

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-2011, 3rd Edition, Environmental Standard for Paints and Coatings.
- .3 National Fire Code of Canada (NFCC 2005)
- .4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards.
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

**1.2 ACTION AND
INFORMATIONAL
SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 DELIVERY,
STORAGE AND
HANDLING**

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

Disposal.

Part 2 Products

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Primers, paints and coating in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11 or to SCAQMD Rule 1113.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 or to SCAQMD Rule 1113.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168 or to GSES GS-36.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168 or to GSES GS-36.
- .4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 or to GSES GS-36.
- .5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

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

3.3 CLEARANCES

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

3.4 DRAINS

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

3.5 AIR VENTS

- .1 Install air vents to at high points in piping systems.
- .2 Install isolating valve at each automatic air vent.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow

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

lines on discharge of pumps and as indicated.

3.8 SLEEVES

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

3.9 ESCUTCHEONS

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

sleeve.

- .1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .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 fire stopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.

- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276-16, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-15, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-14a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-14, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 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.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data

Sheets in accordance with Section
02 81 01 - Hazardous Materials.

.3 Shop Drawings:

- .1 Submit shop drawings in PDF format.
- .2 Submit data for valves specified in this Section.

**1.3 CLOSEOUT
SUBMITTALS**

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

**1.4 MAINTENANCE
MATERIAL
SUBMITTALS**

.1 Extra Materials/Spare Parts:

- .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
- .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

**1.5 DELIVERY,
STORAGE AND
HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.

- .2 Bonnet: union with hexagonal shoulders.
- .3 Connections: screwed with hexagonal shoulders.
- .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
- .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .7 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders and solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to

body.

- .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
- .7 Stem seal: TFE with external packing nut.
- .8 Operator: removable lever handle.

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.

3.2 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-84(2014), Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in PDF format.
 - .2 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.

	.3	Structural assemblies.
	.4	Certificates:
	.1	Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
	.5	Manufacturers' Instructions:
	.1	Provide manufacturer's installation instructions.
	.1	Departmental Representative will make available 1 copy of systems supplier's installation instructions.
1.3 CLOSEOUT SUBMITTALS	.1	Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
1.4 DELIVERY, STORAGE AND HANDLING	.1	Deliver, store and handle materials in accordance with manufacturer's written instructions.
	.2	Delivery and Acceptance Requirements:
	.1	Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
	.3	Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
Part 2 Products		
2.1 SYSTEM DESCRIPTION	.1	Design Requirements:
	.1	Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
	.2	Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
	.3	Ensure that supports, guides, anchors do

not transmit excessive quantities of heat to building structure.

- .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of composite wood beam:
 - .1 Pipes and ducts transverse to joists: screwed fasteners to underside of bottom flange.
 - .2 Pipes and ducts within joist cavity: screwed fasteners to face of web.
- .3 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies: 25 x 25 hot dip galvanized unistrut.
 - .2 Steel brackets: 25 x 25 hot dip galvanized unistrut.
- .4 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.
- .5 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.

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- .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
 - .6 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
 - .7 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper pipework: epoxy coated with formed portion plastic coated.
- 2.4 RISER CLAMPS**
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- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.
 - .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
 - .3 Bolts: to ASTM A307.
 - .4 Nuts: to ASTM A563.
- 2.5 INSULATION PROTECTION SHIELDS**
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- .1 Insulated cold piping:
 - .1 64 kg/m3 density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
 - .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.
- 2.6 EQUIPMENT SUPPORTS**
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- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings.
- 2.7 EQUIPMENT**
- .1 Provide templates to ensure accurate location

**ANCHOR BOLTS AND
TEMPLATES**

of anchor bolts.

**2.8 HOUSE-
KEEPING PADS**

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

**2.9 OTHER
EQUIPMENT
SUPPORTS**

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

**3.1 MANUFACTURER
'S INSTRUCTIONS**

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

3.3 HANGER SPACING

- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

- .1 Plumbing piping: to Canadian Plumbing Code.
- .2 Fire protection: to applicable fire code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .5 Within 300 mm of each elbow.

Maximum Pipe Size :	NPS	Maximum Spacing	Steel
up to 1-1/4	2.4 m		1.8 m
1-1/2	3.0 m		2.4 m
2	3.0 m		2.4 m
2-1/2	3.7 m		3.0 m
3	3.7 m		3.0 m

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.

.2 Adjustable clevis:

- .1 Tighten hanger load nut securely to ensure proper hanger performance.
- .2 Tighten upper nut after adjustment.

3.7 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management

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

- .2 Dispose of unused paint or coating material at official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused paint or coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

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

2.2 SYSTEM NAMEPLATES

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

Size #	mm	Sizes (mm)	No. of Lines	Height
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.

