

Part 1 General

1.1 USE OF SYSTEMS

- .1 Use of new and or existing permanent systems for supplying temporary heat or ventilation] is permitted only under following conditions:
 - .1 There is no possibility of damage.
 - .2 Supply ventilation systems are protected by 60% filters, inspected daily, changed every week or more frequently as required.
 - .3 Return systems have approved filters over openings, inlets, outlets.
 - .4 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
 - .5 Warranties and guarantees are not relaxed.
 - .6 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
 - .7 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

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 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 CLEARANCES

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

3.3 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 AIR VENTS

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

3.5 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.

3.6 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install 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.
- .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 and as required.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball valves at branch take-offs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .15 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.7 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:

- .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
- .2 Other floors: Terminate 25 mm above finished floor.
- .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

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

3.9 PREPARATION FOR FIRESTOPPING

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

3.10 FLUSHING OUT OF PIPING SYSTEMS

- .1 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.

3.11 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.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.12 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .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.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 GENERAL

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

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W (1/2 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 575 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

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

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

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

1.2 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified in this section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 MAINTENANCE

- .1 Extra Materials:

.2 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.

Part 2 Products

2.1 MATERIALS

.1 Valves:

- .1 Except for specialty valves, to be single manufacturer.
- .2 All products to have CRN registration numbers.

.2 End Connections:

- .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: Solder ends to ANSI/ASME B16.18.

.3 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.
- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:

- .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel.
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel.
- .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 PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.

- .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: Handwheel.
 - .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: Handwheel.
- .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.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .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.
 - .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
 - .1 NPS 2 and under:

- .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
- .2 Pressure rating: Class 125.
- .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
- .4 Disc and seat: renewable rotating disc.
- .5 Stainless steel spring, heavy duty.
- .6 Seat: regrindable.
- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class125, 860 kPa steam.
 - .3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
 - .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.

SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A125, Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563, Specification for Carbon and Alloy Steel Nuts.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP69, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)

1.2 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.

1.3 SUBMITTALS

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

- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

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

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut [UL listed] [FM approved].
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP69.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .7 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.

- .2 Attachments for copper piping: copper plated black steel.
- .3 Use insulation shields for hot pipework.
- .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69 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.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized 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.

2.4 INSULATION PROTECTION SHIELDS

- .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.

2.5 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

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

2.7 EQUIPMENT SUPPORTS

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

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 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.

2.10 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.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 vertical movement of pipework is 13 mm or more,
 - .2 transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 transfer of load to adjacent piping or to connected equipment is not critical.

- .2 variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Provincial Code.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

- .7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

3.7 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14, Standard for the Installation of Standpipe and Hose Systems.

1.2 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 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

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

- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

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:

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:

- .1 Terminal cabinets, control panels: use size # 5.
- .2 Equipment in Mechanical Rooms: use size # 9.
- .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 EXISTING IDENTIFICATION SYSTEMS

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

2.4 PIPING SYSTEMS GOVERNED BY CODES

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

2.5 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: 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 or 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	Legend
** Add design temperature		
++ Add design temperature and pressure		
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
No. [____]	Yellow	# [____] FUEL

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
fuel oil suction		OIL
No. [____]	Yellow	# [____] FUEL
fuel oil return		OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Natural gas	to Codes	
Propane	to Codes	
Sprinklers	Red	SPRINKLERS

2.6 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.

2.7 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.

2.8 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.

2.9 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 and 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 boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.

- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

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

3.7 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 GENERAL

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Names of personnel it is proposed to perform TAB to be submitted to and approved by Department Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.

1.3 PURPOSE OF TAB

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

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

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

1.6 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other

aspects of design and installation pertinent to success of TAB.

- .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

- .1 Notify Department Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere.
 - .4 All provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .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.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 10 %, minus 5 %.
 - .2 Hydronic systems: plus or minus 10 %.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

- .1 TAB report to show results in SI units and to include:
 - .1 Project record drawings.

.2 System schematics.

- .2 Submit 6 copies of TAB Report to Engineer for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

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

1.17 SETTINGS

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

1.18 COMPLETION OF TAB

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

1.19 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC.
- .2 Do TAB of systems, equipment, components, controls.
- .3 Qualifications: personnel performing TAB to be current member in good standing of AABC.
- .4 Quality assurance: Perform TAB under direction of supervisor qualified by AABC.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

- .6 Locations of equipment measurements: To include, but not be limited to, following 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, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 HYDRONIC SYSTEMS

- .1 Definitions: for purposes of this section, to include TAB on chilled water flows to relocated fan coils.
- .2 Standard: TAB to be to most stringent of this section or TAB standards of AABC.
- .3 Do TAB of systems, equipment, components, controls.
- .4 Qualifications: personnel performing TAB to be current member in good standing of AABC.
- .5 Quality assurance: Perform TAB under direction of supervisor qualified by AABC.
- .6 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, noise, vibration.
- .7 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of heat exchangers (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .8 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of primary and secondary loops (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

1.21 OTHER TAB REQUIREMENTS

- .1 Zone pressure differences:
 - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with all systems in all possible combinations of normal operating

modes. Adjust air flows in PSOHP clinic rooms to achieve negative pressure with respect to adjacent corridors. These rooms include:

- .1 IMMUNIZATION
- .2 CLINICAL EXAM
- .3 CLINICAL EXAM / FIT TO WORK INTERVIEW
- .4 TESTING AND LABELING OF ALL NEW FIRE DAMPERS

1.22 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 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual.

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.
 - .2 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.

- .6 Manufacturer's field reports specified.

1.3 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review Manufacturer's installation instructions and warranty requirements.
 - .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 TEST INSTRUMENTS

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- 3% of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .5 Re-calibrated every six months thereafter.

2.2 EQUIPMENT LEAKAGE TOLERANCES

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

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 TEST PROCEDURES

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

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Small duct systems up to 250 Pa: leakage 2%.
 - .2 VAV box and duct on downstream side of VAV box: leakage 2%.
 - .3 Large low pressure duct systems up to 500 Pa: leakage 2%.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

- .1 Test ducts before installation of insulation or other forms of concealment.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

- .4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services.
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.
- .2 Performance Verification:
 - .1 Departmental Representative to witness tests and to verify reported results.
 - .2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 CLEANING

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation Polyotrene, Boards and Pipe Covering.

1.2 DEFINITIONS

- .1 For purposes of this section:

- .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
- .2 "EXPOSED" - will mean "not concealed" as defined herein.
- .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
- .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.

1.3 SHOP DRAWINGS

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

1.4 SAMPLES

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

1.5 MANUFACTURERS' INSTRUCTIONS

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

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE AND HANDLING

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

- .4 Store at temperatures and conditions recommended by manufacturer.

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code 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.
 - .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.
- .3 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Stucco embossed.
 - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

- .1 Stainless steel:
- .5 Type: 304.
- .6 Thickness: 0.50 mm sheet.
- .7 Finish: Stucco embossed.
- .8 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/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
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of ductwork systems complete, witnessed and certified.

