

## **PART 1 - GENERAL**

### **1.1 INTERFERENCE SHOP DRAWINGS**

- .1 Provide interference shop drawings prior to the installation of the building mechanical and electrical systems as described in Section 01 33 00 - Submittal Procedures

### **1.2 RELATED SECTIONS**

- .1 Section 01 91 13 – General Commissioning
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 21 05 01 - Mechanical General Requirements

### **1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Collect, separate and recycle all site generated waste materials in accordance with Section 01 74 21.
- .2 Confirm the following forms, included at the end of Section 01 74 21, are completed and submitted to the Contractor.
  - .1 Waste Audit (WA) Sheet - Schedule A
- .3 Waste Tracking Form - Schedule B
- .4 Coordinate all work related to Section 01 74 21 with Contractor.

## **PART 2 - PRODUCTS**

- .1 Not applicable.

## **PART 3 - EXECUTION**

- .1 Not applicable.

**END OF SECTION**

**PART 1- GENERAL**

**1.1 USE OF SYSTEMS**

- .1 Use of new permanent heating and ventilation systems for supplying temporary heat or ventilation is not permitted.
- .2 Filters referred to herein are over and above those specified elsewhere in this specification.
- .3 Exhaust systems are not included in any approvals for temporary heating ventilation.
- .4 Contractor is responsible for fuel used during this time.
- .5 In the event that the contractor wishes to consider the use of HVAC systems during construction this request must be submitted to the Departmental Representative and approved in writing.

**PART 2- PRODUCTS**

- .1 Not applicable.

**PART 3 - EXECUTION**

- .1 Not applicable.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

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

## **PART 2 – PRODUCTS**

### **2.1 NOT USED**

- .1 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 Canadian Electrical Code.
- .5 Minimum 750mm in front of VAV terminal units.
- .6 Maintain equipment and valves a maximum of 900mm 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, 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 manual air vents at high points in piping systems in areas within accessible mechanical spaces.
- .2 Install automatic air vent with isolating valve at each high point in finished areas.
- .3 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.
  - .7 Install butterfly valves on chilled water and related condenser water systems only.
  - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
  - .9 Install plug cocks or ball valves for glycol service.
  - .10 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .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 un-insulated 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 - Firestopping.
- .2 Un-insulated unheated pipes not subject to movement: No special preparation.
- .3 Un-insulated 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 Before start-up, clean interior of piping systems supplemented as specified in relevant sections of Division 21, 22 and 23.
- .2 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 Piping: pressure test piping at either the main 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 Submit tests results to the Departmental Representative. Work to be carried out in off hours after 5 p.m., weekends or holidays.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after review of tests by the Departmental Representative.

### **3.11 EXISTING SYSTEMS**

- .1 Connect into existing piping systems at times approved by the Departmental Representative. Work to be carried out off hours after 5 p.m., weekends or holidays.
- .2 Request written approval ten (10) days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Conduct daily clean-up of existing areas.

**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
- .3 Structural Steel: Section 05 12 23

### **1.2 REFERENCES**

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-2016, Power Piping, (SI Edition).
  - .2 ANSI/ASME B31.3-2014, Process Piping.
  - .3 ANSI/ASME B31.5-2016, 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 A125-04(R2014), Specification for Steel Springs, Helical, Heat Treated.
  - .2 ASTM A307-2014, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563-15, 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 Do not allow that supports, guides or anchors to 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.

#### **1.5 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Submit shop drawings and product data for following items:
  - .1 Bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

#### **1.6 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 zinc rich paint after manufacture.
  - .2 Use electroplating galvanizing process or hot dipped galvanizing process.
  - .3 Confirm 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 C-clamp 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. Confirm the eye is 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 SP58.
- .6 Hanger rods: threaded rod material to MSS SP58.
  - .1 Only subject hanger rods to tensile loading.
  - .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 SP58, UL listed FM approved, where required clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Confirm "U" has hole in bottom for riveting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP58.
- .10 U-bolts: 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 3 m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP58.

### **2.5 CONSTANT SUPPORT SPRING 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 two (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 05121. Submit calculations with shop drawings.

