3 Installation: TIAC Code: 1501C.
- .3 TIAC Code: C2 with vapour retarder jacket.
  - .1 Insulation securements: 18 ga SS wire or 12 mm x 05 mm ss bands at 300 mm oc.
  - .2 Seals: lap seal adhesive, lagging adhesive.
  - .3 Installation: TIAC Code: 1501C.
- .4 Thickness of insulation to be as listed in following table.
  - .1 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp (°C) Run out	TIAC code to 1 to 2	Pipe sizes (NPS) and insulation thickness(mm)				
			1 1/4 to 4	2 1/2	5 to 6	8&over	
Domestic Cold Water, Chilled Water, Ground Water Loop, Condensate Drains	A-3	25	25	25	25	25	25
Domestic Hot Water, Heating Water Piping	A-3	25	25	25	38	38	38

- .5 Finishes:
  - .1 Exposed indoors: PVC jacket.
  - .2 Exposed in mechanical rooms: PVC jacket.
  - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
  - .4 Use vapour retarder jacket on TIAC code A3 insulation compatible with insulation.
  - .5 Outdoors: Waterproof Aluminum or SS jacket.
  - .6 Finish attachments: SS screws or bands, at 150 mm oc. Seals: wing or closed.
  - .7 Installation: To appropriate TIAC code CPF/1 through CPF/5.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 American Society for Testing and Materials
  - .1 ASTM E202-2012, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

## PART 2 - PRODUCTS

### 2.1 CLEANING SOLUTIONS

- .1 Low foaming detergent at all temperatures
- .2 No pH neutralization required
- .3 Designed for use on most metals including aluminum
- .4 Biodegradable
- .5 Phosphate Free
- .6 Nitrite Free

## PART 3 - EXECUTION

### 3.1 CLEANING HYDRONIC AND STEAM 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 used to ensure water will not damage systems or equipment.

- .5 Conditions at time of cleaning of systems:
  - .1 Systems: free from construction debris, dirt and other foreign material.
  - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
  - .3 Strainers: clean prior to initial fill.
  - .4 Install temporary filters on pumps not equipped with permanent filters.
  - .5 Install pressure gauges on strainers to detect plugging.
  
- .6 Report on Completion of Cleaning:
  - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
  
- .7 Hydronic Systems:
  - .1 Flush system thoroughly with water, back flush pump, strainers, blow down drain valves and risers to remove all loose debris. Remove accumulated sludge in boilers if necessary.
  - .2 Then add 2% solution on low foaming detergent to the system through a bypass feeder or another feeding device.
  - .3 Circulate for 36 hours at 82°C. For chilled systems, circulate at least 48 hours at ambient temperature.
  - .4 During recirculation, back flush strainers, drain valves and risers at their lowest point once every 8 hours.
  - .5 Drain cleaning water completely.
  - .6 Then fill and drain system several times. Circulate 30 minutes every time the system is refilled.
  - .7 Bleed system at several points until water is clear and nonfoaming. Clean pup strainers.
  - .8 Draw a water sample from the system and sent it to out laboratory for analysis.
  - .9 If the laboratory report is satisfactory, the system must then be treated with the appropriate formula.
  
- .8 Glycol Systems:
  - .1 In addition to procedures specified above perform procedures specified herein.
  
- .9 Test to prove concentration will prevent freezing to minus 40°C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

### 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.
  - .5 Clean out strainers repeatedly until system is clean.
  - .6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
  - .7 Repeat with water at design temperature.
  - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
  - .9 Bring system up to design temperature and pressure slowly over a 48 hour period.
  - .10 Perform TAB as specified in Section 23 05 95 Testing, Adjusting and Balancing (TAB).
  - .11 Adjust pipe supports, hangers, springs as necessary.
  - .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
  - .13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly,

shut down system, realign, repeat startup procedures.

.14 Retighten bolts, etc. using torque wrench, to compensate for heat-caused relaxation.  
Repeat several times during commissioning.

.15 Check operation of drain valves.

.16 Adjust valve stem packing's as systems settle down.

.17 Prior to balancing, fully open all balancing valves (except those that are factory set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement,  
absence of noise or vibration transmission.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SUMMARY

- .1 Section Includes
  - .1 Materials and installation for piping, valves and fittings for gas fired equipment.

### 1.2 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 22 – Construction/Demolition Waste Management and Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 01 45 00 – Quality Control
- .5 Section 23 05 05 – Installation of Pipework.
- .6 Section 23 08 02 – Cleaning and Start-up of Mechanical Piping Systems.

### 1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.3-2011, Malleable Iron Threaded Fittings, Classes 150 and 300.
  - .2 ASME B16.5-2013, Pipe Flanges and Flanged Fittings
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A47/A47M-99(R2014), Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53/A53M-2012, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .3 Canadian Standards Association (CSA International).
  - .1 CSA W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA) / Canadian Gas Association (CGA)
  - .1 CAN/CSA B149.1(R2015), Natural Gas and Propane Installation Code.
  - .2 CAN/CSA B149.2(R2015), Propane Storage and Handling Code.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .6 Canadian Underwriters Laboratory (CAN/ULC)
  - .1 CAN/ULC S642-2007, Compounds and Tape for Threaded Pipe Joints.

### 1.4 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 for piping, fitting and equipment.
- .2 Indicate on manufacturer's catalogue literature following: valves.
- .3 Submit WHMIS MSDS and indicate VOC's for adhesive and solvents during application and curing.
- .4 Test Reports: Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Instructions: Submit manufacturer's installation instructions.
- .7 Closeout Submittals: Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

### 1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
  - .1 Convene pre-installation meeting one (1) week prior to beginning Work of this Section and on-site installations.
    - .1 Verify Project requirements.
    - .2 Review Installation and substrate conditions.
    - .3 Co-ordination with other building subtrades.
    - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Do construction occupational health and safety in accordance with Section 01 35 29 – Health and Safety Requirements.
- .3 Trades people to have journeyman qualifications.

### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 – Construction /Demolition Waste Management and Disposal.
  - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
  - .4 Separate for reuse and recycling and place in designated containers, steel, metal , plastic waste in accordance with WMP.
  - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.

## PART 2 – PRODUCTS

### 2.1 PIPE

- .1 Steel pipe: to ASTM A 53/A53M, Schedule 40, seamless as follows:
  - .1 NPS ½ to 1 ½ screwed.
  - .2 NPS 2 and over, plain end.

## 2.2 JOINTING MATERIAL

- .1 Screwed fittings: sealant certified to CAN/ULC S642.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: non-metallic flat.

## 2.3 FITTINGS

- .1 Steel pipe fittings, screwed:
  - .1 Malleable iron: screwed to ANSI B16.3, Class 150 for service pressures up to and including 861 kPa.
  - .2 Unions: malleable iron, brass to iron, ground seat, to ASTM A47M.
  - .3 Nipples: schedule 40, to ASTM A53.

## 2.4 MANUAL SHUT-OFF VALVES

- .1 Full port, forged brass ball valve for two piece body construction complete with the following:
  - .1 Blowout-proof stem.
  - .2 Adjustable packing gland.
  - .3 Chrome-plated ball.
  - .4 Class 150 WSP, 600 WOG.
  - .5 CGA 3.16 approved.
  - .6 Provide complete with CRN.
  - .7 Lever handle.
  - .8 Flanged ends.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

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

### 3.2 PIPING

- .1 Install piping in accordance Section 23 05 05 – Installation of Pipework, applicable Provincial Codes, CAN/CSA-B149.1, supplemented as specified.
- .2 Slope piping down in direction to flow to low points.
- .3 Install drip points:
  - .1 At low points in piping system and where indicated.
  - .2 Provide complete with blowdown valve i.e. manual shut-off valve as specified above.
  - .3 Minimum 75mm in length from tee connection in riser to top of valve. Size to be minimum NPS ¾. Provide complete with threaded end cap.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage.

- .5 Provide clearance for access and for maintenance.
- .6 Ream pipes, clean scale and dirt, inside and out.
- .7 Install piping to minimize pipe dismantling for equipment removal.
- .8 Field ending of piping to be prohibited.
- .9 Nesting of bushings to be prohibited. Utilize properly sized reducing fittings.
- .10 Do not utilize propane piping as an electrical ground.

### 3.3 VALVES

- .1 Install valves with stems upright or horizontal unless approved otherwise by Consultant.
- .2 Install valves as indicated.

### 3.4 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
  - .1 Test system in accordance with CAN/CSA B149.1 and CAN/CSAB149.2 and requirements of authorities having jurisdiction.
- .2 Manufacturer's Field Services:
  - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of Work with contract.
  - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
  - .3 Schedule site visits to review Work at stages listed:
    - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
    - .2 Twice during progress of work at 25% and 60% complete.
    - .3 Upon completion of Work, after cleaning is carried out.
- .3 Obtain reports within three (3) days of review and submit immediately to Consultant.
- .4 PV procedures:
  - .1 Test performance of components.

### 3.5 ADJUSTING

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

### 3.6 CLEANING

- .1 Cleaning: in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.
- .2 Perform cleaning operations as specified in Section 01 74 11 – Cleaning, and in accordance with manufacturer's recommendations.
- .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

### 3.7 PURGING

- .1 Purge after pressure test in accordance with CSA-B149.1.