- .2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

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

3.3 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	Yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	50
Mixing plenums	C-1	Yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Rectangular	C-1	Weather proof	50

	TIAC Code	Vapour Retarder	Thickness (mm)
ducts outside Acoustically lined ducts			none

.2 HERE 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:

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Acronyms:

- .1 Cx - Commissioning.
- .2 CxA - Commissioning Agent

1.2 INTENT

- .1 Provide commissioning of HVAC equipment and systems in accordance with this, Section 01 91 13 and related sections.
- .2 All items noted in this document are the responsibility of the contractor supplying and installing the equipment, unless noted otherwise.

1.3 MANUFACTURER'S SERVICE ON SITE

- .1 Arrange and pay for qualified Manufacturer's representatives to supervise starting and testing of the following mechanical equipment and systems (if applicable):
 - .1 Exhaust Fans/Supply Fans/Transfer Fans
 - .2 VAVs
 - .3 Rooftop Unit
 - .4 Electric Reheat Coils
 - .5 Unit Heaters/Force Flow Heaters
 - .6 Fan Coils
 - .7 Electric Humidifier
 - .8 Split System A/C
- .2 Use manufacturers factory trained personnel where required to maintain manufacturer's warranty.
- .3 Maintain documentation of all equipment start-up and commissioning and provide to Commissioning Agent.

1.4 AIR & HYDRONIC SYSTEM TESTING, ADJUSTING & BALANCING

- .1 The Contractor will hire a Certified Balancing Agent for completion of the testing, adjusting and balancing of all air handling and hydronic systems as per Section 23 05 93.

Part 2 Products

2.1 Not Used

Part 3 Execution

3.1 GENERAL

- .1 Commission all equipment and systems installed as part of this contract. Typical required information or actions are listed below for each equipment or system.
- .2 Document the commissioning process by completing the Product Information (PI) forms, Performance Verification (PV) Tests and System PV Tests.
- .3 The following procedures noted below outline generally accepted good practices for HVAC equipment and systems. If these systems do not apply to this building project, then they are not applicable to commissioning.

3.2 HYDRONIC EQUIPMENT AND SYSTEMS - MISCELLANEOUS

- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
- .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 Confirm all gauges and thermometers can be read from the floor level and are installed and calibrated as recommended by Manufacturer
 - .2 Verify following equipment is installed as recommended by the Manufacturer.
 - .1 PRVs.
 - .2 Air eliminators.
 - .3 Strainers.
 - .4 Check valves.
 - .5 Balancing valves.
 - .6 Plumbing fixtures.
 - .7 Backflow preventers.
 - .8 Vacuum breakers.
 - .9 Bypass valves.

3.3 HYDRONIC EQUIPMENT AND SYSTEMS - SPLIT SYSTEM A/C

- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

- .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 No physical damage to the unit has occurred.
 - .2 Unit is clean and free of foreign debris.
 - .3 All bolts and screws are tight.
 - .4 All piping connections are properly installed.
 - .5 Vibration isolation and flexible connections on pipes are properly installed.
 - .6 All ducting connections are properly installed.
 - .7 Provisions for draining system in the event of leakage or additions to the system.
 - .8 Controls and valves are installed in a neat and tidy manner.
 - .9 Control's points list and flowcharts are completed.
 - .10 Disconnect switches are functional.
 - .11 Equipment is labelled.
 - .12 Check insulation installation for specified thickness and quality of installation.
- .3 Complete PV testing to ensure that split system A/C perform as per specifications.
- .4 Provide maintenance services.
 - .1 Ensure that all equipment is installed so as to provide easy access for maintenance and removal

3.4 HYDRONIC EQUIPMENT AND SYSTEMS - HUMIDIFIER

- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
- .2 Complete Manufacturer's installation and start-up check sheets and include the following items:
 - .1 Manifold slopes back to unit to drain condensate away from duct.
 - .2 Clearances allowed for servicing.
 - .3 Interlocks and safeties operational.
 - .4 Make-up water and drain connections complete.
- .3 Start as recommended by Manufacturer:
 - .1 Check humidistat control of unit.
 - .2 Check automatic blowdown cycle.
 - .3 Measure humidifier steaming rate.
- .4 Complete PV testing to ensure that humidifiers perform as per specifications.

- .5 Provide maintenance services.
 - .6 Ensure that all equipment is installed so as to provide easy access for maintenance and removal.
- 3.5 AIR HANDLING EQUIPMENT AND SYSTEMS - FANS
- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
 - .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 Backdraft dampers.
 - .2 Accessories.
 - .3 Special features.
 - .4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
 - .5 Lubricate bearings on fans as recommended by Manufacturer.
 - .6 Ensure fan wheels rotate in correct direction without binding.
 - .7 Adjust belts to proper alignment and tension.
 - .8 Ensure ductwork and fan casing is free of dirt or foreign material.
 - .9 Ensure electrical connections are complete and disconnect is within sight of fan.
 - .10 Ensure inlet and discharge duct geometry is correct.
 - .3 Follow Manufacturer's recommendations for starting
 - .1 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.
 - .4 Complete PV testing to ensure fan performance meets or exceeds performance outlined in the specifications.
 - .5 Provide maintenance services.
 - .1 Check that bearings are not over heating.
 - .2 Lubricate bearings.
 - .3 Check belts for tension and wear.
 - .4 Confirm that all equipment is easily accessible for maintenance purposes.

3.6 AIR HANDLING EQUIPMENT AND SYSTEMS - ENERGY RECOVERY VENTILATOR

- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
- .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 Backdraft and/or isolation dampers.
 - .2 Drain and trap.
 - .3 Accessories.
 - .4 Special features.
 - .5 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
 - .6 Lubricate bearings on fans as recommended by Manufacturer.
 - .7 Ensure fan wheels rotate in correct direction without binding.
 - .8 Ensure ductwork and fan casing is free of dirt or foreign material.
 - .9 Ensure electrical connections are complete and disconnect is within sight of fan.
 - .10 Ensure inlet and discharge duct geometry is correct.
 - .11 Verify filter installation and access.
- .3 Follow Manufacturer's recommendations for starting
 - .1 Check for correct static deflection of unit vibration isolators, and that start-up and shut down deflection is within resilience limits.
 - .2 Verify wall controller settings and interlocks to reheat coils and fans as specified in 23 72 00.
- .4 Complete PV testing to ensure ERV performance meets or exceeds performance outlined in the specifications.
- .5 Provide maintenance services.
 - .1 Lubricate bearings (if recommended by manufacturer).
 - .2 Check belts for tension and wear.
 - .3 Confirm that all equipment and filters are easily accessible for maintenance purposes.

3.7 AIR HANDLING EQUIPMENT AND SYSTEMS - VAV BOXES

- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.