.5 Identification for PWGSC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

2.3 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm

- high.
- .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
- .1 To full circumference of pipe or insulation.
- .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
- .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
- .2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:
- | Background colour: | Legend, arrows: |
|--------------------|-----------------|
| Yellow | BLACK |
| Green | WHITE |
| Red | WHITE |
- .3 Background colour marking and legends for piping systems:
- | Contents | Background colour marking |
|--|---------------------------|
| ** Add design temperature | |
| ++ Add design temperature and pressure | |
| Well water | Green WELL WATER |
| Domestic hot water supply | Green |
| Dom. HWS recirculation | Green |
| Domestic cold water supply | Green |
| Storm water | Green STORM |
| Sanitary | Green SAN |
| Plumbing vent | Green SAN. VENT |
| Refrigeration suction | Yellow |
| Refrigeration liquid | Yellow REF. LIQUID |

2.4 IDENTIFICATION DUCTWORK SYSTEMS	.1	50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
	.2	Colours: back, or co-ordinated with base colour to ensure strong contrast.
2.5 VALVES, CONTROLLERS	.1	Brass tags with 12 mm stamped identification data filled with black paint.
	.2	Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.
2.6 CONTROLS COMPONENTS IDENTIFICATION	.1	Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
	.2	Inscriptions to include function and (where appropriate) fail-safe position.
2.7 LANGUAGE	.1	Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS	.1	Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
3.2 TIMING	.1	Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.
3.3 INSTALLATION	.1	Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
	.2	Provide ULC or CSA registration plates as required by respective agency.
	.3	Identify systems, equipment to conform to PWGSC PMSS.

3.4 NAMEPLATES

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

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in mechanical room and basement: at not more than 3 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and

dirt.

- | | | |
|------------|-----------------|--|
| 3.6 | CLEANING | |
|------------|-----------------|--|
-
- | | |
|----|--|
| .1 | Proceed in accordance with Section 01 74 11 - Cleaning. |
| .2 | Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment. |

END OF SECTION

Part 1 General

1.1 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Departmental Representative within 60 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC,

NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.2 PURPOSE OF TAB

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

1.3 EXCEPTIONS

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

1.4 CO- ORDINATION

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

1.5 PRE-TAB REVIEW

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

accessories, measurement ports and fittings.

1.6 START-UP

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

**1.7 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.

1.8 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 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.
	.3	Liquid systems:
	.1	Flushed, filled, vented.
	.2	Correct pump rotation.
	.3	Strainers in place, baskets clean.
	.4	Isolating and balancing valves installed, open.
	.5	Calibrated balancing valves installed, at factory settings.
	.6	Chemical treatment systems complete, operational.
1.9 APPLICATION TOLERANCES	.1	Do TAB to following tolerances of design values:
	.1	HVAC systems: plus 10 %, minus 10 %.
1.10 ACCURACY TOLERANCES	.1	Measured values accurate to within plus or minus 2 % of actual values.
1.11 INSTRUMENTS	.1	Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
	.2	Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
	.3	Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.
1.12 ACTION AND INFORMATIONAL SUBMITTALS	.1	Submit, prior to commencement of TAB:
	.2	Proposed methodology and procedures for performing TAB if different from referenced standard.
1.13 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.

1.14 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit pdf copy of TAB Report to Departmental Representative for verification and approval, in English.

1.15 VERIFICATION

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

1.16 SETTINGS

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

1.17 COMPLETION OF TAB

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

1.18 AIR SYSTEMS

- .1 Standard: TAB to most stringent of TAB standards of AABC or NEBB.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:
 - .1 HRV-1
- .3 Qualifications: personnel performing TAB

current member in good standing of AABC or NEBB.

- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.19 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Laboratory fume hoods:
 - .1 Standard: Canada Labour Code state applicable Provincial or other standard.
 - .2 TAB procedures: as described in standard.
- .3 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.

1.20 POST-OCCUPANCY TAB

- .1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED .1 Not used.

Part 3 Execution

3.1 NOT USED .1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 For purposes of this section:

- .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
- .2 "EXPOSED" - means "not concealed" as previously defined.
- .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

- .1 CRD: Code Round Ductwork,
- .2 CRF: Code Rectangular Finish.

.2 Reference Standards:

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

- .1 ANSI/ASHRAE/IESNA 90.1-13, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

- .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- .2 ASTM C335-10a¹, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
- .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M-13, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C547-15, Standard

- Specification for Mineral Fiber Pipe Insulation.
- .6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .8 ASTM C795-13, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .9 ASTM C921-15, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-13, Commercial Adhesives.
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-11, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 ACTION AND

- .1 Provide submittals in accordance with Section

**INFORMATIONAL
SUBMITTALS**

01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

.3 Shop Drawings:

.1 Provide shop drawings in PDF format.

.4 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, cleaning procedures.