## **2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

## **2.9 PLATFORMS AND CATWALKS**

- .1 To Section 05 31 00.

## **2.10 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.

## **2.11 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, chillers, cooling towers, 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 the Canadian Fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 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: NPS	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	

- .6 Within 300 mm of each elbow.
- .7 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 Interior Painting: Section 09 91 23

### **1.2 REFERENCES**

- .1 Canadian Gas Association (CGA)
  - .1 CSA/CGA B149.1-2015, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB1.60-97, Interior Alkyd Gloss Enamel.
  - .2 CAN/CGSB24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association
  - .1 NFPA 13-2016, Installation of Sprinkler Systems.
  - .2 NFPA 14-2016, Standpipe and Hose Systems.
- .4 CSA Z7396.1-2012, Medical Gas Piping 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 or plastic laminate 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.

## 2.2 SYSTEM NAMEPLATES

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

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
  - .1 Terminal cabinets, control panels: Use size # 5.
  - .2 Equipment in Mechanical Rooms: Use size # 9.
  - .3 Use maximum of 25 letters/numbers per line.

## 2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.

- .3 Before starting Work, obtain written approval of identification system from Departmental Representative.

## **2.4 PIPING SYSTEMS GOVERNED BY CODES**

- .1 Identification:
  - .1 Propane gas: to CSA/CGA B149.1 authority having jurisdiction.
  - .2 Sprinklers: to NFPA 13.
  - .3 Standpipe and hose systems: to NFPA 14.

## **2.5 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>
** Add design temperature		
++ Add design temperature and pressured		
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Heating water supply	Black	HWS
Heating water return	Black	HWR

## 2.6 DUCTWORK IDENTIFICATION

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Black, or coordinated with base colour to ensure strong contrast.
- .3 Identify system: e.g. Supply AHU1, Exhaust F7.

## 2.7 VALVES, CONTROLLERS

- .1 Brass tags 12 mm 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.

## 2.8 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this Section. If no EMCS included in project, identification as per this section.
- .2 Inscriptions to include function and (where appropriate) failsafe position, component ID name.

## **2.9 LANGUAGE**

- .1 Identification to be in English.
- .2 Use one nameplate, label, etc. 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 NAMEPLATES**

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

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

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels:  
At not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.

- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, 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.

### **3.5 VALVES, CONTROLLERS**

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with 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 copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

**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 TAB agency must be 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 the 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 the 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 the 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 the Departmental Representative for verification of TAB reports.

## **1.9 START OF TAB**

- .1 Notify the 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 the 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 the 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 the 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 the 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 the 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 the Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of the Departmental Representative.

### **1.17 SETTINGS**

- .1 After TAB is completed to satisfaction of the 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 will be considered complete when final TAB Report received and approved by the 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, 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 precleaned. 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, 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**

### **2.1 NOT USED**

- .1 Not applicable.

## **PART 3 - EXECUTION**

### **3.1 NOT USED**

- .1 Not applicable.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 23 05 29 - Bases, Hangers and Supports.
- .3 Section 23 05 53 - Mechanical Identification.

### **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 C335-2010e1, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
  - .3 ASTM C449-07(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 C612-14, Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .6 ASTM C921-10(R2015), 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 S701-2011, 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 Submittal Procedures.
- .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 Submittal Procedures.
- .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 - Submittal Procedures.
- .2 Installation instructions to include procedures used and installation standards achieved.

#### **1.7 QUALIFICATIONS**

- .1 Installer: specialist in performing work of this section and 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/ULCS102:
  - .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).
- .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.

## **2.3 JACKETS**

- .1 Canvas:
  - .1 220 gm/m2 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 Stainless steel:
  - .1 Type: 304 or 316 where additional corrosion protection is required.
  - .2 Thickness: 0.25 mm sheet.
  - .3 Finish: Corrugated or stucco embossed.
  - .4 Jacket banding and mechanical seals: 12mm wide, 0.5 mm thick stainless steel.
- .4 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 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 - Bases, Hangers and Supports.
- .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 (2) rows each side.