### 3.8 IDENTIFICATION

- .1 Identify new propane or natural gas piping systems in accordance with requirements for CSA-B149.1.
- .2 Above ground propane or natural gas piping to be primed and painted yellow with two (2) coats of epoxy paint along its entire length. All below ground propane or NG piping to be covered with plastic yellow identification marker tape suitable for direct burial.
- .3 Supply and install "Propane Gas" or "Natural Gas" pipe identification markers along length of piping installation in accordance with CSA-B149.1 and Section 23 05 53 – Mechanical Identification. Maximum spacing along straight length of pipe to be 20 feet.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Mechanical General Requirements: Section 21 05 01

### 1.2 REFERENCES

- .1 ASME B18.2.1-2012, Square and Hex Bolts and Screws, Inch Series.
- .2 ANSI/AWWA C111/A21.11-2012, Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
- .3 ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125 and 250.
- .4 ASME B16.3-2011, Malleable-Iron Threaded Fittings, Classes 150 and 300.
- .5 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: CPS 1/2 through NPS 24 Metric/Inch Standard.
- .6 ASME B16.9-2012, Factory-Made Wrought Steel Butt-Welding Fittings.
- .7 ASME B18.2.2-2010, Square and Hex Nuts.
- .8 ASTM A47/A47M-99(R2014), Specification for Ferritic Malleable Iron Castings.
- .9 ASTM A 53/A 53M-2012, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .10 ASTM A536-84(R2010), Specification for Ductile Iron Castings.
- .11 ASTM B 62-09, Specification for Composition Bronze or Ounce Metal Castings.
- .12 CSA-B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
- .13 CSA-W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel.

### 1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate on manufacturer's catalogue literature the following:
  - .1 Valves.
  - .2 Grooved fittings.

#### 1.4 MAINTENANCE DATA

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

### PART 2 – PRODUCTS

#### 2.1 PIPE

- .1 Steel pipe: to ASTM A53, Grade B, as follows:
  - .1 To NPS 6, Schedule 40 (Hydronic Systems).
  - .2 NPS 8 and over, Schedule 30.
  - .3 Chemical pot feeder piping, Schedule 80.

#### 2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with teflon tape.
- .2 NPS 2-1/2 and over: welded fittings and flanges to CSA W47.1.
- .3 Roll grooved: rigid coupling to CSA B242, except for first three (3) couplings next to circulating pumps which are to be flexible pattern, minimum pressure rating 2069 kPa. Victaulic or approved equivalent. (Note: This is in addition to flexible connections specified elsewhere).
- .4 Flanges: plain, slip-on or weld neck.
- .5 Orifice flanges: slip-on raised face, 2069 kPa.
- .6 Flange gaskets: to ANSI/AWWA C111/A21.11. 3 mm, red rubber impregnated cloth to ANSI B2.1.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ANSI B18.2.1 and ANSI/ASME B18.2.2.
- .9 Roll grooved coupling gaskets: grade E, type EPDM. All grooved products to be of one manufacturer.
- .10 Acceptable Material: Victaulic Style 07 Rigid Couplings; Victaulic Style 77 Flexible Couplings.

#### 2.3 FITTINGS

- .1 NPS 2 and smaller screwed fittings: malleable iron, to ANSI/ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
  - .1 Cast iron: to ANSI/ASME B16.1, Class 125.
  - .2 Steel: to ANSI/ASME B16.5.
- .3 NPS 2.5 and larger butt-welding fittings: steel, to ANSI/ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47M and ANSI/ASME B16.3.

- .5 Fittings for roll grooved piping: ductile iron to ASTM A536. All grooved products to be of one (1) manufacturer.

### PART 3 - EXECUTION

#### 3.1 PIPING INSTALLATION

- .1 Connect to equipment in accordance with equipment manufacturer's instruction and the specified requirements unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers pipe size changes, installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves, fittings.
- .6 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .7 Assemble piping using fittings manufactured to ANSI standards.
- .8 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .9 Install circuit balancing valves complete with flow measuring fittings for all coils, air handling units, unit heaters, force flow heaters, perimeter radiation, ceiling radiant panels and heat exchangers.

#### 3.2 FLUSHING, CLEANING AND FILLING

- .1 Flush after pressure test for minimum of 4 hrs.
- .2 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for 3 hrs. minimum.
- .3 Drain and flush for 4 hrs. Remove strainer screen/basket and clean.
- .4 Refill system with clean water. Circulate for 2 hrs. minimum.
- .5 Drain and flush for 2 hrs. Remove strainer screen/basket and clean. Re-install after obtaining approval of Departmental Representative.
- .6 Refill with clean water, adding water treatment as specified.

#### 3.3 FILLING OF SYSTEM

- .1 Refill system with clean water adding water treatment as specified.
- .2 Confirm all air is vented from the system.

**3.4 TESTING**

- .1 Test system in accordance with Section 21 05 01.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

### 1.2 REFERENCES

- .1 ASME Section VIII Set for Unfired Pressure Vessels, 2013.
- .2 ASTM A278-01(R2011), Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650°F.
- .3 ASTM B62-2015, Specification for Composition Bronze or Ounce Metal Castings.

### 1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate on manufacturer's catalogue literature: expansion tanks, air vents, air separators, valves, strainers, suction diffusers, triple duty valves.

### 1.4 MAINTENANCE DATA

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

## PART 2 - PRODUCTS

### 2.1 BLADDER TYPE EXPANSION TANKS

- .1 Cylindrical carbon steel, pressurized, bladder type expansion tanks.
- .2 Capacities: as per schedule on the drawings.
- .3 EPDM bladder suitable for 115°C operating temperature.
- .4 Working pressure: 862 kPa with ASME stamp and certification.
- .5 Vertical floor mounted tanks as indicated on the drawings.
- .6 Capacity: refer to equipment schedule on mechanical drawings.
- .7 Acceptable Manufacturers: Taco; ITT Bell & Gossett; Armstrong; Expanflex.

### 2.2 DIAPHRAGM TYPE EXPANSION TANK

- .1 Vertical steel pressurized diaphragm type expansion tank.

- .2 Diaphragm sealed in EPDM suitable for 115°C operating temperature.
- .3 Working pressure: 860 kPa with ASME stamp and certification.
- .4 Air pre-charged to 84 kPa (initial fill pressure of system).
- .5 Base mount for vertical installation.
- .6 Supports: Provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .7 Capacity: refer to equipment schedules on mechanical drawings.

### 2.3 AUTOMATIC AIR VENTS

- .1 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 862 kPa working pressure.
  - .1 Acceptable Manufacturers: Amtrol; Armstrong; Braukmann; Taco; Watts.
- .2 Float: solid material suitable for 116°C working temperature.
- .3 Provide manual air vents where indicated.

### 2.4 COMBINATION VORTEX AIR SEPARATOR/STRAINER

- .1 Welded steel construction, tested and stamped in accordance with Air Section 8D of ANSI/ASME Code, for 862 kPa operating pressure, with integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.
- .2 Size: same size as pipe.
- .3 Applications:
  - .1 Glycol system.
  - .2 Heating hot water system.
- .4 Acceptable Material: ITT Bell & Gossett, Rolairtrol, or approved equivalent.

### 2.5 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

- .1 Adjustable pressure setting: 862 kPa rated.
- .2 Low inlet pressure check valve.
- .3 Removable strainer.
- .4 Acceptable Manufacturers: Armstrong; ITT Bell & Gossett; Taco; Watts.

### 2.6 PIPE LINE STRAINERS

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections.

- .2 NPS 2 1/2 to 12; cast steel body to ASTM A278M, Class 30, flanged connections.
- .3 Blowdown connection: NPS 1 complete with shut-off valve.
- .4 Screen: brass with 1 mm perforations.
- .5 Working pressure: 862 kPa.
- .6 Acceptable Manufacturers: Spriax/Sarco, Victaulic, Style 732 (Wye type); Armstrong.

### 2.7 SUCTION DIFFUSER

- .1 Body: cast iron with flanged connections.
- .2 Strainer: with built-in, disposable 1 mm mesh, low pressure drop screen and NPS 1 blowdown.
- .3 Full length straightening vanes.
- .4 Pressure gauge tapings.
- .5 Adjustable support leg complete with 12 mm thick elastomeric pad.
- .6 Gaskets compatible with fluid.
- .7 Acceptable Manufacturers: ITT Bell & Gossett; Armstrong; Taco; Victaulic Style 731.

### 2.8 TRIPLE DUTY VALVES

- .1 Class 125, 862 kPa bronze fitted cast iron, F.F. ANSI flanges, replaceable bronze or brass disc and soft EPDM seat; angle pattern, non-slam, calibrated nameplate, stainless steel stem and spring, teflon-graphite packing, adjustable pipe support legs complete with 12 mm thick elastomeric pad.
- .2 Valve to combine the following functions:
  - .1 Shut-off.
  - .2 Balancing with brass readout/meter ports.
  - .3 Non-slam swing check.
- .3 Gaskets shall be compatible with type of fluid.
- .4 Acceptable Manufacturers: Taco; ITT Bell & Gossett; Armstrong, Victaulic Tri-service.