**1.3 QUALITY
ASSURANCE**

.1 Qualifications:

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

**1.4 DELIVERY,
STORAGE AND
HANDLING**

.1 Deliver, store and handle in accordance with manufacturer's requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

.3 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND

.1 To CAN/ULC-S102:

SMOKE RATING

- .1 Maximum flame spread rating: 25.
- .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

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.
 - .1 Maximum VOC limit 200 g/L to SCAQMD Rule 1168 or GSES GS-36.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
 - .1 Maximum VOC limit 170 g/L to SCAQMD Rule 1168 or GSES GS-36.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging

adhesive to ASTM C921.

- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m2.
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
 - .1 Maximum VOC limit 200 g/L to SCAQMD Rule 1168 or GSES GS-36.
- .8 Canvas adhesive: washable.
 - .1 Maximum VOC limit 200 g/L to SCAQMD Rule 1168 or GSES GS-36.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on both faces of insulation.
- .12 Fasteners: 2 mm diameter pins with 35 mm square clips, length to suit thickness of insulation.

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE- INSTALLATION REQUIREMENTS

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

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.

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

**3.4 DUCTWORK
INSULATION
SCHEDULE**

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

Application	TIAC Code	Vapour Retarder	Thickness
Rectangular cold and dual temperature supply air ducts	C-1	yes	25
Round cold and dual temperature supply air ducts	C-2	yes	25
Supply, return and exhaust ducts exposed in space being served		none	
Outside air ducts to mixing plenum			C-1
Mixing plenums	C-1		yes
Exhaust duct between dampers and louvres			C-1
Acoustically lined ducts		none	

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

- .1 Finishes: conform to following table:

Application	TIAC Code	
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room		CRF/1
Indoor, exposed elsewhere		CRF/2
Outdoor, exposed to precipitation		CRF/3
Outdoor, elsewhere	CRF/4	CRD/5

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 -
Cleaning.
 - .1 Remove surplus materials, excess
materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials
for recycling in accordance with Section
01 74 21 - Construction/Demolition Waste
Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-13, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-10a, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-13, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-2013, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-2015, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795-13, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921-15, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)

- .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
- .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-11, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-14, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-10, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.2 DEFINITIONS

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

characteristics, performance criteria,
and limitations.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Shop Drawings:

- .1 Submit shop drawings in PDF format in accordance with Section 01 33 00 - Submittal Procedures.

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

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.4 QUALITY
ASSURANCE**

.1 Qualifications:

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

.3 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

**1.5 DELIVERY,
STORAGE AND
HANDLING**

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 or ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702 or ASTM C547.

2.3 INSULATION SECUREMENT	.1	Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
	.2	Contact adhesive: quick setting.
	.3	Canvas adhesive: washable.
	.4	Tie wire: 1.5 mm diameter stainless steel.
	.5	Bands: stainless steel, 19mm wide, 0.5 mm thick.
2.4 CEMENT	.1	Thermal insulating and finishing cement:
	.1	Hydraulic setting on mineral wool, to ASTM C449/C449M.
2.5 VAPOUR RETARDER LAP ADHESIVE	.1	Water based, fire retardant type, compatible with insulation.
2.6 INDOOR VAPOUR RETARDER FINISH	.1	Vinyl emulsion type acrylic, compatible with insulation.
2.7 OUTDOOR VAPOUR RETARDER FINISH	.1	Vinyl emulsion type acrylic, compatible with insulation.
	.2	Reinforcing fabric: fibrous glass, untreated 305 g/m2.
2.8 JACKETS	.1	Polyvinyl Chloride (PVC):
	.1	One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
	.2	Colour: white.
	.3	Minimum service temperatures: -20 degrees C.
	.4	Maximum service temperature: 65 degrees C.
	.5	Moisture vapour transmission: 0.02 perm.
	.6	Thickness: 1 mm.
	.7	Fastenings:
	.1	Use solvent weld adhesive compatible with insulation to seal laps and joints.
	.2	Tacks.
	.3	Pressure sensitive vinyl tape of

matching colour.

.2 Canvas:

- .1 220 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

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

3.3 INSTALLATION

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

3.4 PIPING INSULATION SCHEDULES

- .1 Includes piping, valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 Hot Piping.
 - .1 Securements: Tape at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 Cold Piping.
 - .1 Securements: Tape at 300 mm on centre.
 - .2 Seals: Vapour retarder lap seal adhesive, Vapour retarder lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation as listed in following table.

.1	Run-outs to individual units and equipment not exceeding 4000 mm long.
.2	Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe si
	to 1	1 1/4 to 2	2 1/2
to 4	5 to 6	8	
Run out up to 175	A-1	38	50 65
Domestic HWS	A-1	25	25 38
Domestic CWS	N/A	A-3	25 25
Domestic CWS with vapour retarder			N/A C-2
Refrigerant	N/A	A-6	25 25
RWL and RWP	N/A	C-2	25 25
Cooling Coil cond. drain		N/A	C-2 25
- .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 A-3 insulation compatible with insulation.
 - .5 Installation: to appropriate TIAC code CRF/1 through CPF/5.