- .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 No physical damage to the unit has occurred.
 - .2 Unit is free of foreign debris.
 - .3 All bolts and screws are tight.
 - .4 All ducting connections are properly installed.
 - .5 Takeoffs for future installations are provided.
 - .6 Controls and damper actuators are installed in a neat and tidy manner.
 - .7 Control's points list and flowcharts are completed.
 - .8 Equipment is labeled.
 - .9 Check insulation installation for specified thickness and quality of installation.
 - .10 Unit is clean and free from debris.
 - .3 Complete PV testing to ensure that dampers perform as per specifications.
 - .4 Ensure that all equipment is installed so as to provide easy access for maintenance and removal.
- 3.8 AIR HANDLING EQUIPMENT AND SYSTEMS - ELECTRIC REHEAT COILS
- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
 - .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 Disconnect switches are functional.
 - .2 Interlocks and safeties (air flow proving switch and high temperature cutoff) are installed and operational.
 - .3 Unit is clean and free from debris.
 - .4 No physical damage to unit has occurred.
 - .5 All bolts, screws are tight.
 - .6 All fins have been combed and are not bent.
 - .7 All equipment is installed so as to provide access for maintenance and removal.
 - .8 Controls points list and flowcharts are completed.
 - .9 Equipment is labelled.
 - .3 Provide maintenance services.
 - .1 Adjust thermostat to final setting

- 3.9 AIR HANDLING EQUIPMENT AND SYSTEMS - FORCE FLOW/UNIT HEATERS
- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
 - .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 Disconnect switches are functional.
 - .2 Unit is clean and free from debris.
 - .3 No physical damage to unit has occurred.
 - .4 All bolts, screws are tight.
 - .5 All fins have been combed and are not bent.
 - .6 Controls and valves are installed in a neat and tidy manner.
 - .7 All equipment is installed so as to provide access for maintenance and removal.
 - .8 Controls points list and flowcharts are completed.
 - .9 Equipment is labelled.
 - .3 Provide maintenance services.
 - .1 Adjust thermostat to final setting
 - .2 Clean unit
- 3.10 AIR HANDLING EQUIPMENT AND SYSTEMS - ROOFTOP UNIT
- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
 - .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 Air blender and mixing baffles.
 - .2 Fresh, exhaust and recirculation air motorized dampers, operation and size.
 - .3 Filters.
 - .4 Check that fan base vibration isolation and flexible connections to ductwork are properly installed.
 - .5 Special features, access doors, liners, inlet vanes and labels.
 - .6 Lubricate bearings on fans as recommended by Manufacturer. Ensure fan wheels rotate in correct direction without binding. Adjust belts to proper alignment and tension.
 - .7 Vacuum clean air systems.
 - .8 Ensure temporary filters are installed. Never operate system without filters installed.

- .9 Ensure all balancing and fire dampers are open and ductwork is complete.
 - .10 Ensure electrical connections are complete and system disconnects are within sight of unit.
 - .11 Ensure controls are operational.
 - .12 Ensure inlet and discharge duct geometry is correct.
 - .13 Ensure gas-train complete and approved by authority having jurisdiction.
 - .3 Start the system in accordance with the Manufacturer's recommendations.
 - .1 Check for correct static deflection of unit vibration isolators and that start-up and shut down deflection is within resilience limits.
 - .2 Run for one day and check filters for bypass. Seal as required.
 - .4 Complete PV testing to ensure equipment meets specifications.
 - .1 Confirm that unit is performing as per specifications.
 - .2 Check controls operation and tune operating parameters to optimize rooftop unit performance.
 - .3 Tune system for energy efficient operation
 - .5 Provide maintenance services.
 - .1 Check that bearings are not overheating.
 - .2 Replace temporary filters with permanent filters.
 - .3 Lubricate bearings.
 - .4 Check belts for tension and wear.
 - .5 Ensure that coils can be drained and that the drainage system is functioning properly.
 - .6 Ensure that all equipment is serviced prior to owner takeover.
 - .6 Ensure that all equipment is installed so as to provide easy access for maintenance and removal.
- 3.11 HYDRONIC EQUIPMENT & SYSTEMS - PERIMETER RADIATION
- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
 - .2 Complete Manufacturer's installation and start-up check sheets and include the following:
 - .1 No physical damage to the unit has occurred.
 - .2 Shut off valve are accessible.

- .3 Lines have been pressure tested prior to pouring of concrete or wall construction.
- .4 Takeoffs for future installations are provided.
- .5 Provisions for draining system in the event of leakage or additions to the system.
- .6 Controls and valves are installed in a neat and tidy manner.
- .7 Control's points list and flowcharts are completed.
- .8 Equipment is labeled.
- .3 Confirm that perimeter radiation is performing as intended.
- .4 Provide maintenance services.
 - .1 Ensure that all equipment is serviced prior to owner takeover.
 - .2 Ensure that all equipment is installed so as to provide access for maintenance and removal.
 - .3 Clean fins and cabinets.
 - .4 Calibrate controls.

3.12 AIR HANDLING EQUIPMENT AND SYSTEMS - DISTRIBUTION

- .1 Check that installation is in accordance with drawings, specifications and Manufacturer's recommendations.
- .2 Complete Manufacturer's installation and start-up check sheets.
- .3 Inspect air systems including ductwork layout, support, and vibration isolation before pressure testing any section of ductwork.
- .4 Power vacuum all ducts, if deemed necessary by Departmental Representative and/or CxA.
- .5 Pressure test sections of ductwork prior to application of insulation or concealment. Include pressure testing of ductwork on commissioning schedule and notify Owner prior to any system pressure tests.
- .6 Check that insulation is installed as per specifications and is neat and tidy.
- .7 Check that insulation has not been damaged during construction and note any sections that require repair.
- .8 Check that all distribution ductwork is labelled.

- .9 Provide Testing, Adjusting and Balancing for all Air Handling Equipment and Systems by a Certified Independent Agent.
- .10 Provide PV testing to ensure that air handling equipment and systems perform as per specifications.
- .11 Provide maintenance services.
 - .1 Ensure all equipment is serviced prior to take-over.
 - .2 Ensure all equipment is installed so as to provide easy access for maintenance and removal.
- 3.13 MECHANICAL EQUIPMENT AND SYSTEMS TESTING, ADJUSTING AND BALANCING
 - .1 Provide Testing, Adjusting and Balancing in accordance with Section 23 05 93.
- 3.14 MECHANICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION
 - .1 Provide demonstrations and instruction in accordance with Section 01 91 13.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.3 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere.
 - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
 - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.

1.4 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Ensure that traps are fully and permanently primed.
- .2 Ensure that fixtures are properly anchored, connected to system.
- .3 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.
- .4 Cleanouts: Refer to Section 22 42 01 - Plumbing Specialities and Accessories.

1.5 REPORTS

- .1 In accordance with Section 01 91 00 - Commissioning: Reports, supplemented as specified herein.