### 2.9 CIRCUIT BALANCING VALVES

- .1 General:
  - .1 Y-style globe valve, designed to provide precise flow measurement and control with valved ports for connecting to differential pressure meter.
- .2 Accuracy:
  - .1 Readout to be with plus or minus 2% of actual flow at design flow rate.

- .3 Pressure die-cast zinc dezincification resistant copper alloy (A metal) construction; maximum WP: 862kPa; maximum temperature: 121°C, screwed ends, teflon disc, screwed in bonnet.
- .4 Flow control: at least four (4) full turns of handwheel with digital handwheel and tamper-proof concealed mechanical memory.
- .5 Insulation: use prefabricated shipping packaging of R-514 polyurethane as insulation for installation.
- .6 Acceptable material: ITT Bell & Gossett; Armstrong; Taco; Tour & Anderson.

#### 2.10 HYDRONIC COILS

- .1 Construct coils with copper tubes and aluminum fins. Fins must be mechanically bonded to the tubes by mechanical expansion of the tubes. Coils to have a galvanized steel casing.
- .2 Refer to schedule on drawings for performance data.

#### 2.11 POT FEEDER

- .1 Pot feeder to be a bypass feeder with a 19L capacity.
- .2 Construct the bypass feeder with 10 gauge steel as a minimum for the shell and 9 gauge steel as a minimum for the tank head.
- .3 The bypass feeder must be rated at 2068 kPa at 177°C.
- .4 Tank to have a wide mouth, 89mm opening for chemical addition.
- .5 Construct the cap of cast iron with an epoxy-coated underside to prevent corrosion and use a square ring gasket seal.
- .6 Provide the bypass feeder with legs to elevate the feeder off the floor. Legs to have holes to allow mounting by anchor bolts.
- .7 Provide the bypass feeder with a 20 micron cartridge filter for simultaneous side stream filter.
- .8 Acceptable materials: Neptune; BFS Industries; Ashland Canada.

#### 2.12 ETHANOL FILL STATION

- .1 Minimum 180L storage.
- .2 Moulded strong polypropylene holding tank.
- .3 Centrifugal pump: all bronze construction.
- .4 Pump suction with inlet strainer.
- .5 Isolation vale: bronze construction.
- .6 Check valve: bronze construction.

- .7 Low cut out float switch: 24V maximum.
- .8 Pressure gauge and integral pressure switch.
- .9 Cord and plug, 120/1.
- .10 Acceptable materials: Axiom Industries Ltd.; S.A. Armstrong Ltd.; Expanflex.

### 2.13 BUFFER TANKS

- .1 Vertical tank, complete with integral baffle.
- .2 Constructed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII requirements and stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. Tank to include two (2) flanged or NPT connections, one (1) air vent tapping, one (1) relief valve tapping and one (1) drain pipe.
- .3 Buffer tanks must have a working pressure of 862KPa and all shall be equipped with a base ring.
- .4 Insulate tanks in accordance with Section 23 07 16.
- .5 Provide tanks complete with a five (5) year warranty against tank failure resulting from defects in material or workmanship.
- .6 Standard of acceptance: Lochinvar or approved equivalent.

## PART 3 - EXECUTION

### 3.1 GENERAL

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Pipe drains and blow off connections to nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow the Departmental Representative's directive.
- .5 Refer to manufacturer's installation drawings.
- .6 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

### 3.2 STRAINERS

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

- .3 Install ahead of each pump.

### 3.3 AIR VENTS

- .1 Install at high points of systems.
- .2 Install mini-ball valve on automatic or manual air vent inlet.
- .3 Arrange the piping so that the air purging will follow the direction of water flow in branches and risers.

### 3.4 EXPANSION TANKS

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

### 3.5 PRESSURE SAFETY RELIEF VALVES

- .1 Pipe discharge to nearest funnel drain.

### 3.6 SUCTION DIFFUSERS AND TRIPLE DUTY VALVES

- .1 Install for all vertical in-line circulating pumps.
- .2 Install as per the manufacturer's recommendations.

### 3.7 ETHANOL SOLUTION

- .1 Provide sufficient inhibited denatured ethanol to maintain a 20% (by weight) concentration in the geothermal system.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Commissioning: Section 01 91 00
- .3 Thermometers and Pressure Gauges - Piping Systems: Section 23 05 20

### 1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .3 Submit shop drawings of pump curves for review showing point of operation.
- .4 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.

### 1.3 MAINTENANCE DATA

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

## PART 2 - PRODUCTS

### 2.1 IN-LINE COMMERCIAL DUTY CIRCULATING PUMPS

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: corrosion resistant alloy steel or cast iron.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135°C.
- .5 Coupling: flexible self-aligning.
- .6 Motor: (1750 rpm maximum) resilient mounted open, drip proof, sleeve bearing, high efficiency.
- .7 Motors must be non-overloading over the published performance curve.
- .8 Capacities: as indicated on the Project Drawings.
- .9 Design pressure: 862 kPa.
- .10 Tapped openings in volute and flanges for draining and gauge connections.

- .11 Performance: refer to pumps schedule on mechanical drawings.
- .12 Acceptable Manufacturers: ITT Bell & Gossett; Taco; Armstrong.

## 2.2 VERTICAL IN-LINE CIRCULATING PUMPS

- .1 Volute: cast iron, radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: bronze.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135°C.
- .5 Coupling: rigid self-aligning.
- .6 Motor: (1750 rpm maximum) resilient mounted, open, drip proof, stainless steel or bronze sleeve bearing.
- .7 Motors to be non-overloading over the published performance curve.
- .8 Capacities: as indicated on the Project Drawings.
- .9 Design pressure: 862 kPa.
- .10 Performance: refer to pumps schedule on mechanical drawings.
- .11 Acceptable Manufacturers: Armstrong; ITT Bell & Gossett; TACO.

## 2.3 SINGLE SUCTION CENTRIFUGAL PUMP

- .1 General: bronze fitted pump complete with motor.
- .2 Base: common cast iron with drip rim and tapping for drain connection.
- .3 Volute: cast iron radially split, end suction, flanged suction and discharge, with drain plug and vent cock, suction and discharge pressure gauge tappings.
- .4 Impeller: bronze enclosed type, keyed drive with locking nut or screw.
- .5 Shaft: alloy steel with two (2) point support, sleeve bearings.
- .6 Seal assembly: mechanical seal lubricated.
- .7 Coupling: flexible self-aligning.
- .8 Motor: EEMAC Class B, squirrel cage induction, 1,725 r/min. 11.2 kW, continuous duty, drip proof, ball bearing, maximum temperature rise 50°C.
- .9 Capacity: as indicated.
- .10 Design pressure: 1200 kPa.

- .11 Acceptable Manufacturers: Armstrong; ITT Bell & Gossett; TACO.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible. Do not support motor. Provide 12 mm thick neoprene pads below pipe supports for vertical in-line pumps.
- .2 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .3 Pipe drain tapping to floor drain.
- .4 Install volute venting pet cock in accessible location.
- .5 Check rotation prior to start-up.
- .6 Install pressure gauges and test cocks. Refer also to Section 23 05 20.

#### 3.2 START-UP

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

### 3.3 PERFORMANCE VERIFICATION (PV)

- .1 General:
  - .1 In accordance with manufacturer's recommendations.
- .2 Exclusions:
  - .1 This paragraph does not apply to small in-line circulators.
- .3 Assumptions: These PV procedures assume that:
  - .1 Manufacturer's performance curves are accurate.
  - .2 Valves on pump suction and discharge provide tight shut-off.
- .4 Multiple Pump Installations - Series and Parallel:
  - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .5 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .6 Commissioning Reports: In accordance with Section 01 91 00 reports supplemented as specified herein. Reports to include:
  - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
  - .2 Report forms as acceptable to Departmental Representative.
  - .3 Pump performance curves (family of curves).

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

### 1.2 REFERENCES

- .1 ANSI/ASME Boiler and Pressure Vessel Code, Section VII-2013.

### 1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.

### 1.4 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for water treatment equipment for incorporation into manual specified in Section 01 33 00.
- .2 Include following: pot feeder, chemicals, MSDS information sheets.
- .3 Provide operation and maintenance demonstration and training.

## PART 2 – PRODUCTS

### 2.1 MANUFACTURER

- .1 Equipment, chemicals and service by one manufacturer.
- .2 Acceptable Material: Nalco Canada; Drew Chemical Limited; Betz; Bird Archer, Dearborn; Magnor; Mogul; Industrial Boiler- Tech; Eclipse Chemical.

### 2.2 BY-PASS POT FEEDER

- .1 Welded steel. Pressure rating: 200 psig. Temperature rating: 194°F.

### 2.3 CHEMICAL FEED PIPING

- .1 Schedule 80, black steel pipe and fittings with threaded crosses at all changes in direction and plugs in unconnected ports.

### 2.4 CLOSED HOT WATER HEATING SYSTEM

- .1 Pot feeder: capacity five (5) US gallons minimum to control sludge, scale and corrosion.
- .2 Provide phosphate polymer for scale control and catalyzed sodium sulphite for oxygen removal.