- | | | |
|------------|-----------------|--|
| 3.5 | CLEANING | |
|------------|-----------------|--|
-
- | | |
|----|--|
| .1 | Proceed in accordance with Section 01 74 11 - Cleaning. |
| .2 | Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment. |

END OF SECTION

PART 1 GENERAL

**1.1 RELATED
REQUIREMENTS**

- .1 Section 23 05 05 - Installation of Pipework.
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 ASME
 - .1 ASME B16.22-13, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-11, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-13, Refrigeration Piping and Heat Transfer Components.
- .2 ASTM International
 - .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .2 ASTM B280-13, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 CSA Group
 - .1 CSA B52-13, B52 Package, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

**1.3 ADMINISTRATIVE
REQUIREMENTS**

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning on-site installation,

with Departmental Representative in
accordance with Section 01 31 19 -
Project Meetings to:

- .1 Verify project requirements.
- .2 Review installation and substrate conditions.
- .3 Co-ordination with other building construction subtrades.
- .4 Review manufacturer's written installation instructions and warranty requirements.

**1.4 ACTION AND
INFORMATIONAL
SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.5 CLOSEOUT
SUBMITTALS**

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

maintenance manual.

**1.6 DELIVERY,
STORAGE AND
HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, well-ventilated area.
 - .2 Store and protect refrigerant piping, fittings and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling of all packaging.

PART 2 PRODUCTS

2.1 TUBING

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

2.2 FITTINGS

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 15% Ag-80% Cu-5%P copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.

- .2 Gaskets: suitable for service.
- .3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

- .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 JOINTS

- .1 Brazing materials shall be SIL-FOS-15 phosphor-copper-silver alloy for copper piping jointed by copper fittings and silver solder for brass fittings.
- .2 Flexible connections: NPS3/8 nominal or less shall be made using coiled soft copper tubing. For larger sizes, use seamless flexible bronze hose with bronze wire braid covering. Use factory sealed neoprene jacket unit where freezing may occur.

2.4 PIPE SLEEVES

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

2.5 VALVES

- .1 Shut-Off Valves:
 - .1 Line size; selected for low pressure drop.
 - .1 22 mm and under: Class 500, 3.5 MPa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
 - .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.
- .2 Solenoid Valves:
 - .1 With field replaceable coil, serviceable without removing valve from line.
 - .2 Coil voltage to suit field requirements.

-
- .3 Provide upstream of thermostatic expansion valves.
 - .3 Expansion Valves:
 - .1 Thermostatic type with external equalizer, adjustable superheat setting, capacity and bulb charge to suit operating conditions.
 - .4 Charging and Purging Valves
 - .1 Valves to be the same size as line size into which they are connected or 12 mm whichever is the larger.
 - .2 Valve complete with a removable seal cap chained to the valve body.
-
- 2.6 SIGHT GLASS**
-
- .1 Provide sight glass in liquid line following filter drier.
 - .2 Sight glass shall be combination moisture-liquid indicator and with a protective removable cap.
 - .3 Sight glass to be fitted in-line.
-
- 2.7 ACCESS FITTINGS**
-
- .1 Provide brass access fittings in each suction connection from an evaporator, located adjacent to the superheat sensing element of the expansion valve.
 - .2 Fittings to be used for checking the superheat of the suction gas.
 - .3 Access fitting shall be soldered into a tee and shall be complete with a quick-seal cap.
-
- 2.8 FILTER DRIERS**
-
- .1 Provide a filter drier in the liquid line from the condenser. Shut-off valves shall be installed on each side of drier and sight glass.
 - .2 Filter drier shall be selected to have a pressure drop of not more than 13 kPa when passing 150% of the system flow rate.
 - .3 Removable core with flare connections.
 - .4 Desiccant drier material shall be replaceable.

**2.9 REFRIGERANT
DRIERS**

- .1 Driers shall be in-line or angle type with copper or brass shell.
- .2 Desiccant drier material shall be replaceable.

2.10 STRAINERS

- .1 Refrigerant strainers shall be angle replaceable cartridge type with brass shell.
- .2 Cartridge material and screen size shall be suitable for refrigerant and piping material utilized in the system.

**2.11 EVAPORATOR
DRAINS**

- .1 Each evaporator shall be fitted with a copper drain line, size as shown.
- .2 Drain line shall be complete with a running trap.

**2.12 FLEXIBLE
CONNECTIONS**

- .1 Braided tin-bronze convoluted flexible connections.
- .2 Design pressure 2070 kPa.

**2.13 REFRIGERANT
TUBE SUPPORTS**

- .1 Middle Attachments (Rod):
 - .1 Carbon steel black (electro-galvanized for mechanical rooms) continuous threaded rod.
- .2 Pipe Hangers:
 - .1 Maximum horizontal pipe hanger spacing:

Pipe Size	Maximum Spacing	Rod Diameter
up to NPS ¾	1.5 m	10 mm
NPS 1 & NPS 1¼	1.8 m	10 mm
- .3 Wall Supports:
 - .1 Comply with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .2 Outdoors: Stainless steel unistrut with cushion clamps.
 - .3 Indoors: Galvanized steel unistrut with cushion clamps.
- .4 Note:
 - .1 On insulated piping, where the insulation is specified to have a

continuous sealed vapour barrier, (cold services) install oversized clevis hangers and insulation protection shields.