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 SUMMARY

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B75M, Standard Specification for Seamless Copper Tube [Metric].
 - .4 ASTM B837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

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

- .2 Indicate on manufacturers catalogue literature following: [valves] [____].
- .3 Submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

- .1 NPS 1/2 to 2, screwed.
- .2 NPS 2 1/2 and over, plain end.
- .2 Copper tube: to ASTM B837.

2.2 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Brazing: to ASTM B837.

2.3 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.

2.4 VALVES

- .1 Provincial Code approved, lubricated type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install in accordance with Section 23 05 01 - Installation of Pipework, applicable Provincial/Territorial Codes, CAN/CSA B149.1, supplemented as specified.
- .2 Install drip points:

- .1 At low points in piping system.
- .2 At connections to equipment.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless otherwise approved by Departmental Representative.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

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

3.5 ADJUSTING

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

3.6 CLEANING

- .1 Cleaning: in accordance with CAN/CSA B149.1, supplemented as specified.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-[04], Specification Filler Metals for Brazing and Bronze Welding.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.4, Gray-Iron Threaded Fittings.
 - .2 ANSI/ASME B16.15, Cast Bronze Threaded Fittings.
 - .3 ANSI B16.18, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B32, Standard Specification for Solder Metal.
 - .2 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M, Standard Specification for Seamless Copper Water Tube Metric.
 - .5 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society (MSS)
 - .1 MSS SP67, Butterfly Valves.
 - .2 MSS SP70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP71, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP80, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS SP85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 SUBMITTALS

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

product characteristics, performance criteria, and limitations.

- .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.

.2 Shop Drawings:

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

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

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Closeout Submittals:

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

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.

.2 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 MAINTENANCE

.1 Extra Materials:

- .1 Furnish following spare parts:

- .1 Valve seats: one for every ten valves, each size. Minimum one.
- .2 Discs: one for every ten valves, each size. Minimum one.
- .3 Stem packing: one for every ten valves, each size. Minimum one.
- .4 Valve handles: two of each size.
- .5 Gaskets for flanges: one for every ten flanges.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal:
separate waste materials for reuse and recycling in
accordance with Section 01 74 19 -
Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 TUBING

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

2.2 FITTINGS

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

2.3 FLANGES

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

2.4 JOINTS

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

2.5 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
- .2 Gate Valves Application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
- .3 Balancing, for TAB:

- .1 Sizes: calibrated balancing valves, as specified.
- .2 NPS 2 and under:
 - .1 Elsewhere: globe, with plug disc as specified
Section 23 05 22 - Valves - Bronze.
- .4 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
- .5 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section [23 05 22 - Valves - Bronze.
- .6 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 23 05 22 - Valves - Bronze.
- .7 Ball valves:
 - .1 NPS 2 and under: as specified Section 23 05 22 - Valves - Bronze.
- .8 Lubricated Plug Valves:
 - .1 NPS 2 and under

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

- .6 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .3 Install globe valves for balancing and in by-pass around control valves as indicated.
- .4 Install silent check valves on discharge of pumps and in vertical pipes with downward flow.
- .5 Install swing check valves in horizontal lines on discharge of pumps.

3.4 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.5 FLUSHING AND CLEANING

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

3.6 FILLING OF SYSTEM

- .1 Refill system with clean water adding water treatment.

3.7 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Test system in accordance with Section 21 05 01 - Common Work Results - Mechanical.
- .2 Balancing:
 - .1 Balance water systems to within plus or minus 5% of design output.

3.8 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2, Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67, Butterfly Valves.
 - .2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

- .5 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals.
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Health and Safety.
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal.
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.5 MAINTENANCE

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

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape.
- .2 Pipe thread: taper.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.
 - .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

2.4 VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
- .2 Gate valves: to MSS-SP-70, Application: Isolating equipment, control valves, pipelines:
 - .1 NPS2 and under:
 - .1 Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
- .3 Globe valves: to MSS-SP-80, Application: Throttling, flow control, emergency bypass:
 - .1 NPS2 and under:
 - .1 Globe, with composition disc, as specified Section 23 05 22 - Valves - Bronze.
- .4 Balancing, for TAB:
 - .1 Sizes: Calibrated balancing valves, as specified this section.
 - .2 NPS2 and under:
 - .1 Globe, with plug disc as specified Section 23 05 22 - Valves - Bronze.
- .5 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
- .6 Swing check valves: to MSS-SP-71.
 - .1 NPS2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 22 - Valves - Bronze.
- .7 Silent check valves:
 - .1 NPS2 and under:
 - .1 As specified Section 23 05 22 - Valves - Bronze.
- .8 Ball valves:
 - .1 NPS2 and under: as specified Section 23 05 22 - Valves - Bronze.

- .9 Lubricated Plug Valves
 - .1 NPS2 and under.

Part 3 Execution

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 01 - Installation of Pipe Work.

3.2 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 BALANCING

- .1 Balance water systems to within plus or minus 5% of design output.
- .2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

END OF SECTION

Approved: 2005-06-30

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.22, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5, Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B52, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Submit WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with

specifications for specified performance characteristics and physical properties.

- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 TUBING

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

2.2 FITTINGS

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 15% Ag-80% Cu-5%P or 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 PIPE SLEEVES

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

2.4 VALVES

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

Part 3 Execution

3.1 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 GENERAL

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 01 - Installation of Pipework.

3.3 BRAZING PROCEDURES

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

3.4 PIPING INSTALLATION

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction

- .2 Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
 - .3 Provide inverted deep trap at top of risers.
 - .4 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

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 CLEANING

- .1 Perform cleaning operations in accordance with manufacturer's recommendations.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Approved: 2005-03-31

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual.
 - .3 IAQ Guideline for Occupied Buildings Under Construction, 1st Edition.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.2 SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.
- .3 Indoor Air Quality (IAQ) Management Plan.
 - .1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance for construction and preoccupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 47 19 - 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 A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.
- .3 Class C: transverse joints and connections made airtight with sealant. Longitudinal seams unsealed.

2.2 SEALANT

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C for interior ductwork.
- .2 Use sealants appropriate for expected temperatures when ducts are outside.

2.3 TAPE

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

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct, 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.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radiused elbows.

- .7 Obstruction deflectors: maintain full cross-sectional area.

2.6 FIRE STOPPING

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

2.7 GALVANIZED STEEL

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

2.8 STAINLESS STEEL

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: No. 4.
- .3 Thickness, fabrication and reinforcement: to SMACNA.
- .4 Joints: to ASHRAE and SMACNA.

2.9 ALUMINUM

- .1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

2.10 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 ASHRAE and SMACNA.
 - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10

Duct Size	Angle Size	Rod Size
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

- .1 For concrete: manufactured concrete inserts.
- .2 For steel joist: manufactured joist clamp.
- .3 For steel beams: manufactured beam clamps:

2.11 ROOF DUCTING SUPPORT

.1 Exterior Duct Support System:

- .1 Roof ductwork shall be supported using a manufactured and engineered service support system consisting of rubber base foots and H-frame channel supports.
- .2 The system shall be engineered by the manufacturer for the projects specific application, considering weight, local wind and snow loading.
- .3 The system shall be non-penetrating and adjustable.
- .4 System shall be suitable for temperatures of -40C to 80C.