### 2.5 SUPPLY OF CHEMICALS

- .1 Provide a one (1) year supply. Chemicals must be compatible with piping system materials.

### 2.6 TEST EQUIPMENT

- .1 Provide, for each type of system specified herein, one set of basic test equipment complete with carrying case and reagents for chemicals supplied. Include required specialized or supplementary equipment.

## PART 3 – EXECUTION

### 3.1 INSTALLATION

- .1 Perform HVAC water treatment in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction together with additional specified requirements by the manufacturer.
- .2 Provide adequate clearances to permit performance of servicing and maintenance of equipment.

### 3.2 WATER TREATMENT SERVICES

- .1 Provide water treatment monitoring and consulting services for a period of one year after system start-up. Service to include:
  - .1 Initial water analysis and treatment recommendations.
- .2 System start-up assistance.
- .3 Operating staff training, one (1) day minimum.
- .4 Visit site every 90 days during period of operation or as required until the system stabilizes, and advise on treatment system performance.
- .5 Provide necessary recording charts and log sheets for one year operation.
- .6 Provide necessary laboratory and technical assistance.
- .7 Instructions and advice to operating staff to be clear and concise and in writing.

### 3.3 CLEANING OF SYSTEM

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
- .2 Thoroughly flush the heating system piping with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use.
- .3 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.

- .4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill the low pressure systems with clean water treated to prevent scale and corrosion during system operation.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

### 1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
  - .1 ASTM A480/A480M-2014b, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-2014, Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
  - .3 ASTM A653/A653M-2013, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .2 National Fire Protection Agency (NFPA)
  - .1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
  - .2 NFPA 90B-2015, Installation of Warm Air Heating and Air Conditioning Systems.
  - .3 NFPA 91-2010, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Non-combustible Particle Solids.
  - .4 NFPA 96-2014, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
  - .2 SMACNA HVAC Duct Leakage Test Manual.

### 1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate following:
  - .1 Sealants.
  - .2 Tape.
  - .3 Proprietary Joints.

### 1.4 CERTIFICATE OF RATINGS

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

### 1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 22.

## PART 2 - PRODUCTS

### 2.1 SEAL CLASSIFICATION

- .1 Classification to SMACNA Seal Class A.
- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

### 2.2 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 300°C to plus 930°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 Rectangular: Centreline radius: 1.5 times width of duct.
  - .2 Round: smooth radius or five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 45° entry on branch.
  - .2 Round main and branch: enter main duct at 45° with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with volume control damper.
- .5 Transitions:
  - .1 Diverging: 200 maximum included angle.
  - .2 Converging: 300 maximum included angle.
- .6 Offsets:
  - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

### 2.5 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA. Less than 24 gauge is not permitted.

- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

## 2.6 STAINLESS STEEL

- .1 To ASTM A480/A480M, Type 316, 18 gauge minimum.
- .2 Finish: No 4. finish on exposed side of duct in finished area's, No. 3 finish or lower where concealed.
- .3 Thickness, fabrication and reinforcement: to SMACNA.
- .4 Joints: to SMACNA and be continuous inert gas welded. Lateral seam orientated at the top of the duct.

## 2.7 HANGERS AND SUPPORTS

- .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500 mm.
- .2 Hanger configuration: to SMACNA.
- .3 Hangers: galvanized steel angle with black steel rods to ASHRAE or SMACNA following table:

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

- .4 Upper hanger attachments:
- .1 For concrete: manufactured concrete inserts.
- .1 Acceptable manufacturers Myatt, Grinnell, Hunt.
- .2 For steel joist: manufactured joist clamp steel plate washer.
- .1 Acceptable manufacturers Myatt, Grinnell, Hunt.
- .3 For steel beams: manufactured beam clamps:
- .1 Acceptable manufacturers Myatt, Grinnell, Hunt.
- .5 Duct shaft supports:
- .1 Design with steel angles to rigidly support ductwork within the shaft opening. Use SMACNA standard details where possible. Submit shop Drawing with supported weights for installations outside SMACNA guidelines.
- .2 Steel angle shall never be smaller than 38mm x 38mm x 7mm for shaft supports.

### PART 3 - EXECUTION

#### 3.1 DUCT SYSTEMS

- .1 Exhaust ducts must be galvanized steel except where indicated on the plans to be stainless steel. All stainless steel duct systems must be fully welded, i.e. transverse and longitudinal seams.
- .2 Supply ducts must be galvanized steel except 1.5m of acoustic flex duct for ceiling diffusers and flexible connections at equipment.

#### 3.2 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.
- .7 Protect all ductwork from dirt and weather during transportation, prior to and during installation. Use enclosed trailers and store material indoors in a covered and protected area.

#### 3.3 FIRE STOPPING

- 1 Retaining angles around duct, on both sides of fire separation only if required by authority having jurisdiction.
- .2 Firestopping material and installation must not distort duct.

#### 3.4 HANGERS

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

<u>Duct Size (mm)</u>	<u>Spacing (mm)</u>
to 1500	3000
1501 and over	2500

### 3.5 WATERTIGHT DUCT

- .1 Provide watertight duct for:
  - .1 Fresh air intake and exhaust plenums.
  - .2 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served. Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and NPS 1 drain connected, with deep seal trap and valve and discharging to open funnel drain or service sink.

### 3.6 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 (1) coat of sealant to manufacturers recommendations. Sealant and tape to be applied to full perimeter of duct.

### 3.7 LEAKAGE TESTS

- .1 Perform duct leakage on all fume exhaust ductwork in accordance with SMACNA, HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Install no additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90° elbows.
- .6 Complete test before insulation or concealment.

### 3.8 BRANCH CONNECTIONS AND TEES

- .1 Use low loss fittings with conical tee's at round branch ducts.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

### 1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA 1966-2006, HVAC Duct Construction Standards Metal and Flexible.

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Flexible connections.
  - .2 Duct access doors.
  - .3 Turning vanes.
  - .4 Instrument test ports.

### 1.4 CERTIFICATION OF RATINGS

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

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Manufacture in accordance with SMACNA 1966 - HVAC Duct Construction Standards.

### 2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 400°C to plus 900°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 (2) sash locks complete with safety chain.
  - .2 301 to 450 mm: four (4) sash locks complete with safety chain.
  - .3 451 to 1000 mm: piano hinge and minimum two (2) sash locks.
  - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
    - .1 Hold open devices.
    - .2 300 x 300 mm glass viewing panels.

#### 2.4 TURNING VANES

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

#### 2.5 INSTRUMENT TEST PORTS

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

#### 2.6 BRANCH CONNECTIONS

- .1 Conical galvanized sheet metal with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.
- .3 Use only low loss fittings. For round branches with a diameter of 100mm or less smaller than the main, use regular to round low loss fittings.
- .4 No branch fittings at the same size as the branch duct will be permitted. Use conical or square-to-round only.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:

- .1 Ducting on sides of flexible connection to be in alignment.
- .2 Ensure slack material in flexible connection.
  
- .2 Access doors and viewing panels:
  - .1 Size:
    - .1 600 x 600 mm for person size entry.
    - .2 450 x 450 mm for servicing entry.
    - .3 300 x 300 mm for viewing.
    - .4 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Intake and exhaust plenums.
    - .6 Turning vanes.
    - .7 As required for duct cleaning (minimum 30 ft apart and at all changes in direction).
    - .8 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 submain ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 At inlet and outlet of coils.
      - .3 And as indicated.
  
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

### 1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
  - .1 SMACNA 1966-2006, HVAC Duct Construction Standards, Metal and Flexible.

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following: dimensions, materials.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Manufacture to SMACNA standards.

### 2.2 SINGLE BLADE DAMPERS

- .1 Of same material as duct, 0.8 mm up to 450 mm wide, 1.6 mm maximum up to 1200 mm wide, Vgroove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

### 2.3 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm.
- .4 Bearings: pin in bronze bushings or self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.

- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage: 2% at 500 Pa.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- .4 Runouts to registers and diffusers: located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Confirm damper operators are observable and accessible.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00
- .3 Duct Accessories: Section 23 33 00

### 1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
  - .1 ASTM A653/A653M-2013, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Performance data.
  - .2 Specifications.

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 CERTIFICATION OF RATINGS

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

## PART 2 - PRODUCTS

### 2.1 MULTI-LEAF DAMPERS

- .1 Opposed or parallel blade type as indicated, or opposed blades for modulating control functions, parallel for two position operation.
- .2 Structurally formed steel or extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.
- .3 Pressure fit self lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

- .5 Performance:
  - .1 Leakage: in closed position to be less than 2% of rated air flow at 500 Pa differential across damper.
  - .2 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.
  