### 3.3 DUCTWORK INSULATION SCHEDULE

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

	<u>TIAC Code</u>	<u>Vapour Retarder</u>	<u>Thickness (mm)</u>
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
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing Plenum	C1	Yes	50
Intake and exhaust plenums	C1	Yes	50
Exhaust duct between dampers and louvers	C1	No	50
Rectangular ducts outside	C1	special	75

Round ducts outside C1 special 75

.2 Jackets: Exposed round ducts 600mm 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	
	<u>Rectangular</u>	<u>Round</u>
Indoor, concealed	None	None
Indoor, exposed within mechanical room	CRF/ Canvas	CRD/ Canvas
Indoor, exposed elsewhere	CRF/ Aluminum CRF/Self	CRD/ Aluminum CRD/Self
Outdoor, exposed	adhesive weather barrier membrane	adhesive weather barrier membrane

**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-16A, Specification for General Requirements for Flat Rolled Stainless and Heat Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-15, Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Carbon, Hot Rolled.
  - .3 A653/A653M-15E1, 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-2016, Installation of Air Conditioning and Ventilating Systems.
  - .2 NFPA 90B-2016, Installation of Warm Air Heating and Air Conditioning Systems.
  - .3 NFPA 91-2015, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Noncombustible 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 1966-20016, HVAC Duct Construction Standards, Metal and Flexible.
  - .2 SMACNA 016-2012, 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 standards.

## **1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with municipal regulations and Section 01 74 21.

## **PART 2 - PRODUCTS**

### **2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:
- .2 Seal classification:
  - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
  - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant tape or combination thereof.
  - .3 Class C: transverse joints and connections made air tight with gaskets sealant tape or combination thereof. Longitudinal seams unsealed.

### **2.2 SEALANT**

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

### **2.3 TAPE**

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

### **2.4 DUCT LEAKAGE**

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

### **2.5 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 450mm entry on branch.
  - .2 Round main and branch: enter main duct at 450mm 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.

## **2.6 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.

## **2.7 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

## **2.8 STAINLESS STEEL**

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: No 4 finish on exposed side of duct in finished areas, No. 3 finish or lower where concealed.
- .3 Thickness, fabrication and reinforcement: to SMACNA.
- .4 Joints: to SMACNA and be continuous inert gas welded.

## 2.9 ALUMINUM

- .1 To SMACNA. Aluminum type: 3003H14.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA and be continuous weld.

## 2.10 BLACK STEEL

- .1 To ASTM A635/A635M.
- .2 Thickness: 1.2 mm
- .3 Fabrication: ducts and fittings or SMACNA.
- .4 Reinforcement: to SMACNA.
- .5 Joints: continuous weld.

## 2.11 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:

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

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
    - .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.

### **PART 3 - EXECUTION**

#### **3.1 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.

#### **3.2 HANGERS**

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

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

#### **3.3 WATERTIGHT DUCT**

- .1 Provide watertight duct for:
  - .1 Fresh air intake.
  - .2 Minimum 3000 mm from duct mounted humidifier in all directions.
  - .3 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 ½ drain connected, with deep seal trap and valve and discharging to open funnel drain or service sink or as approved by Departmental Representative.

### **3.4 SEALING AND TAPING**

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

### **3.5 LEAKAGE TESTS**

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 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 degree elbows.
- .6 Complete test before insulation or concealment.

**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 - 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 400C to plus 900 degrees C, density of 1.3 kg/m2.

### **2.3 ACCESS DOORS IN DUCTS**

- .1 Non-insulated ducts: sandwich construction of same material as duct, one (1) 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 mm x 300 mm: two (2) sash locks complete with safety chain.
  - .2 301 mm to 450 mm: four (4) sash locks complete with safety chain.
  - .3 451 mm to 1000 mm: piano hinge and minimum two (2) sash locks.
  - .4 Doors over 1000 mm: piano hinge and two (2) handles operable from both sides.
  - .5 Hold open devices.
  - .6 300 mm 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 SPIN-IN COLLARS**

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

## **PART 3 - EXECUTION**

### **3.1 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 Allow for slack material in flexible connection.
- .2 Access doors and viewing panels:
  - .1 Size:
    - .1 600 mm x 600 mm for person size entry.
    - .2 450 mm x 450 mm for servicing entry.
    - .3 300 mm 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 Reheat coils.
    - .6 Elsewhere as indicated.
- .3 Instrument test ports.
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations.
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and submain ducts.
      - .4 And as indicated.