Part 3 Execution

3.1 GENERAL

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

3.2 HANGERS

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

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Dishwasher exhaust.

- .2 Fresh air intake.
- .3 Minimum 3000 mm from duct mounted humidifier in all directions.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards 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 discharging to open funnel drain.

3.4 SEALING AND TAPING

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

3.5 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .7 Complete test before performance insulation or concealment Work.

END OF SECTION

Approved: 2005-03-31

Part 1 General

1.1 REFERENCES

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

1.2 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Manufacturer's Field Reports: manufacturer's field reports specified.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - 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 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.
 - .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 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.
 - .6 300 x 300 mm glass viewing panels.

2.4 TURNING VANES

- .1 Factory or shop fabricated single thickness or double thickness with 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 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 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 required to perform necessary maintenance.
 - .2 Locations:
 - .1 Fire and smoke dampers.

- .2 Control dampers.
- .3 Devices requiring maintenance.
- .4 Required by code.
- .5 Reheat coils.
- .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and 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 Perform cleaning operations in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 PRODUCT DATA

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

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal , and with the Waste Reduction Workplan.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

- .1 Of same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

- .1 Of 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 nylon end bearings.

- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 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: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Approved: 1999-01-26

Part 1 General

1.1 PRODUCT DATA

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

1.2 CLOSEOUT SUBMITTALS

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

1.3 CERTIFICATION OF RATINGS

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

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.

Part 2 Products

2.1 MULTI-LEAF DAMPERS

- .1 Opposed blade type.
- .2 Structurally formed steel, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Insulated aluminum dampers:
 - .1 Frames: insulated with extruded polystyrene foam with R factor of 5.0.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 5.0.

2.2 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted, spring assisted or counter weighted.

2.3 RELIEF DAMPERS

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights.

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of break-away joints.

1.3 CLOSEOUT SUBMITTALS

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

1.4 EXTRA MATERIALS

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

1.5 CERTIFICATION OF RATINGS

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

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type C , listed and bear label of ULC, meet requirements of provincial fire authority and ANSI/NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking 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.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with ANSI/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 Coordinate with installer of firestopping.

- .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.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA) c. 33.
 - .2 Transportation of Dangerous Goods Act, (TDGA), c. 34.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for 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.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition.
- .6 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110, Fire Tests for Air Ducts.

1.2 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Submit Indoor Air Quality (IAR) Management Plan in accordance with Section 01 47 15 - Sustainable Requirements - Construction.
- .4 Product Data: submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 61 33 - Hazardous Materials for the following:

- .1 Thermal properties.
- .2 Friction loss.
- .3 Acoustical loss.
- .4 Leakage.
- .5 Fire rating.
- .5 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

1.3 QUALITY ASSURANCE

- .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.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

1.5 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

- .1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance for construction and preoccupancy phases of building.
- .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

Part 2 Products

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

- .1 Type 1: spiral wound flexible aluminum.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

Part 3 Execution

3.1 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .5 North American Insulation Manufacturers Association (NAIMA).
 - .1 NAIMA AH116, Fibrous Glass Duct Construction Standards.
- .6 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - .1 SMACNA, HVAC DCS, HVAC, Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings 95.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .8 Underwriter's Laboratories of Canada (ULC).

- .1 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance Section 02 61 33 - Hazardous Materials.
- .3 Submit Indoor Air Quality (IAQ) Management Plan.

1.3 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

1.6 SUSTAINABLE REQUIREMENTS

- .1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

Part 2 Products

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: air surface coated. Mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102 and NFPA 90A.
 - .3 Fungi resistance: to ASTM C1338.
- .2 Rigid:
 - .1 Use on flat surfaces.
 - .2 25 mm thick, to ASTM C1071, Type 2, fibrous glass rigid board duct liner.

- .3 Provide product with polymer films in transfer ducts located in PSOHP clinic area to meet requirements of CSA Z317.2.
- .4 Density: 48 kg/m³ minimum.
- .5 Thermal resistance to be minimum 0.76 (m². degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
- .6 Maximum velocity on faced air side: 20.3 m/sec.
- .7 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.
- .3 Flexible:
 - .1 Use on round or oval surfaces.
 - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
 - .3 Provide product with polymer films in transfer ducts located in PSOHP clinic area to meet requirements of CSA Z317.2.
 - .4 Density: 24 kg/m³ minimum.
 - .5 Thermal resistance to be minimum 0.74 (m².degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
 - .6 Maximum velocity on coated air side: 25.4 m/sec.
 - .7 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

2.2 ADHESIVE

- .1 Adhesive: to NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degreesC to plus 93 degreesC.
- .3 Water-based fire retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with SMACNA HVAC DCS.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive to ASTM C916
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMAC HVAC DCS.
- .2 In systems, where air velocities exceeds 20.3 m/sec, install galvanized sheet metal nosing to leading edges of duct liner.

3.3 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Departmental Representative.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

Approved: 1999-01-26

Part 1 General

1.1 REFERENCES

- .1 AMCA 99, Standards Handbook.
- .2 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Rating.
- .3 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
- .4 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 ANSI/ASHRAE 51, Laboratory Methods of Testing Fans for Rating.
- .6 CGSB 1-GP-181M, Coating, Zinc Rich, Organic, Ready Mixed.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide :
 - .1 Fan performance curves showing point of operation, motor HP (kW) and efficiency.
 - .2 Sound rating data at point of operation.
- .3 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.

1.3 CLOSEOUT SUBMITTALS

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

1.4 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Spare parts to include:
 - .1 Matched sets of belts.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.5 MANUFACTURED ITEMS

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

Part 2 Products

2.1 FANS GENERAL

- .1 Capacity: flow rate, external static pressure, motor hp (kW), efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
- .5 Motors:
 - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - .2 For use with variable speed controllers.
 - .3 Sizes as indicated.
- .6 Accessories and hardware: matched sets of V-belt drives, adjustable motor bases, belt guards, coupling guards fan inlet and or outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment. Inlet or outlet dampers and vanes and as indicated.
- .7 Factory primed before assembly in colour standard to manufacturer.
- .8 Scroll casing drains: as indicated.
- .9 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .10 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 CABINET FANS

- .1 Ceiling mounted exhaust fans shall be of the centrifugal direct drive type. The fan housing shall be constructed of heavy-gauge galvanized steel. The housing interior shall be lined with 0.5 in. acoustical insulation. The outlet duct collar shall include a spring loaded aluminum backdraft damper. Outlet shall be adaptable for horizontal or vertical discharge. The designer grille shall be constructed of high-impact polystyrene. Grilles shall be non-yellowing.
- .2 The access for wiring shall be external. The motor disconnect shall be internal and of the plug-in type. The motor shall be mounted on vibration isolators. The fan wheel shall be of the forward-curved centrifugal type and dynamically balanced. All fans shall bear the AMCA Certified Ratings program AMCA Sound and Air Performance seal and shall be UL/cUL Listed.