- .6 Insulated aluminum dampers:
  - .1 Extruded aluminum (6063T5) damper frame is not less than 2.03mm in thickness. Damper frame is 101.6mm deep and is insulated with polystyrene on four sides if type.
  - .2 Flanged to Duct Type.
  - .3 Blades are extruded aluminum (6063T5) profiles, internally insulated with expanded polyurethane foam and thermally broken. Complete blade has an insulating factor of R 2.29 and a temperature index of 55.
  - .4 Blade seals are extruded EPDM. Frame seals are extruded silicone. Seals are secured in an integral slot within the aluminum extrusions.
  - .5 Bearings are composed of a Celcon inner bearing fixed to a 11.11mm aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
  - .6 Linkage hardware is installed in frame side and constructed of aluminum and corrosion resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
  - .7 Dampers are designed for operation in temperatures ranging between - 40°C) and 85°C.
  - .8 Dampers are parallel blade action.
  - .9 Leakage does not exceed 15.2 l/s/m<sup>2</sup> against .25 kPa w.g. differential static pressure.
  - .10 Pressure drop of a fully open 1219mm x 1219mm damper does not exceed .007kPa w.g. at 5.08 l/s.
  - .11 Dampers are made to size required without blanking off free area.
  - .12 Installation of dampers must be in accordance with current manufacturer's installation guidelines provided with each shipment of dampers.
  - .13 Intermediate or tubular steel structural support is required to resist applied pressure loads for dampers that consist of two (2) or more sections in both height and width.
  - .14 Acceptable material: Tamco Series 9000, Nailor, E. H. Price, Honeywell, Johnson.

### PART 3 - EXECUTION

#### 3.1 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.
- .5 Ensure dampers are observable and accessible.
- .6 Provide motorized insulated dampers at each duct connected to the outdoors.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
  - .1 ANSI/NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC S112-10, Fire Test of Fire Damper Assemblies.
  - .2 CAN4 S112.2-M84, Fire Test of Ceiling Firestop Flap Assemblies.
  - .3 ULC S505-74, Fusible Links for Fire Protection Service.

### 1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Fire dampers.
  - .2 Smoke dampers.
  - .3 Operators.
  - .4 Fusible links.
  - .5 Design details of breakaway joints.

### 1.3 CLOSEOUT SUBMITTALS

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

### 1.4 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 33 00.
- .2 Provide following:
  - .1 Six (6) fusible links of each type.

### 1.5 CERTIFICATE OF RATINGS

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

## PART 2 - PRODUCTS

### 2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B or C, blades out of air stream listed and bear label of ULC, meet requirements of provincial fire authority and NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN/ULC S112. Minimum rating 1.5 hours, dynamically rated.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

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

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

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

#### 3.2 COMMISSIONING

- .1 Commission in accordance with the Commissioning Plan specified in Section 01 91 00.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- 1 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
  - .2 NFPA 90B-2015, Installation of Warm Air Heating and Air Conditioning Systems.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA 1966-2006, HVAC Duct Construction Standards Metal and Flexible.
- .3 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN/ULC S110-07, Fire Tests for Air Ducts.
  - .2 UL 181-2005, Factory Made Air Ducts and Connectors.

### 1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Thermal properties.
  - .2 Friction loss.
  - .3 Acoustical loss.
  - .4 Leakage.
  - .5 Fire rating.

### 1.3 CERTIFICATION OF RATINGS

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

### 1.4 SAMPLES

- .1 Submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00.

## PART 2 - PRODUCTS

### 2.1 GENERAL

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

2.2 METALLIC - ACOUSTIC INSULATED

- .1 Non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible glass fibre acoustic insulation and encased in aluminum foil and mylar laminate vapour barrier.
- .2 Performance:
  - .1 Factory tested to 1000 Pa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Duct Dia.	Frequency (Hz)				
	<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

PART 3 – EXECUTION

3.1 DUCT INSTALLATION

- .1 Install in accordance with: NFPA 90A and NFPA 90B SMACNA.
- .2 Do trial test to demonstrate workmanship.
- .3 Use for minimum 0.9m and maximum 1.5m between ceiling mounted diffusers and branch ducts on supply duct systems only. Do not use for exhaust air duct systems.
- .4 Flexible duct to have no more than a 15° offset and shall have a minimum of two (2) hangers.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Commissioning: Section 01 91 00
- .2 Motors, Drives and Guards: Section 23 05 13
- .3 Vibration Isolation and Seismic Control: Section 23 05 48
- .4 Duct Accessories: Section 23 33 00

### 1.2 REFERENCES

- .1 AMCA 99-2010, Standards Handbook.
- .2 ANSI/AMCA 210/ASHRAE 51-2007, Laboratory Methods of Testing Fans for Rating.
- .3 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
- .4 ANSI/AMCA 301-2014, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 CGSB 1.181M-99, Coating, Zinc Rich, Organic, Ready Mixed.
- .6 NEMA ICS 7.1-2006, Safety Standard for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .7 American Bearing Manufacturers Association (ABMA).

### 1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Provide:
  - .1 Fan performance curves showing point of operation, BHP and efficiency.
  - .2 Sound rating data at point of operation.
  - .3 Dimensional data.
  - .4 Installation procedures.
- .3 Indicate:
  - .1 Motors, sheaves, bearings, shaft details.
  - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate, dimensions, installation procedure.

### 1.4 CLOSEOUT SUBMITTALS

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

### 1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 33 00.
  - .1 Spare parts to include:
    - .1 Matched sets of belts.
    - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

### 1.6 MANUFACTURED ITEMS

- .1 Catalogued or published ratings must be those obtained from tests carried out by manufacturer or from independent testing agency signifying adherence to codes and standards in force.

### 1.7 WARRANTY

- .1 Provide warranty for parts and labour for one (1) year following project Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 FANS GENERAL

- .1 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit must bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
- .5 Open drip proof outside of air stream.
- .6 Motors:
  - .1 In accordance with Section 23 05 13 Motors, Drives and Guards supplemented as specified herein.
  - .2 Sizes as specified.
- .7 Accessories and hardware: matched sets of Vbelt drives, adjustable slide rail motor bases, belt guards, coupling guards, fan inlet and/or outlet safety screens as indicated and as specified in Section 23 05 13 Motors, Drives and Guards, inlet or outlet dampers and vanes and as indicated.
- .8 Factory primed before assembly in colour standard to manufacturer.
- .9 Scroll casing drains: as indicated.
- .10 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .11 Vibration isolation: to Section 23 05 48 Vibration Isolation and Seismic Control.

- .12 Flexible connections: to Section 23 33 00 Duct Accessories.

## 2.2 CENTRIFUGAL FANS

- .1 Fan wheels:
- .1 Welded steel or aluminum construction.
  - .2 Maximum operating speed of centrifugal fans not more than 40 % of first critical speed.
  - .3 Air foil or backward inclined blades, as indicated.
- .2 Bearings: air handling quality, heavy duty, split pillow block, flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life to ABMA L10 of 100,000 hours.
- .3 Housings:
- .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, or steel, 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 nonflammable material.
  - .3 Provide bolted latched airtight access doors with handles.

## PART 3 - EXECUTION

### 3.1 FAN INSTALLATION

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 Vibration Isolation and Seismic Control, flexible electrical leads and flexible connections in accordance with Section 23 33 00 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.
- .5 Provide installation in strict accordance with manufacturer's recommendations.
- .6 Grease fan bearing prior to operation.

### 3.2 COMMISSIONING

- .1 Do commissioning in accordance with Section 01 91 00 - Commissioning.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00

### 1.2 REFERENCES

- .1 American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE).
  - .1 ASHRAE 70-2006(RA2011), Method of Testing the Performance of Air Outlets.

### 1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 Submittal Procedures.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

### 1.4 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 Submittal Procedures.

### 1.5 CERTIFICATIONS

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

### 1.6 EXTRA MATERIALS

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

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity.
- .2 Frames:

- .1 Full perimeter gaskets.
- .2 Plaster frames where set into plaster or gypsum board.
- .3 Concealed fasteners.
  
- .3 Concealed manual volume control damper operators as indicated.
  
- .4 Colour: standard except Bone White PSP4186J in areas with metal baffle ceilings, to match ceiling colour, chilled beams and lights, or as directed by Departmental Representative.
  
- .5 Acceptable manufacturers: E. H. Price, Titus, Nailor, Carnes, Airvector, Anemostat.

## 2.2 MANUFACTURED UNITS

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

## 2.3 SUPPLY GRILLES AND REGISTERS

- .1 Refer to Schedule on drawings.

## 2.4 DIFFUSERS

- .1 Refer to Schedule on Project Drawings.

## 2.5 LINEAR GRILLES

- .1 Refer to Schedule on Project Drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere.
- .5 Coordinate clips and fasteners to match architectural ceiling types. Refer to architectural Drawings.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)
  - .1 ANSI/NFPA 96-2014, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 American Society for Testing and Materials (ASTM)
  - .1 ASTM E90-09, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

### 1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Pressure drop.
  - .2 Face area.
  - .3 Free area.
  - .4 Dimensions.

### 1.3 TEST REPORTS

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

### 1.4 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying

## PART 2 - PRODUCTS

### 2.1 FIXED LOUVRES – ALUMINUM

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm. Drainable blades.
- .4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit. Flanged frame or flush frame as indicated.
- .5 Mullions: at 1500 mm maximum centres.