- .2 For temperature readings:
  - .1 At outside air intakes.
  - .2 In mixed air applications in locations as approved by Department Representative.
  - .3 At inlet and outlet of coils.
  - .4 Downstream of junctions of two converging air streams of different temperatures.
  - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

**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, V-groove 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 must be vibration free.
- .6 Confirm damper operators are observable and accessible.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 REFERENCES**

- .1 Section 01 33 00 Submittal Procedures.

### **1.2 REFERENCES**

- .1 National Fire Protection Association (NFPA)
  - .1 NFPA 90A-2016, Installation of Air Conditioning and Ventilating Systems.
  - .2 NFPA 90B-2016, 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/ULCS110-07, Fire Tests for Air Ducts.
  - .2 UL 181-2013, Factory Made Air Ducts and Connectors.

### **1.3 PRODUCT DATA**

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

### **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.

### **1.5 SAMPLES**

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

## **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 Noncollapsible, 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 3 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.
  - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Duct Diam.	Frequency (Hz)				
	125	250	500	1000	2000
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 shall have no more than a 15° offset and must have a minimum of two (2) hangers.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Commissioning: Section 01 91 00
- .2 Duct Accessories: Section 23 33 00

### **1.2 REFERENCES**

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

### **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 78 00.
- .2 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 to 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.

**COMMISSIONING**

- .7 Do commissioning in accordance with Section 01 91 13 - Commissioning.

**END OF SECTION**

## **PART 1 - GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Submittal Procedures: Section 01 33 00
- .2 Quality Control: Section 01 45 00
- .3 Closeout Submittals: Section 01 78 00
- .4 Commissioning: Section 01 91 13
- .5 Control System: Division 25

### **1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI/ASHRAE 51/AMCA 210-2007, Laboratory Methods of Testing Fans for Rating.
  - .2 ANSI/NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .2 International Organization of Standardization (ISO)
  - .1 ISO 3741-2010, Acoustics Determination of Sound Power Levels of Noise Sources Using Sound Pressure Precision Methods for Reverberation Rooms.
- .3 Underwriter's Laboratories (UL)
  - .1 UL 181-2005, Factory-Made Air Ducts and Air Connectors.

### **1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Pressure drop.
  - .3 Noise rating.
  - .4 Leakage.
  - .5 Dimensions.

### **1.4 SAMPLES AND MOCK-UPS**

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

## **1.5 TEST REPORTS**

- .1 To ANSI/ASHRAE 51/AMCA 210. Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity. Sound power level with minimum inlet pressure of 0.25 kPa in accordance with ISO 3741 for 2nd through 7th octave band, by independent testing agency. Pressure loss through silencer must not exceed 60% of inlet velocity pressure maximum.

## **1.6 CLOSEOUT SUBMITTALS**

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

## **1.7 CERTIFICATION**

- .1 Catalogued or published ratings must be those obtained from tests carried out by manufacturer or those ordered by him from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

## **1.8 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.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURED UNITS**

- .1 Terminal units of the same type to be product of one (1) manufacturer.

### **2.2 VARIABLE VOLUME BOXES**

- .1 Pressure independent factory reset to air flow between minimum and maximum air volume.
- .2 Sizes, capacities, differential pressures and sound ratings: as indicated in schedule.
- .3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.
- .4 Sound ratings of assembly not to exceed 35 NC at 750 Pa. Use sound attenuator if necessary to achieve rating.