- .2 Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).
- .3 Cold Services include refrigerant suction lines.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 GENERAL

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05 - Installation of Pipework and Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

3.4 INSTALLATION

- .1 Refrigerant Tubing:
 - .1 Fittings shall be "Sil-Fos" brazed or silver soldered as specified. Lead

-
- solder will not be permitted. Special precautions shall be taken to prevent the overheating of copper tube. Joints shall be made with a pressurized nitrogen flow through the joint.
- .2 Tubing shall be cut square and have all burrs removed.
 - .3 Piping shall be kept meticulously clean. All cleaned piping in the process of erection, whether installed or awaiting installation shall be capped or plugged.
 - .4 Piping shall be installed in true vertical and horizontal planes close to walls and ceilings, with specified pitch. Provide suitable offsets to account for expansion.
 - .5 Piping connections to equipment and terminal apparatus shall be supported independently and arranged to give easy access for maintenance.
 - .6 Provide rubber grommets where refrigerant piping passes through a metal surface.
 - .7 Grade horizontal pipe carrying gases 1:240 down in direction of flow.
 - .8 Locate double risers in hot gas or suction piping as required.
 - .9 Locate trap every 4.5 m of vertical rise in any suction riser 9 m or more in length.
 - .10 Install piping to prevent condensate or oil from flowing back into compressor or evaporator.
- .2 Strainers:
- .1 Provide full size strainer ahead of each automatic valve. Where multiple expansion valves with integral strainers are used, install single main liquid line strainer.
 - .2 On steel piping systems provide adequate strainer in suction line to remove scale and rust inherent in steel pipe.
 - .3 Provide shut-off valve on each side of strainer to facilitate maintenance.
- .3 Refrigerant Driers:
- .1 Provide full flow permanent refrigerant

-
- drier in low temperature systems and systems utilizing hermetic compressors.
 - .2 Mount drier vertically in liquid line adjacent to receiver with three valve bypass assembly to permit isolation of drier for servicing.
 - .4 Filter Driers:
 - .1 Filter-driers may be used in systems instead of separate strainers and driers.
 - .2 Install with three valve bypass assembly to permit isolation for servicing.
 - .5 Solenoid Valves:
 - .1 Provide solenoid valves in liquid line of system operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into suction line when system shuts down.
 - .2 Provide solenoid valves with manually operated stems.
 - .6 Expansion Valves:
 - .1 Size expansion valves properly to avoid penalty of being undersized at full load and of being excessively oversized at partial load.
 - .2 Properly evaluate refrigerant pressure drop through system to determine the available pressure drop across the valve.
 - .3 Select valves for maximum load at design operating pressure and minimum 42°C of superheat.
 - .4 Locate remote expansion valve sensing bulb immediately after evaporator outlet and suction line.
 - .7 Charging and Purging Valves:
 - .1 Provide refrigerant charging connections in liquid line between receiver shut-off valve and expansion valves.
 - .8 Flexible Connectors:
 - .1 In general install suction and hot

pipng connections to compressors with three directional changes for distance of minimum six pipe diameters before reaching point of support.

- .2 Flexible connectors shall only be utilized at or near compressor where it is not physically possible to absorb vibration within piping configuration.

3.5 PRESSURE AND LEAK TESTING

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

3.6 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 h.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 h.

- .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
- .5 Submit test results to Departmental Representative.

.7 Charging:

- .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
- .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
- .3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

- .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
- .2 Record and report measurements to Departmental Representative.

3.7 DEMONSTRATION

.1 Instructions:

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

3.8 CLEANING

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

- .1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

.3 Waste Management: separate waste materials for reuse or recycling.

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

appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM A480/A480M-15, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-15, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
 - .3 ASTM A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Green Seal Environmental Standards (GS)
 - .1 GS-36-13, Standard for Adhesives for Commercial Use.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-15, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-15, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 2007.
- .6 South Coast Air Quality Management District

(SCAQMD), California State, Regulation XI.
Source Specific Standards

.1 SCAQMD Rule 1168-A2005, Adhesives and
Sealants Applications.

**1.2 ACTION AND
INFORMATIONAL
SUBMITTALS**

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

.2 Product Data:

.1 Submit manufacturer's instructions,
printed product literature and data
sheets for metal ducts and include
product characteristics, performance
criteria, physical size, finish and
limitations.

.3 Shop Drawings:

.1 Submit shop drawings in PDF format.

.4 Test and Evaluation Reports:

.1 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.