- .6 Fastenings: stainless steel with nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.
- .7 Screen: 12 mm on exhaust and intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: factory applied enamel, or anodized as indicated. Colour: to Departmental Representative's approval.
- .9 Acceptable product: Greenheck, Nailor, Airolite K6776 Ventex.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

**END OF SECTION**

PART 1 - GENERAL

1.1 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate the following: construction, ASHRAE test efficiency, clean and maximum recommended pressure drop, gauges and accessories.

1.2 MAINTENANCE DATA

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

1.3 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings must be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Filters: suitable for non- condensing air at 100% RH and air temperatures between -40°C and +40°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: "T" section or channel section construction of stainless steel.
- .2 Seals: to ensure leak-proof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors on each side of air handling unit cabinet.
  - .1 Prefilters: through doors on each side of AHU.
  - .2 Final Filters: face loading from within AHU.

2.3 AIR FILTER GAUGES

- .1 Dial type: diaphragm actuated, direct reading.
- .2 Range: 0 to 750 Pa.
- .3 One (1) for each bank of filters as indicated on the drawings.
- .4 Permanent pointer set for manufacturer's recommended final pressure drop.

- .5 Acceptable Material: Magnehelic 2000 series diaphragm actuated direct reading, dial type.

PART 3 - EXECUTION

3.1 INSTALLATION GENERAL

- .1 Install in accordance with manufacturers recommendations.

3.2 REPLACEMENT MEDIA

- .1 Provide three (3) complete sets of filters for each HRV.  
.2 Replace all temporary media with new prior to air balance testing.  
.3 Filter media to be new and clean, as indicated by pressure gauge, at time of acceptance.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Section 01 33 00 Submittal Procedures.
- .2 Section 01 74 22 Waste Management and.
- .3 Section 01 78 00 Closeout Submittals.
- .4 Section 23 05 20 - Thermometers and Pressure Gauges.

### 1.2 REFERENCES

- .1 American Boiler Manufacturer's Association (ABMA)
- .2 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
  - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV.
- .3 Canadian Standards Association (CSA)
  - .1 CSA B51-2014, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CSA B139-09, Installation Code for Oil Burning Equipment.
  - .3 CSA B140.7-05(R2010), Burning Equipment: Steam and Hot Water Boilers.
  - .4 CSA B149.2-2010, Natural Gas and Propane Installation Code.
- .4 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

### 1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 Submittal Procedures.
- .2 Indicate the following:
  - .1 General arrangement showing terminal points, instrumentation test connections.
  - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
  - .3 Foundations with loadings, anchor bolt arrangements.
  - .4 Piping hookups.
  - .5 Equipment electrical drawings.
  - .6 Burners and controls.
  - .7 All miscellaneous equipment.
  - .8 Flame safety control system.
  - .9 Breeching and stack configuration.
  - .10 Installation procedures.
- .3 Engineering data to include:
  - .1 Boiler efficiency at 25%, 50%, 75%, 100%, and 110% of design capacity.
  - .2 Radiant heat loss at 100% design capacity.

### 1.4 CLOSEOUT SUBMITTALS

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

## 1.5 MAINTENANCE

- .1 Maintenance materials to include:
  - .1 Special tools for burners, manholes, handholes and Operation and Maintenance.
  - .2 Spare parts for one (1) year of operation.
  - .3 Spare gaskets one (1) set.
  - .4 Spare gauge glass inserts one (1) of each size and type.
  - .5 Probes and sealants for electronic indication one (1) set
  - .6 Spare burner tips one (1) set.
  - .7 Spare burner gun one (1).
  - .8 Safety valve test gauge one (1).

## PART 2 - PRODUCTS

### 2.1 GENERAL

- .1 Packaged boiler:
  - .1 Complete with burner and necessary accessories and controls.
  - .2 Laboratory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7.
  - .3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
  - .4 Designed and constructed to ANSI/ASME Boiler and Pressure Vessel Code.
  - .5 CRN (Canadian Registration Number), to CSA B51.
  - .6 Boiler/burner package to bear ULC label.
- .2 Performance:
  - .1 In accordance with American Boiler Manufacturers Association (ABMA) testing procedures.
  - .2 High efficiency condensing, natural gas fired boilers:
    - .1 Minimum 93% thermal efficiency.
    - .2 Modulating burner with 5:1 turndown.
    - .3 Direct spark ignition.
    - .4 Low NOx operation.
    - .5 Sealed combustion.
    - .6 Low gas pressure operation.
    - .7 Category IV venting.
    - .8 ASME stainless steel heat exchanger.
  - .3 Input: Refer to schedule.
  - .4 Output: Refer to schedule.
- .3 Controls: factory wired NEMA 1 steel cabinet.
  - .1 Complete with on/off switch, adjustable high limit with manual reset, flow switch, inlet and outlet temperature sensor, flue temperature sensor, low air pressure switch, 345KPa (50psi) ASME relief valve, temperature and pressure gauge.
- .4 Thermal insulation:
  - .1 50 mm thick mineral fibre. Seal insulation at handholes, manholes, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
- .5 Jackets: heavy gauge metal, finished with heat resisting paint.
- .6 Mounting:
  - .1 Factory floor stand.
  - .2 Adjustable leveling legs.

- .7 Anchor bolts and templates:
  - .1 Supply for installation by other Divisions. Anchor bolts to be sized to Section 23 05 48 Vibration Isolation and Seismic Control Measures.
- .8 Startup, instruction, onsite performance tests: 3 days per boiler.
- .9 Trial usage:
  - .1 Departmental Representative may use boilers for test purposes prior to acceptance and commencement of warranty period.
  - .2 Supply labour, materials and instruments required for tests.
- .10 Temporary use by contractor:
  - .1 Contractor may use boilers providing warranty is not affected and only after written approval from Departmental Representative.
  - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
  - .3 Refurbish to as-new condition before final inspection and acceptance.

## 2.2 AUXILIARIES

- .1 Provide for each boiler and to meet ANSI/ASME requirements.
- .2 Hot water boilers:
  - .1 Relief valves: ANSI/ASME rated, set at 275 kPa, to release entire boiler capacity.
  - .2 Pressure gauge: to Section 23 05 20.
  - .3 Thermometer: to Section 23 05 20 range 10 to 150o C.
  - .4 Low water cutoff: with visual and audible alarms.
  - .5 Auxiliary low water cutoff: with separate cold water connection to boiler.
  - .6 Isolating gate valves: on supply and return connections.
  - .7 Drain valve: NPS 2.
  - .8 Stack thermometer: Range 65 to 400 oC.
  - .9 Outdoor controller: to reset operating temperature controller.
  - .10 One (1) set of cleaning tools.

## 2.3 BURNER

- .1 Fully modulating, natural gas fired burner.
- .2 Stainless steel assembly with woven steel mesh.
- .3 Must fire along the entire length of the primary heat exchanger.

## 2.4 VENT

- .1 AL29-4C venting complete with 25mm AIU space and AU required fittings for installation up to building roof.
- .2 Seal all joints and seams gas tight.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level.
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Natural gas fired installations in accordance with CSAB149.1.
- .7 All boilers to be approved by the local authorities having jurisdiction. Obtain all required inspections and approvals prior to startup and commissioning. Provide copies of affidavits, approval letters, etc., to the Departmental Representative for record purposes.

#### 3.2 MOUNTINGS AND ACCESSORIES

- .1 Safety valves and relief valves:
  - .1 Run separate discharge from each valve.
  - .2 Terminate discharge pipe as indicated.
  - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

#### 3.3 COMMISSIONING

- .1 Manufacturer to:
  - .1 Certify installation.
  - .2 Start up and commission installation.
  - .3 Carry out on-site performance verification tests.
  - .4 Demonstrate operation and maintenance.
- .2 Provide Departmental Representative at least 72 h notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.
- .3 Do commission in accordance with Section 01 91 00 - Commissioning.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

- .1 Painting: Section 09 91 13
- .2 Vibration Isolation and Seismic Control Measures: Section 23 05 48
- .3 Duct Accessories Section: 23 33 00
- .4 Commercial Fans: Section 23 34 00

### 1.2 REFERENCES

- .1 Nation Fire Protection Association (NFPA)
  - .1 NFPA90A-2015, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 1.181-99, Ready Mixed Organic Zinc Rich Coating.
- .3 Canadian Standards Association:
  - .1 C22.2 No. 113-201, Fans and Ventilators.
- .4 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
- .5 Canadian Standards Association
  - .1 CSA B52-2013, Mechanical Refrigeration Code
- .6 American Bearing Manufacturer's Association
  - .1 ANSI/ABMA 9-2015, Load Ratings and Fatigue Life for Ball Bearings
  - .2 ANSI/ABMA 11-2014, Load Ratings and Fatigue Life for Roller Bearings.
- .7 Air Movement and Control Association
  - .1 AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
- .8 American Society of Heating Refrigeration and Air-Conditioning Engineers.
  - .1 ASHRAE 68-1997, Laboratory Method of Testing to Determine the Sound Power in a Duct.
- .9 National Electrical Manufacturer's Association
  - .1 NEMA MG-1-2014, Motors and Generators
  - .2 NEMA/ICS 7.1-2006, Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .10 Provincial Boiler Pressure Vessel and Compressed Gas Regulations.