2.3 ROOF EXHAUST FANS

- .1 Roof exhaust fans shall be centrifugal belt driven type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength. Galvanized rigid wire protects the fan's discharge from birds or small objects.
- .2 Motors shall be heavy duty ball bearing type, carefully matched to the fan load, and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted on vibration isolators, out of the airstream. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge contaminants. Motors shall be readily accessible for maintenance.
- .3 Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators. Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150 percent of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.
- .4 A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment.

- .5 A fan conduit chase shall be provided through the curb cap to the motor compartment for ease of installation.
- .6 All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
- .7 Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

2.4 FAN INSTALLATION

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

END OF SECTION

Approved: 2002-12-04

Part 1 General

1.1 RELATED SECTIONS

- .1 Section [01 33 00 - Submittal Procedures].
- .2 Section [01 74 19 - Construction/Demolition Waste Management And Disposal].
- .3 Section [01 78 00 - Closeout Submittals].

1.2 REFERENCES

- .1 Air Movement and Control Association (AAMC)
 - .1 AMCA 99-[1986(R1998)], Standards Handbook.
 - .2 AMCA 300-[1996], Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301-[1990], Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)
 - .1 ANSI/ASHRAE 51/AMCA 210-[1999], Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Include :
 - .1 Fan performance curves showing specified point of operation.
 - .2 Sound rating data.

1.4 CLOSEOUT SUBMITTALS

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

1.5 CERTIFICATIONS

- .1 Catalogued or published ratings shall be those 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.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section [01 74 19 - Construction/Demolition Waste Management And Disposal].
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by[Engineer] [Consultant].
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of [corrugated cardboard] [polystyrene] [plastic] [wood] packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.7 EXTRA MATERIALS

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

Part 2 Products

2.1 FANS GENERAL

- .1 Capacity: [flow rate, [total] [static] pressure Pa, r/min, [bhp] [W], [model and size] and sound ratings] [as indicated on schedule].
- .2 Statically and dynamically balanced. Constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. [Unit shall bear AMCA certified sound rating seal.]
- .4 Performance ratings: based on tests performed in accordance with ANSI/ASHRAE 51/AMCA 210, [unit to bear AMCA certified rating seal].
- .5 Bearings: [sealed lifetime [oilite] [ball] bearings] [heavy duty grease lubricated ball or roller bearings] of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of [80,000] [100,000] h.

2.2 ROOF EXHAUSTERS

- .1 [Centrifugal] [or] [Axial] [V belt] [direct] driven.
 - .1 Housings: [spun aluminum] [galvanized] [black steel] [prefinished in enamel][FRP] [PVC] [stainless steel] complete with resilient mounted motor and fan.

- .2 Impeller: aluminum non-overloading.
 - .3 [Adjustable motor sheave.]
 - .4 [12] mm mesh [2.0] mm dia aluminum birdscreen.
 - .5 [Automatic] [Motorized] gasketted aluminum backdraft dampers.
 - .6 Disconnect switch within fan housing.
 - .7 Continuous curb gaskets, [cadmium plated] [stainless steel] securing bolts and screws, and [special mated [sound insulating] [300] mm high] curbs where indicated. [Hinge curb plate for access to internals for maintenance.]
- .2 Eisenheiss coated wheel and upblast discharge for fume hood service with motor out of air stream.
- .3 Sound curbs: of same manufacturer as fan and built to suit model specified.
- .1 Double baffle and self-flashing type. Required decibel sound attenuation spectrum:
- | | | | | | | | | |
|-------------|---|---|----|----|----|----|----|----|
| Frequency | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Octave Band | | | | | | | | |
| dB | 3 | 5 | 11 | 16 | 22 | 20 | 17 | 13 |
| Attenuation | | | | | | | | |
- .2 Pressure loss through curbs: [37] Pa max at rated L/s.
- .4 Two speed fan motors: two windings or split windings with speeds of approximately [[___] RPM high] [and] [[___] r/s low] [as indicated].
- .5 Acceptable material: [___].
- 2.3 WALL EXHAUSTERS**
- .1 [Centrifugal backward inclined] [or] [Axial] fan units, [V belt] [direct] driven.
- .1 [Spun aluminum] [FRP] [PVC] housings, complete with resilient mounted motor and fan.
- .2 [12] mm mesh [2.0] mm dia aluminum birdscreen.
- .3 [Motorized] [Automatic] gasketted aluminum backdraft dampers.
- .4 Disconnect switch within fan housing.
- .5 [Cadmium plated] [stainless steel] securing bolts and screws.
- .2 Eisenheiss coated wheel for fume service [with motor out of air stream].
- .3 Housings:
- .1 Provide with rubber or neoprene grommets for wiring passages, integral attachment collar, or angle ring mounted to mating flanged wall sleeve with full gasketting.

- .2 Discharge pattern: away from building.
- .4 Two speed motors: two windings or split windings with speeds of approximately[[____] r/min high] [and] [[____] r/min low] [as indicated].
- .5 Acceptable material: [____].

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.

3.2 ANCHOR BOLTS AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified in section [____].

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

1.3 CLOSEOUT SUBMITTALS

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

1.4 CERTIFICATION

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.6 EXTRA MATERIALS

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

Part 2 Products

2.1 MANUFACTURED UNITS

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

2.2 CONSTANT VOLUME BYPASS BOXES

- .1 Maintains space condition by bypassing supply air to return air.
- .2 Sizes, capacities, pressure loss: as indicated.
- .3 Discharge sound pressure level: to be less than 30 NC.
- .4 Complete with:
 - .1 Minimum air volume stop.
 - .2 Controller and operator.
 - .3 Manual balancing damper.
 - .4 Multi-port outlets.
- .5 Casing: constructed of 22 gauge galvanized steel, internally lined with 13 mm, 0.7 kg density fibrous glass. Mount control components inside protective metal shroud.
- .6 Damper: galvanized steel with peripheral gasket and self-lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .7 Provide a packaged control system (not interfaced with existing BMS) with thermostat, relays, controller and actuators. Where thermostats are controlling VAV bypass box and perimeter heat, provide controller with capability of controlling auxiliary heating. Provide connections and interface as required to control existing hydronic heating valves.
- .8 Sequence of, operation: On rise in room temperature, the thermostat energizes the actuator. The actuator slowly rotates the damper shaft to increase cold air to the room.

On fall in room temperature, the thermostat reverses the above action. The actuator slowly rotates the damper shaft to decrease cold air to the room. If room temperature continues to fall, the thermostat activate the control relay of the perimeter heating.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate so that controls, dampers and access panels are easily accessible.