.5 Sustainable Design Submittals:

.1 Construction IAQ Management Plan:

.1 Submit Indoor Air Quality (IAQ)
Plan for construction and pre-
occupancy phases of building.

.2 During construction meet or exceed
the requirements of SMACNA IAQ
Guideline for Occupied Buildings
Under Construction.

.3 During construction, all open ends
of ductwork shall be sealed with
plastic sheeting.

**1.3 DELIVERY,
STORAGE AND
HANDLING**

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

.2 Delivery and Acceptance Requirements: deliver
materials to site in original factory
packaging, labelled with manufacturer's name

and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
- .2 Seal classification:
 - .1 Class C: transverse joints and connections made air tight with gaskets or sealant or combination thereof. Longitudinal seams unsealed.
 - .2 Unsealed seams and joints.

2.2 SEALANT

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .2 Adhesives and sealants: VOC limit 70 g/L maximum to SCAQMD Rule 1168 or GS-36.
- .2 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 DUCT LEAKAGE

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

2.4 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: standard radius centreline radius: 1.0 times width of duct.
 - .2 Round: smooth radius centreline radius: 1.0 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.5 FIRE STOPPING

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

2.6 GALVANIZED STEEL

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

manufactured duct joint.

**2.7 STAINLESS
STEEL**

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: number 4.
- .3 Thickness, fabrication and reinforcement: to SMACNA as indicated.
- .4 Joints: to SMACNA and to be continuous inert gas welded.

**2.8 HANGERS AND
SUPPORTS**

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

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
 - .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

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

unacceptable conditions immediately upon discovery.

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

3.2 GENERAL

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

3.3 HANGERS

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

3.4 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.
 - .1 Weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.

- .3 Slope horizontal branch ductwork down towards fume hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve and discharging to open funnel drain.

3.5 SEALING AND TAPING

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

3.6 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 Do not install 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 degrees elbows.
- .6 Complete test before performance insulation or concealment Work.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at

appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2013.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling all packaging materials in

accordance with Section 01 74 21 -
Construction/Demolition Waste Management and
Disposal.

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 1.5 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 40 degrees C
to plus 90 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 sheet metal
thickness heavier, minimum 0.6 mm thick
complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of
same material as duct, one sheet metal
thickness heavier, minimum 0.6 mm thick
complete with sheet metal angle frame and 25
mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks
complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete
with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum
two sash locks.
 - .4 Hold open devices.

2.4 TURNING VANES

- .1 Factory or shop fabricated single thickness
for ducts up to 400 mm and double thickness
for ducts 401 mm and larger without trailing
edge, to recommendations of SMACNA and as

indicated.

**2.5 INSTRUMENT
TEST**

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

**2.6 SPIN-IN
COLLARS**

- .1 Not permitted.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 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 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Heating coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental 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.

3.3 CLEANING

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

.1 Leave Work area clean at end of each
day.

.2 Final Cleaning: upon completion remove
surplus materials, rubbish, tools and
equipment in accordance with Section 01 74 11
- Cleaning.

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

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2013.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling all packaging materials in

accordance with Section 01 74 21 -
Construction/Demolition Waste Management and
Disposal.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside 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.
- .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 EXAMINATION

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

instructions.

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

3.2 INSTALLATION

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

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-15, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .3 ULC-S505-2004, Standard for Fusible Links for Fire Protection Service.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for fire and smoke dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Fire stop flaps.
 - .3 Operators.
 - .4 Fusible links.
 - .5 Design details of break-away joints.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit

operation and maintenance data for fire and smoke dampers for incorporation into manual.

**1.4 MAINTENANCE
MATERIAL
SUBMITTALS**

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

**1.5 DELIVERY,
STORAGE AND
HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect fire and smoke dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type C, bearing label of ULC, meet requirements of authorities having jurisdiction and Fire Commissioner of Canada (FCC) and NFPA 90A. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

- .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
- .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Curtain 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 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption 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 Dampers shall be installed 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 Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 FIRE STOP FLAPS

- .1 Fire smoke flaps: ULC listed and labelled and fire tested in accordance with CAN/ULC-S112.2.
- .2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and

hinges.

- .3 Flaps held open with fusible link conforming to ULC-S505 and close at 74 degrees C.

Part 3 Execution

3.1 EXAMINATION

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

3.2 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 - Air Duct Accessories.
- .5 Co-ordinate with installer of fire stopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2005.
- .4 Underwriters' Laboratories (UL)
 - .1 UL 181-2005, Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-2007, Standard Methods of Tests for Air Ducts.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.

	.3	Test and Evaluation Reports:
	.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.
1.3 DELIVERY, STORAGE AND HANDLING	.1	Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
	.2	Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
	.3	Storage and Handling Requirements:
	.1	Store materials indoors, and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
	.2	Store and protect flexible ducts from nicks, scratches, and blemishes.
	.3	Replace defective or damaged materials with new.
	.4	Packaging Waste Management: remove for recycling all packaging materials.
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 NON-METALLIC - INSULATED	.1	Type 4: non-collapsible, coated mineral base fabric or aluminum foil/mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and vinyl reinforced mylar/neoprene laminate

jacket, as indicated.