- .5 Complete with:
  - .1 Operator and controller: as specified under Division 25.
  - .2 Multiport outlet adapter: as indicated.
  - .3 Reheat coil: as indicated.
- .6 Minimum 35 kPa reset span for pneumatic controllers.
- .7 Adjustable reset start point.
- .8 Operator to be factory or field mounted and calibrated where indicated.
  - .1 Gauge taps for balancing with standard pressure gauge.
  - .2 Controller to have adjustable flow settings.
- .9 Casing: constructed of 0.75 mm thick galvanized steel, internally lined with 25 mm, 0.7 kg density fibrous glass, to UL181 and ANSI/NFPA 90A. Mount control components inside protective metal shroud.
- .10 Damper: galvanized steel with peripheral gasket and self-lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install a minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate controls, dampers and access panels for easy access.

#### **3.2 COMMISSIONING**

- .1 Do commission in accordance with Section 01 91 13.

**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 PRODUCT DATA**

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

### **1.3 SAMPLES**

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

### **1.4 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.

### **1.5 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 or as directed by Departmental Representative.

### **2.2 MANUFACTURED UNITS**

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

### **2.3 SUPPLY GRILLES AND REGISTERS**

- .1 See Schedule.

### **2.4 RETURN AND EXHAUST GRILLES AND REGISTERS 2.5 DIFFUSERS**

- .1 See Schedule.
- .2
- .3 See Schedule.

### **2.5 LINEAR GRILLES**

- .1 See Schedule.

## **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 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere.

**END OF SECTION**

## **PART 1- GENERAL**

### **1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 01 91 13 – Commissioning (Cx) Requirements.

### **1.2 DESCRIPTION**

- .1 Provide all horizontal water source heat pumps and accessories required to complete the building closed loop heat pump system.

### **1.3 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings in accordance with Sections 01 33 00 - Submittal Procedures.
- .2 Indicate:
  - .1 Capacities.
  - .2 ARI Ratings.
  - .3 Sound Power levels.
  - .4 Installation instructions.
  - .5 Start-up Instructions.
  - .6 O&M, Instructions.

### **1.4 REFERENCES**

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
  - .1 ANSI/NFPA 90A-2016, Installation of Air Conditioning and Ventilating Systems.
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 15-2013, Safety Code for Mechanical Refrigeration System and Classification of Refrigerants.
- .3 Canadian Standards Association (CSA)
  - .1 CAN/CSA-C656-14, Performance Standard for Split-System Central Air-Conditioners and Heat Pumps.
  - .2 CAN/CSA-13256-2-01(R2015), Water Source Heat Pumps – Testing and Rating for Performance – Part 2: Water to Water and Brine to Water Heat Pumps.
- .4 Environment Canada
  - .1 EPS 1/RA/2, Code of Practice for the Reduction of Chlorofluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

- .2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.
- .5 ETL Listing Laboratories (ETL).

## **1.5 TRAINING**

- .1 Provide training in accordance with Section 01 79 00.