### 1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate following:
  - .1 Construction specifications, dimensions, weights, fans, motors, vibration isolation, coils, capacities,

curves, filter housings, filters, mixing boxes, dampers. Controls actuators, accessories installation procedures, and control wiring diagrams.

#### 1.4 CLOSEOUT SUBMITTALS

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

#### 1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .3 One (1) set of filters for start up, one set for commissioning, one spare set of filters for each unit.

#### 1.6 WARRANTY

- .1 Provide extended parts and labour warranty for five (5) years from the Substantial Performance Completion date.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- .1 Factory assembled components to form units supplying air at design conditions as indicated.

#### 2.2 MANUFACTURED ITEMS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

#### 2.3 HRV-1

- .1 Flat plate heat recovery ventilator that complies with CSA C22.2 No. 113 and UL 1812, CETL and ETL approved, airflow data that complies with AMCA 210.
- .2 Polypropylene core complying with UL 94-HB.
- .3 Steel construction, minimum 50mm insulation complying with NFPA 90A requirements for flame spread and smoke generation.

### 2.3 HRV-2 to 6

- .1 Flat plate heat recovery ventilator that complies with CSA C22.2 and UL 1812
- .2 Polypropylene core
- .3 Steel construction
- .4 30% medium efficiency filters

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- .1 Fabricate to provide smooth air flow through all components. Limit air leakage to 1 % of rated air flow at 2.5 kPa suction pressure.
- .2 Apply sealer into all seams prior to assembly. Secure toe angles continuous along entire length of assembly.

### 3.2 COMMISSIONING

- .1 Manufacturer's representative to provide one day on site per unit for start- up and one day for commissioning to Section 01 91 00.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 REFERENCES

- .1 Air-Conditioning and Refrigeration Institute (ARI)
  - .1 ARI 210/240-2008, Performance Rating for Unitary Air Conditioning and Air-Source Heat Pump Equipment.
  - .2 ARI 325-98, Ground Water - Source Heat Pumps.
- .2 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
  - .1 ANSI/ARI 320-98, Water- Source Heat Pumps.
- .3 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
  - .1 ANSI/NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .4 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 15-2013, Safety Standard for Refrigeration Systems and Designation and Classification of Refrigeration.
- .5 American Society of Testing and Materials (ASTM)
  - .1 ASTM B280-2013, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .6 Canadian Standards Association (CSA)
  - .1 CAN/CSA C13256-1-01(R2015), Water Source Heat Pumps - Test and Rating Performance.
- .7 Environment Canada
  - .1 EPS 1/RA/2-1996, Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
  - .2 Environment Canada-1994, Ozone-Depleting Substances Alternatives and Suppliers List.

### 1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings in accordance with Sections 01 33 00.
- .2 Indicate:
  - .1 Capacities.
  - .2 ARI Ratings.
  - .3 Sound Power levels.
  - .4 Installation instructions.
  - .5 Start-up Instructions.
  - .6 O&M, Instructions.
  - .7 Refrigerant pipe routing and sizes.
  - .8 Control system details.

### 1.3 SYSTEM DESCRIPTION

- .1 Simultaneous heating and cooling Variable Refrigerant Flow (VRF) system to consist of an outdoor unit, high efficiency heat recovery units designed for minimum piping and maximum design flexibility, indoor units, and controls by the equipment manufacturer. Every indoor unit must be independently capable of operating in either heating or cooling mode regardless of the mode of other indoor units. The system must be capable of changing mode of individual indoor units (cooling to heating or heating to cooling) within a maximum time of 5 minutes to ensure indoor temperature can be properly maintained. Supervisory controls

will be via the AC Smart Controller. Provide and install LG software and all necessary accessories to permit Owner maintenance and trouble shooting.

#### 1.4 QUALITY ASSURANCE

- .1 Units to be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- .2 Install all wiring in accordance with the National Electrical Code (NEC).
- .3 The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

#### 1.5 STORAGE AND HANDLING

- .1 Store all VRF equipment protected from weather, extreme temperature, etc. as suggested by the manufacturer. Move and lift all VRF equipment as suggested by the manufacturer.

#### 1.6 WARRANTY

- .1 Provide VRF equipment warranted by the manufacturer's limited warranty for a period of one year from date of installation or 18 months from the project substantial completion. An extended warranty including one (1) additional year parts and labour and five (5) additional years compressor shall be granted upon submission to the manufacturer and acceptance by the manufacturer of proper installation with documentation including:
  - .1 Selection output and layout of the VRF system.
  - .2 60 minutes of operational history upon commissioning from the VRF service tool.
  - .3 Completed commissioning report as per the VRF equipment manufacturer.
- .2 During this period, repair or replace any part failing to function properly due to faulty workmanship or material at the VRF equipment manufacturer's discretion and provide all associated include labor.
- .3 Install the VRF system by a licensed mechanical contractor trained by the VRF equipment manufacturer or certified manufacturer's agent.
- .4 Have commissioning and start-up performed by the manufacturer or certified manufacturer's agent.

### PART 2 - PRODUCTS

#### 2.1 SIMULTANEOUS HEATING AND COOLING OUTDOOR UNIT

- .1 General:
  - .1 Use outdoor units with VRF components of the same manufacturer consisting of the outdoor unit, high efficiency heat recovery units, indoor units, factory designed and supplied Y-branches, and controls.
  - .2 Use system components of the same manufacturer or as recommended by the manufacturer of the VRF equipment.
  - .3 Unit control boards must perform all functions required to effectively and efficiently operate the VRF system and communicate in a daisy chain configuration from outdoor unit to heat recovery and indoor units via RS485.
  - .4 The outdoor units must be completely factory assembled, piped and wired. Dual and triple frame outdoor units will be field piped with factory designed and supplied Y-branch kits to manifold them together into a single refrigerant circuit.

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- .5 Run test each outdoor unit at the factory.
  - .6 The sum of connected nominal capacity of all indoor air handlers must range from 50% to 130% of outdoor unit nominal capacity to ensure the VRF system will have sufficient capacity to handle the building space loads at peak design.
  - .7 Outdoor units to have a tested sound rating no higher than 65 dB(A) per outdoor unit frame tested per KSA0701. The outdoor unit frame includes three quiet/night time operation settings of 47, 44, and 41 dBA. Note that this level is for the entire two or three module unit.
  - .8 Field insulate all refrigerant lines from the outdoor unit to the heat recovery unit and from the heat recovery unit to the indoor units using ACR copper pipe and in strict accordance with the equipment manufacturer's recommendations.
  - .9 Outdoor units to have an accumulator.
  - .10 Outdoor units to have a high pressure safety switch.
  - .11 Outdoor units to have over-current protection.
  - .12 Outdoor units to use a brazed plate sub-cooling heat exchanger.
  - .13 Outdoor units to have the ability to operate with an elevation difference of up to 110m above or below the indoor units.
  - .14 Outdoor units to allow up to a total equivalent refrigerant piping length of 225m.
  - .15 Maximum length from outdoor unit to indoor unit to be up to 40m without traps.
  - .16 Outdoor units must be capable of operating in heating only mode down to -4F and up to 61F ambient wet bulb without additional low ambient controls.
  - .17 Outdoor units must be capable of operating in cooling only mode down to 21F and up to 110F ambient dry bulb.
  - .18 Outdoor units, must be capable of operating in simultaneous heating and cooling mode down to 14F and up to 86F ambient dry bulb.
  - .19 Outdoor units to have an oil separator for each compressor and controls to ensure sufficient oil supply is maintained for the compressor.
  - .20 Use R410A refrigerant.
  - .21 Each outdoor unit frame to have a removable inspection panel no greater than 150mm tall or 300mm wide to allow access to service tool connection, DIP switches, auto addressing and error codes.
  - .22 Outdoor units to include a factory-applied anti-corrosion coating for use in this exposed coastal environment. The equipment manufacturer will determine the final refrigerant pipe routing and sizing in order to ensure that the system meets their equipment requirements.
- .2 Frame:
- .1 Galvanized steel, bonderized and be finished with powder coat baked enamel paint.
- .3 Compressor:
- .1 Equip all 208V, 3-phase outdoor unit frames with one (1) hermetic digitally controlled inverter driven scroll compressor and one (1) hermetic constant speed scroll compressor.
  - .2 Crankcase heater to be factory mounted on all compressors.
  - .3 Outdoor unit compressor to have an inverter to modulate capacity. The frequency of the inverter compressor shall be completely variable from 25 to 105Hz.
  - .4 Equip the compressor with an internal thermal overload.
  - .5 Mount the compressor to avoid the transmission of vibration.
- .4 Fan:
- .1 Furnish all outdoor unit frames with two (2) direct drive, variable speed propeller type fans.
  - .2 All fan motors shall have inherent protection, have permanently lubricated bearings, and be variable speed with a maximum speed up to 950 rpm.
  - .3 Provide all fans with a raised guard to limit contact with moving parts.
  - .4 Outdoor unit to have vertical discharge airflow.
  - .5 Outdoor unit to have a static pressure capability up to 0.16 inches wg to accommodate additional external static pressure introduced by the air guide.
- .5 Coil:
- .1 Nonferrous construction with louvered fins on copper tubing.