.2 Performance:

- .1 Factory tested to 2.5 kPa without leakage.
- .2 Maximum relative pressure drop coefficient: 3.

Part 3 Execution

3.1 EXAMINATION

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

**3.2 DUCT
INSTALLATION**

- .1 Install in accordance with: CAN/ULC-S110, UL 181, NFPA 90A, NFPA 90B and SMACNA.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse or recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

Interpretive Center
Mary's Point, NB
R.076495.001

FLEXIBLE DUCTS

Section 23 33 46

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END OF SECTION

Part 1 General

**1.1 ACTION AND
INFORMATIONAL
SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

**1.2 MAINTENANCE
MATERIAL
SUBMITTALS**

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

**1.3 DELIVERY,
STORAGE AND
HANDLING**

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

- .2 Store and protect diffusers, registers and grilles from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

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

2.2 GENERAL

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

2.3 MANUFACTURED UNITS

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

2.4 SUPPLY GRILLES AND REGISTERS

- .1 S-2: heavy duty floor mounting frame with aluminum bar slats, 19 mm border, 0 degrees deflection, 6mm bars on 12mm spacing. Finish: mill.
- .2 Dimensions and capacities as indicated in

schedules on drawings.

**2.5 RETURN AND
EXHAUST GRILLES
AND REGISTERS**

- .1 R-1: aluminum, 32 mm border, aluminum, 200 x 200 mm with 12 x 12 x 12mm egg crate type face bars. Finish: white.
- .2 R-2: heavy duty floor mounting frame with aluminum bar slats, 19 mm border, 0 degrees deflection, 6mm bars on 12mm spacing. Finish: mill.
- .3 Dimensions and capacities as indicated in schedules on drawings.

2.6 DIFFUSERS

- .1 General: flat aperture type volume control dampers in areas without suspended ceilings and gaskets.
- .2 S-1: aluminum, square type, having fixed pattern, lay-in mounted. Finish: white.
- .3 Dimensions and capacities as indicated in schedules on drawings.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install with oval head, stainless steel screws in countersunk holes where fastenings

are visible.

- .3 Provide concealed safety chain on each area without suspended ceilings.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .3 Society of Automotive Engineers (SAE)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.
 - .4 Materials of construction.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name

and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM **DESCRIPTION**

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

2.2 FIXED **LOUVRES -** **ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm per section.
- .4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick mounting flange.
- .5 Mullions: at 1500 mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm exhaust and 19 mm intake mesh, 2 mm diameter stainless steel wire birdscreen

on inside face of louvres in formed U-frame.

- .8 Finish: anodized. Colour: to Departmental Representative's approval.
- .9 Refer to schedules on drawings for sizes.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 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.

3.3 CLEANING

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

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

END OF SECTION

PART 1 GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84-2013, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

**1.2 ACTION AND
INFORMATIONAL
SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in pdf format and obtain reviewed shop drawings prior to placing equipment orders.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test Reports:
 - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
 - .2 Provide confirmation of testing.
- .6 Manufacturers' Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

**1.3 MAINTENANCE
MATERIAL**

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

SUBMITTALS

- .2 Extra Materials:
 - .1 Furnish list of individual manufacturer's recommended spare parts for equipment include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .2 List of specialized tools necessary for adjusting, repairing or replacing.

**1.4 DELIVERY,
STORAGE AND
HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect energy recovery equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Comply with ASHRAE 84.

**2.2 ENTHALPY
TYPE AIR TO AIR
FIXED PLATE
EXCHANGER**

- .1 Tag numbers: HRV-1.
- .2 Capacity as indicated in schedules on drawings.
- .3 Double wall satin coated steel casing with hinged and gasketed access doors with camlocks.

- .4 HRV-1 supply and exhaust motors: TEFC, premium efficiency, variable speed with belt drive and factory mounted VFD's..
- .5 HRV-1 filter media: MERV 13.
- .6 Non-fused disconnect.
- .7 24 VAC transformer / relay package.
- .8 Energy recovery media: AHRI 1060 certified, non - metallic, heat and humidity transfer.
- .9 Zero percent cross contamination between supply and exhaust streams.
- .10 Factory mounted filter alarms.
- .11 Factory mounted isolation dampers on O/A and E/A duct collars.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of adjacent ductwork with flexible connections.
- .3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils and dampers.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 210/240-2008, Unitary Air Conditioning and Air-Source Heat Pump Equipment.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air-Conditioning Engineers (ANSI/ASHRAE)
 - .1 ANSI/ASHRAE Standard 15-2013, Safety Standard for Refrigeration Systems.
- .3 CSA International
 - .1 CAN/CSA-C656-05(R2010), Performance Standard for Split-System and Single Package Central Air Conditioners and Heat Pumps.
- .4 Environment Canada, (EC) / Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2-1996, Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada-1994, Ozone-Depleting Substances Alternatives and Suppliers List.
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2009, Standard for Installation of Air Conditioning and Ventilating Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat pumps and include product characteristics, performance

criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawing in pdf format and obtain approval from Departmental Representative prior to placing orders for equipment.