END OF SECTION

Part 1 General

1.1 PRODUCT DATA

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

1.2 CERTIFICATIONS

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

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.4 EXTRA MATERIALS

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

Part 2 Products

2.1 GENERAL

- .1 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board.
 - .3 Concealed fasteners.
- .2 Concealed manual volume control damper operators.
- .3 Colour: as indicated.

2.2 MANUFACTURED UNITS

- .1 Grilles, registers and diffusers of same generic type to be product of one manufacturer.

2.3 DIFFUSERS, GRILLES AND REGISTERS

- .1 S-1.N: 600x600 mm Steel, square cone diffuser. Constructed of 3 die formed cones, providing air supply in 360 degree pattern.
- .2 R-1.N: 13x13x13 mm aluminum core Egg Crate return or exhaust grille with high free area and low sound and pressure drop.
- .3 E-1.N: 13x13x13 mm aluminum core Egg Crate return or exhaust grille with high free area and low sound and pressure drop. Provide opposed blade balancing dampers

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head screws in countersunk holes where fastenings are visible.

END OF SECTION

Approved: 2002-12-04

Part 1 General

1.1 REFERENCES

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

1.2 SHOP DRAWINGS

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

1.3 CLOSEOUT SUBMITTALS

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

1.4 CERTIFICATION

- .1 Catalogued or published ratings shall be those 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.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.6 EXTRA MATERIALS

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

Part 2 Products

2.1 ENTHALPY TYPE AIR TO AIR ROTARY HEAT EXCHANGER

- .1 Capacity: as indicated.

- .2 Casing: Pre-painted white aluminum with 25mm foil faced fiberglass insulation.
- .3 Heat exchanger: polymer membrane enthalpy core
- .4 Blowers: forward curve dual inlet centrifugal supply and exhaust fans.
- .5 24 V hi/low switching by remote controls
- .6 Interlock relay
- .7 Drain and anti-vibration kit
- .8 1" pleated filters
- .9 Controls: Provide wall mounted control with OFF, Stand-By, Low, and High switch positions.
- .10 Sequence of operations: Unit shall be manually controlled by wall mounted controls. Interlock operation of RHC-10.N with operation of ERV-1.N such that supply air temperature is maintained at 18.3C (65F) minimum supply air temperature. ERV-1.N shall also be interlocked with AC-1.N such that if ERV-1.N is operating the AC-1.N fan shall be operating as well.

Part 3 Execution

3.1 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, dampers.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 430, Central Station Air Handling Units.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate following: fan curves showing point of operation, motor hp, filters, mixing box and dampers, cooling and heating section; include performance data.

1.3 CLOSEOUT SUBMITTALS

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

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.

1.5 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide one spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .4 Spare filters: in addition to filters installed immediately prior to acceptance, supply 1 complete set of filters for each filter unit or filter bank.

Part 2 Products

2.1 ROOFTOP UNIT, RTU-1.N

- .1 This specification provides general requirements for packaged Roof Top Units. Refer to schedules on drawing for capacities, performance requirements, and model numbers which indicate unit specific options.
- .1 Construction:
 - .1 Outside Casing: Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvaneal steel.
 - .2 Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
 - .3 Cabinet Insulation: Fiberglass insulation, 2 inch thick.
 - .4 Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge painted galvaneal steel.
 - .5 Unit shall be side discharge configuration. Refer to drawings.
 - .6 Unit shall be constructed to and meet all requirements of CSA Z317.2-10, Class C space.
- .2 Fans:
 - .1 Blower section construction, Supply Air: direct drive motor and blower shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.
 - .2 Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
 - .3 Fan: Airfoil plenum fan statically and dynamically balanced, AMCA certified for air and sound performance, mounted on ground and polished steel fan shafts with ball bearing pillow blocks. Bearings shall be selected for a minimum L10 life in excess of 50,000 hours at maximum catalogued speeds.
 - .4 Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".
 - .5 Blower motors greater than $\frac{3}{4}$ horsepower shall be "NEMA Premium™" unless otherwise indicated.

Compliance with EPart minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower.

- .3 Cooling: Packaged DX System: unit shall have an integral compressors and evaporator coil located within the weather-tight unit housing. Condenser coils and appurtenant condenser fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the exterior of the unit. Condenser fan motors shall be three phase, type 56 frame, Open Air Over and Shaft Up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Motors shall be UL Recognized and CSA Certified. The refrigerant compressors shall be hermetic scroll-type and shall be equipped with liquid line filter drier, thermostatic expansion valves TXV, manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports and safety devices. Compressed refrigerant system shall be fully charged with R-410A refrigerant. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil. Hot gas bypass shall be provided on the lead circuit to prevent icing of the evaporator coil under low load conditions.
- .4 Heating: Shall have 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes. Heat exchanger shall have a 10 year extended warranty. Furnace control shall be 4:1 Modulating. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower. Shall have solid state controls permitting stand-alone operation or control by building controllers
- .5 Economizer:
 - .1 Parallel gear-driven action return air and out door air dampers, fully modulating, spring return motor, adjustable minimum daper position. Provide out door air hoods for both intake and exhaust openings. Control economizer based on

differential enthalpy. Motorized dampers /
Intake Air, Exhaust Air: Motorized damper of
insulated low leakage type shall be factory
installed

- .6 Filters: Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. Combination of MERV 8 and MERV 14 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream
- .7 Controls:
 - .1 This unit shall be controlled by a factory-installed microprocessor programmable controller that is connected to various optional sensors.
 - .2 Unit shall incorporate a controller with integral LCD screen that provides text readouts of status. Controller shall have a built-in keypad to permit operator to access read-out screens without the use of ancillary equipment, devices or software. Controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable
 - .1 Controller shall be capable of interfacing with existing Building DDC system to permit DDC to control unit operating schedule and monitor the following at a minimum:
 - .1 Discharge air temperature
 - .2 Outside air temperature
 - .3 Return air temperature
 - .4 Heating status and stages
 - .5 Cooling status and stages
 - .6 Economizer (free cooling) status
 - .7 All available unit alarms.
 - .3 Economizer control shall be temperature / dew point (enthalpy) controlled.
 - .4 Dirty filter sensor shall be factory-installed.
 - .5 The microprocessor shall be factory programmed for BacNet protocol to communicate with the existing building DDC system. Provide any interface equipment required to communicate to the DDC system via BACnet protocol.
- .8 Sequence of operation:

- .1 Unit shall operate on an adjustable occupied/unoccupied schedule. An override button shall be permitted in the space to permit the unit to run for a period of 2hrs when pushed during unoccupied times.
 - .2 The unit shall supply a constant volume of, rest from 12.8 C (55 F) up to 18.3 C (65 F) based on outside air temperature. If any one zone calls for cooling, the unit shall reduce supply air temperature gradually until zone is satisfied.
 - .3 Perimeter zones shall call on zone reheat coil as first stage of heat and existing perimeter heat as second stage to satisfy zone heating.
 - .4 Interior zones shall call on zone reheat coil as source of heating.
 - .5 Humidifier HU-1.N shall run with packaged (independent controls) based on call for humidification for space sensor, duct air flow sensor, and duct high humidity sensor.
- .9 Electrical: 575 V, 3ph.