- .2 Coil fins to have a factory applied corrosion resistant material with hydrophilic coating. The unit must meet the specified capacities with a provision for this corrosion protection.
  - .3 Complete with integral metal guard.
  - .4 Refrigerant flow from the outdoor unit to be controlled by means of a digitally controlled inverter driven scroll compressor.
- .6 Electrical:
- .1 Outdoor unit electrical power to be 208/230V, 60 Hz, 3 phase.
  - .2 Outdoor unit must be capable of operation within voltage limits of +/- 10% rated voltage.
  - .3 Outdoor unit to be controlled by integral microprocessors.
  - .4 Control circuit between the indoor units, heat recovery box and the outdoor unit to be 24VDC completed using a 2-conductor, stranded, shielded cable for the daisy chain communication.
- .7 Controls:
- .1 Heat Pump and Heat Recovery units to be factory wired with necessary electrical control components, integral microprocessors, printed circuit boards, thermistors, sensors, terminal blocks, and lugs for power wiring. Control circuit between the indoor units, heat recovery unit and the outdoor unit to be 24VDC completed using a two- conductor, stranded, and shielded cable for the RS-485 daisy chain communication. Microprocessor-based algorithms will provide component protection, soft-start capability, refrigeration system pressure, temperature, defrost, and ambient control. Provide the acp and ac smart interface (or equivalent) for complete standalone operation of the heat pump system. Provide interface points for monitoring the heat pump system via the building DDC system using PQNFB17C1 BACNET Gateway. Refer to the controls drawing for additional requirements.
- .8 Wind Baffle Kit:
- .1 Hot dip galvanized, provided by heat pump supplier.
- .9 Unit Stands:
- .1 Minimum 18" aluminum stands.

## 2.2 HEAT RECOVERY UNITS FOR SIMULTANEOUS HEATING AND COOLING SYSTEMS

- .1 General:
- .1 Provide heat recovery units designed for use with VRF equipment of the same manufacturer.
  - .2 Heat recovery units to have factory installed control boards that interface to the VRF equipment controls system and shall perform all functions to effectively and efficiently control the simultaneous heating and cooling VRF system.
  - .3 Provide heat recovery units that are completely factory assembled, internally piped and wired.
  - .4 Run test heat recovery units at the factory.
  - .5 Provide heat recovery units designed for indoor installation.
  - .6 Use R410A refrigerant.
  - .7 Field insulate all refrigerant lines from the outdoor unit to the indoor units.
  - .8 Heat recovery units to allow up to 2, 3, or 4 indoor units to be connected.
  - .9 Y-branches between heat recovery units and indoor units will not be allowed to ensure independent heating and cooling control of each indoor unit regardless of the mode of any other indoor unit connected to that heat recovery unit.
  - .10 Heat recovery units will be permitted to be piped in series or parallel to minimize material cost and labor.
  - .11 The following piping will be allowed:
    - .1 Series piping of up to 16 heat recovery units
    - .2 Indoor units up to 151 equivalent metres of piping length from the respective heat recovery unit
    - .3 Indoor units up to 40 equivalent metres of piping length from the first branch
    - .4 Indoor units not to exceed 5m above or below the heat recovery unit
    - .5 Elevation difference between the highest and lowest elevation indoor unit not to exceed

- 5m.
- .6 Total indoor unit nominal capacity not to exceed 56kW in any series string of 1 to 16 heat recovery units.
- .2 Heat Recovery Unit Construction:
  - .1 Heat recovery unit to have 2, 3, or 4 ports which can individually accommodate up to one indoor unit not to exceed 14kW nominal capacity.
    - .1 Indoor units greater than 14kW nominal capacity to utilize two (2) neighboring heat recovery unit ports.
    - .2 The heat recovery unit housing to be galvanized steel.
    - .3 Each heat recovery unit to contain piping, valves and controls to divert refrigerant for optimum efficiency.
    - .4 Unit to house one (1) double spiral tube-in-tube heat exchanger per port of the heat recovery unit.
    - .5 Heat recovery units to be internally insulated and not require installation of any condensate drain.
- .3 Refrigerant System:
  - .1 R410A refrigerant will be required for all VRF equipment and components including indoor units, outdoor units, refrigerant piping, valves, Y- branches, heat recovery units, etc. as applicable.
- .4 Refrigerant valves:
  - .1 Circuit each port with two 2-position solenoid valves to control refrigerant flow path.
  - .2 Supply and field install isolation valves for ease of service to the heat recovery unit without evacuating the entire system refrigerant charge.
  - .3 Design for use with R410A.
- .5 Electrical:
  - .1 Heat recovery box electrical power to be 208/230V, 1 phase, 60 Hz.
  - .2 All units must be capable of satisfactory operation within +/-10% of nominal voltage.
  - .3 Heat recovery unit will be controlled by integral microprocessors from the main control in the outdoor unit.
  - .4 Control circuit between the indoor units, heat recovery box and the outdoor unit to be 24VDC completed using a 2-conductor, stranded and shielded cable for the daisy chain communication.
- .6 Controls:
  - .1 Heat Recovery units to include factory installed control boards and integral microprocessors that communicate with the main control board in the outdoor unit and interface with the VRF equipment controls system. The control circuit between the indoor units, Heat Recovery unit, and the outdoor unit must be a field wired system, 24VDC using a two conductor, stranded and shielded cable for the RS-485 daisy chain communication. Provide wiring in strict accordance with the manufacturers recommendations. Refer to the controls drawing for additional requirements.

### 2.3 FAN COILS

- .1 Ceiling concealed, low static, horizontal draw through for ducted installation.
- .2 Refer to schedule on drawing for performance.
- .3 Provide unit complete with refrigerant coils, fan, motor, belt drives, drain pan, condensate lift pump and filter.
- .4 Unit to include single point power connection and NEMA 1 electrical/controls enclosure with terminal strip for electrical termination.

**2.4 REFRIGERATION PIPING AND INSULATION**

- .1 Refrigeration Piping: AC/R to ASTM B280 seamless copper tubes. Solder/braze connections in strict accordance with the manufacturer's requirements.
- .2 Insulation for refrigerant piping: 50mm, Armaflex or approved equivalent. Maximum 25/50 flame and smoke rating.
- .3 Covering for exterior refrigeration piping: pipe insulation to be covered with aluminum jacket to ASTM B209. Thickness of 0.50mm with stucco embossed finished.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- .1 Install where indicated and in accordance with manufacturer's instructions.
- .2 Nothing to obstruct ready access to all components or to prevent removal of components for servicing.

**3.2 START-UP**

- .1 Manufacturer to certify installation.
- .2 Manufacturer to test and start up units and certify performance.
- .3 Manufacturer to provide verbal, video, and written instructions to operating personnel.
- .4 Submit written report to Departmental Representative.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate:
  - .1 Equipment, capacity, piping, and connections.
  - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

### 1.2 MAINTENANCE

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

## PART 2 - PRODUCTS

### 2.1 FORCE FLOW HEATERS (F.F.) AND CABINET HEATERS

- .1 Cabinet: type semi-recessed or recessed as indicated, nominal 16 gauge steel with rounded exposed corners and edges, removable panels, glass fiber insulation and integral air outlet and inlet.
- .2 Finish with factory applied primer coat.
- .3 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically test to 1034 KPag.
- .4 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.
- .5 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.
- .6 Filters: removable 25mm thick permanent washable type.
- .7 Capacities: as indicated on the drawings.
- .8 Control:
  - .1 Multi-speed and off switch with integral thermal overloads accessible through a tamper proof access door in the front cover of cabinet.
  - .2 Low limit aquastat strapped on to hot water heating supply set to prevent fan operating below 50°C.
  - .3 Controlled by building management system.
- .9 Acceptable Material: Trane; Dunham- Bush; Engineered Air; Mark Hot; Modine, Rosemex; Sigma Corp.

### 2.2 HORIZONTAL AND VERTICAL UNIT HEATERS (H.U.H. & V.U.H.)

- .1 Casing: nominal 16 ga. thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.
- .2 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1034 KPag.

- .3 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan inlet guard.
- .4 Motor: speed as indicated, direct drive continuous duty, built-in overload protection, and resilient motor supports.
- .5 Air outlet: two-way adjustable louvres.
- .6 Capacities: as indicated on the drawings.
- .7 Controlled by building management system.
- .8 Acceptable Material: Trane; Dunham- Bush; Engineered Air; Mark Hot; Modine; Rosemex; Sigma Corp.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install in accordance with piping layout and reviewed shop drawings.
- .3 Provide double swing pipe joints at each unit.
- .4 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .5 Hot water units: for each unit, install isolating valve on inlet and circuit balancing valve on outlet. Install drain valve at low point. Install manual air vent at high point.
- .6 Clean finned tubes and comb straight.
- .7 Provide supplementary suspension steel as required.
- .8 Thermostats on outside walls (where applicable): mount on insulated backplates.
- .9 Before acceptance, set discharge patterns and fan speeds for proper distribution of heat.
- .10 Provide vibration isolation spring hangers for suspended horizontal unit heaters.

**END OF SECTION**