.2 Indicate on drawings:

- .1 Heating/cooling capacity.
- .2 Ambient conditions.
- .3 Electrical characteristics.
- .4 Dimensions.
- .5 Acoustical performance.
- .6 Materials of construction.

**1.3 CLOSEOUT
SUBMITTALS**

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for heat pumps for incorporation into manual.

**1.4 DELIVERY,
STORAGE AND
HANDLING**

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

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

- .1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect heat pumps from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for recycling all packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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- 1.5 WARRANTY** .1 For computer room air conditioning 12 months warranty period is extended to 60 months.

Part 2 Products

- 2.1 DESCRIPTION** .1 Heat pumps: to EPS 1/RA/2, CSA approved and with ARI or CSA certification seal.

- 2.2 REFRIGERANTS** .1 Type of Refrigerant: R-410A.

- 2.3 DRAIN PANS** .1 Design and construct condensate drain pans under indoor coils so that no water can accumulate and install to allow for easy cleaning.

- 2.4 PACKAGED AIR SOURCE HEAT PUMP** .1 General:
- .1 To consist of air-to-air outdoor unit and multiple DX fan coil indoor units, for use with R-410A.
 - .2 Performance data: as indicated.
 - .1 Electrical: 208 V / 3ph / 60 Hz.
 - .2 Cooling:
 - .1 Total: 21.1 kW minimum.
 - .2 Outdoor coil: 2916 L/s maximum EDBT 43 degrees C.
 - .3 EER: 3.7 kW per watt of input power minimum.
 - .4 COP: 3.8 minimum.
 - .3 Heating:
 - .1 Capacity: 23.4 kW minimum.
 - .2 Indoor coil: refer to schedule on drawings.
 - .3 Outdoor coil: 2916 L/s minimum EDBT -25 degrees C.
 - .4 Unit shall be capable of providing 100% of rated heating capacity down to -20 degrees C and 75% of rated heating capacity down to -25 degrees C outdoor ambient temperature.
 - .5 Total unit power input: 6.3 kW

- maximum.
- .6 Ratings: to ANSI/ARI 210/240.
- .7 Outdoor fan: 2916 L/s, 0.92 kW.
- .3 Outdoor unit: HP-1
 - .1 Variable refrigerant flow, inverter driven, semi-hermetic scroll compressor with crankcase heater, oil pump, internal and external current sensitive overload and over-temperature protection.
 - .2 Outdoor air fan: propeller type with vertical discharge, direct-driven from permanently lubricated motor.
 - .3 Coil: aluminum plate fins mechanically bonded to copper tubing with joints brazed.
 - .4 Mounted legs to elevate unit.
 - .5 Finish: Pre-coated, galvanized steel.
- .4 Indoor Evaporators: EV-1, 2, 3, & 4.
 - .1 Refer to schedule on drawing M-400.
- .5 Refrigeration piping:
 - .1 Between compressor, outdoor coil and indoor coils, complete with refrigerant metering devices and valves.
 - .2 Refer to Section 23 23 00 - Refrigerant Piping.
- .6 Controls and protective devices to include:
 - .1 High pressure stat, loss-of-charge pressure stat.
 - .2 Crankcase heater.
 - .3 Suction line accumulator.
 - .4 Pressure relief device.
 - .5 Short-cycle protection of compressor.
 - .6 Automatic defrost control based on liquid temperature.
 - .7 Defrost interlock relay to ensure only one heat pump can defrost.
- .7 Accessories:
 - .1 Programmable indoor heating/cooling thermostats.
 - .2 Outdoor thermostat.
 - .3 Refrigerant head pressure controls.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION

- .1 Install where indicated and in accordance with manufacturer's instructions.
- .2 Install outdoor units at ground level on reinforced concrete pad.
- .3 Secure with hold-down bolts in accordance with manufacturer's recommendations.
- .4 Make piping connections.
- .5 Nothing to obstruct ready access to components or to prevent removal of components for servicing.

3.3 DRAIN PANS

- .1 Install so that no water can accumulate. Arrange easy access for cleaning.
- .2 Include internal or external trap for proper draining.

3.4 START-UP AND COMMISSIONING

- .1 Have manufacturer certify installation.
- .2 Have manufacturer present during start-up to certify performance.
- .3 Submit written start-up and commissioning reports to Departmental Representative.

**3.5 CLOSEOUT
ACTIVITIES**

- .1 Manufacturer to deliver verbal and written instructions to operating personnel.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

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

END OF SECTION