## **PART 2- PRODUCTS**

### **2.1 WATER TO AIR HORIZONTAL OR VERTICAL MOUNTED HEAT PUMPS**

- .1 General: furnish and install geothermal range Water Source Heat Pumps as described herein and as shown on the plans. Each unit must be CSA listed. Each unit must be fully run tested at the factory. Heat pump must be capable of operating in heating mode down to 4°C supply temperature and up to 43°C supply temperature in cooling mode.
- .2 Casing and Cabinet: fabricated from heavy-gauge G-60 galvanized steel. Interior to be insulated with 12 mm thick, 0.68 kg. coated glass fiber. Panels shall provide access to the fan compartment and the compressor/control box compartment. Unit to have an insulated panel separating the fan compartment from the compressor compartment. Unit to have a 25 mm thick throwaway filter and a factory installed combination filter rack/return air duct collar. The filters must be able to be removed from the side. Unit to have a galvanized steel painted drain pan with a drain connection extending through the unit casing. Cabinet shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections to be copper female NPT fittings and shall protrude through the cabinet for connection to a flexible hose. Supply unit with heavy metal brackets, rubber isolators, fasteners and washers to suspend and isolate the unit from the building structure.
- .3 Refrigerant Circuit: each unit must have a sealed R-410A refrigerant circuit including a hermetic compressor, capillary expansion tubes, finned tube heat exchanger, reversing valve, water-to-refrigerant coaxial heat exchanger, access valves, and safety controls. Compressor to be hermetic type with external vibration or spring mounts and thermal overload protection. Finned tube coil to be constructed of aluminum fins bonded to copper tubes. Coaxial heat exchanger to be constructed of a copper inner tube and a steel outer tube and be UL listed. The heat exchanger must be rated for 2756 kPa on the water side and 3100 kPa on the refrigerant side. Safety controls to include a low suction temperature (freezestat) switch, a high refrigerant pressure switch to lock out compressor operation. Condensate pan overflow switch, dirty filter indicator and general unit alarm. A low pressure switch will not be permitted to replace a low suction temperature switch for freeze protection. Units must be capable of being reset only by interrupting the power supply to the unit. Unit must not be able to be reset from the wall thermostat. Unit shall be capable of starting in an ambient of 4.4°C with both air and water flow rates at the Standard rating conditions.
- .4 Electrical: locate within the unit and include controls for compressor, reversing valve and fan motor operation and have a 50 VA transformer, circuit breaker in the low voltage circuit, and a terminal block for low voltage field wiring connections. The unit must also have a dirty filter switch and a condensate overflow sensor. Provide nameplate for the unit to accept time delay fuses or HACR circuit breaker for branch overcurrent protection

of the power source. Supply the unit with a low voltage terminal strip for control wiring connections to the DDC system. The following controls must be available at the terminal strip:

- .1 Cooling Operation
- .2 Heating Operation
- .3 Fan Only Operation
- .4 Supply Fan Status
- .5 Condensate Overflow

Unit control system to provide heating or cooling as required by the setpoints of the wall thermostat. Unit control scheme to provide for fan operation simultaneous with compressor operation (fan interlock) regardless of the thermostat type.

- .5 Fan and Motor Assembly: each unit must have a direct drive centrifugal fan. Fan housing to have a removable orifice ring to facilitate fan motor and fan wheel removal. Fan housing to protrude through the cabinet to facilitate field duct connection. Fan motor to be a multi-speed, PSC type with integral mounting brackets isolated from the fan housing and thermal overload protection. Units above 3.5 kW (one ton) must have a terminal strip mounted on the fan motor to facilitate motor speed change. Units to have a straight-through or right-angle discharge air arrangement and be able to be field converted from one to the other without the use of additional parts.
- .6 Control System: self-contained deluxe microprocessor based control system. Unit control logic to provide heating and cooling operation as signaled by the DDC System.
- .7 Extra-quiet Construction: unit to have additional isolation under the compressor for reduced sound/vibration transmission.
- .8 Flexible Hoses: supply each unit with two (2) 600 mm long fire rated flexible hoses with ASTM ratings of Flame Spread 25, Fuel Contribution 25 and Smoke Density 50 for connection to unit and field piping.
- .9 Valves: supply each unit with two (2) combination balancing and shutoff valves with adjustable memory stop.
- .10 Solenoid Valve: supply each unit with an electric slow closing solenoid valve.
- .11 One-Inch Filter Rack: supply each unit with a return air duct collar/25 mm filter rack to accept a return air duct connection and a 25 mm thick filter.
- .12 Pleated Filter-Each unit shall have a pleated filter for 30% efficiency.
- .13 Standard of Acceptance: McQuay, Water Furnace, Carrier, Trane.

## **PART 3 - EXECUTION**

### **3.1 HEAT PUMP INSTALLATION**

- .1 Install ceiling heat pumps in accordance with the manufacturer's recommendations.

- .2 Be aware the ceiling space is limited and the size of the unit and condensate piping route to have particular attention paid to it, with regard to placement.
- .3 The final arrangement of each heat pump must allow easy access to all service panels and allow filter removal.
- .4 Provide all wiring and refrigerant tubing as required to connect solenoid valve and water regulating valve.
- .5 Adjust water regulating valve for correct head pressures.
- .6 Provide detailed start-up reports for each heat pump to be completed by manufacturer trained service technicians.

**END OF SECTION**