Part 3 Execution

3.1 INSTALLATION

- .1 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Ensure adequate clearance for servicing and maintenance.

3.2 FANS

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.3 DRIP PANS

- .1 Install deep seal P-traps on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1, Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .2 American Society for Testing and Materials (ASTM International)
 - .1 ASTM C547, Specification for Mineral Fibre Pipe Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-115.10, Disposable Air Filters For Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.15, High Efficiency, Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .5 Environment Canada, (EC)/Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2, Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate major components and accessories including sound power levels of units.
- .3 Type of refrigerant used.

1.3 CLOSEOUT SUBMITTALS

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

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.5 WARRANTY

- .1 For refrigeration compressors, the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 5 years.
- .2 Contractor hereby warrants refrigeration compressors in accordance with GC 24, but for 5 years.

Part 2 Products

2.1 GENERAL

- .1 Applies to unit serving equipment and telecom rooms.
- .2 These specifications describe requirements for an environmental control system. The system shall be designed to maintain temperature and relative humidity conditions within the room.
- .3 The manufacturer shall design and furnish all equipment to be fully compatible with heat dissipation requirements of the site. Integrated package: to CAN/CSA-C656.
- .4 The environmental control system shall be a factory assembled unit. The refrigeration system shall be split, with the compressor located in a remote or close-coupled condensing unit. The evaporator section shall be specifically designed for floor- or wall-mounted installation and serviceable from the front of the system. Condensing units shall be designed for outdoor or indoor mounting, below the raised floor, above-dropped-ceiling, or in room installation.
- .5 The circulating-air fan shall be two speed for precise dehumidification control. The system shall be designed for blow-through air arrangement.
- .6 The system shall have a total cooling capacity shall be as noted on schedules. These units are to be supplied with 208 Volt, 1 ph, 60 Hz power supply.

2.2 STANDARD FEATURES/ALL SYSTEMS

- .1 Evaporator Cabinet and Frame Construction
 - .1 The cabinet and chassis shall be constructed of heavy gauge, painted furniture steel. The cabinet shall be

designed for easy installation and service access from the front only.

.2 Air Distribution

- .1 The air distribution system shall be constructed with a quiet, direct-drive fan assembly equipped with multiple double-inlet blowers, self-aligning sleeve bearings and lifetime lubrication. Fan motor(s) shall be permanent-split capacitor, high efficiency type, equipped with two speeds for air flow modulation. Dehumidification shall utilize the lower fan speed.
- .2 Air filter shall be a cleanable polypropylene monofilament type over expanded aluminum with aluminum frame. It shall be easily removable from the front of the system by means of quarter-turn fasteners and shall not require system shutdown for service.

.3 Microprocessor Control

- .1 The control system shall be microprocessor-based, factory-wired into the system and tested prior to shipment. The wall-mounted control enclosure shall include a 2-line by 16-character LCD providing continuous display of operating status and alarm condition. An 8-key membrane keypad for setpoints/program control, fan speed selection and unit On/Off shall be located below the display. The control display shall be field-wired to the control board using 4-conductor field-supplied thermostat wire.
- .2 Temperature and humidity sensors shall be located in the wall box, which shall be capable of being located up to 300 ft (91.4m) from the evaporator unit.

.4 Monitoring

- .1 The LCD shall provide On/Off indication, operating mode indication (cooling, heating, humidifying, dehumidifying), fan speed indication and current day, time, temperature and humidity (if applicable) indication. The monitoring system shall be capable of relaying unit operating parameters and alarms to the monitoring system.

.5 Control Setpoint Parameters

- .1 Temperature Setpoint: 65-85°F (18 to 29°C)
- .2 Temperature Sensitivity: 1 to 9.9°F (1 to 5°C)
- .3 Humidity Setpoint: 20-80% RH
- .4 Humidity Sensitivity: 1 to 30% RH
- .5 The microprocessor can be set within these ranges; however, the unit may not be able to control to extreme combinations of temperature and humidity.

.6 Unit Controls

- .1 Compressor Short-Cycle Control

- .1 The control system shall prevent compressor short-cycling by a 3-minute timer from compressor stop to the next start.
- .2 Common Alarm and Remote On/Off
 - .1 A common alarm relay shall provide a contact closure to a remote alarm device. Two (2) terminals shall also be provided for remote On/Off control. Individual alarms shall be "enabled" or "disabled" from reporting to the common alarm.
- .3 Setback Control
 - .1 The control shall be user-configurable to use a manual setpoint control or a programmable, time-based setback control. The setback control shall be based on a 5 day/2 day programmed weekly schedule with capability of accepting two events per program day.
- .4 Temperature Calibration
 - .1 The control shall include the capabilities to calibrate the temperature and humidity sensors and adjust the sensor response delay time from 10 to 90 seconds. The control shall be capable of displaying temperature values in °F or °C.
- .7 System Auto Restart
 - .1 For startup after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6-second increments) time delay. Programming can be performed either at the wall-mounted controller or from the central, site-monitoring system.

2.3 Alarms

- .1 Unit Alarm
 - .1 The control system shall monitor unit operation and activate an audible and visual alarm in the event of the following factory preset alarm conditions:
 - .1 High Temperature (max 90°F, 32.2°C)
 - .2 Low Temperature (min 35°F, 1.7°C)
 - .3 High Humidity (max 85% RH)
 - .4 Low Humidity (min 15% RH)
 - .5 High Water Alarm - Lockout Unit Operation
 - .6 High Head Pressure
 - .7 Loss of Power
 - .8 Compressor Short Cycle
 - .2 Custom Alarms (2x)
 - .1 Humidifier Problem
 - .2 Filter Clog
 - .3 Water Detected

- .4 Smoke Detected
- .5 Custom Alarm (1)
- .6 Custom Alarm (2)
- .7 User-customized text can be entered for the two (2) custom alarms.
- .3 Alarm Controls
 - .1 Each alarm (unit and custom) shall be individually enabled or disabled (except for high head pressure and high water in condensate pan) and can be programmed for a time delay of 0 to 255 seconds of continuous alarm condition to be recognized as an alarm. Each alarm shall also be enabled or disabled to activate the common alarm (except high head pressure and high water in condensate pan).
- .4 Audible Alarm
 - .1 The audible alarm shall annunciate at the LCD wall box any alarm that is enabled by the operator.
- .5 Common Alarm
 - .1 A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.

2.4 DIRECT EXPANSION SYSTEM EVAPORATOR COMPONENTS

- .1 Direct Expansion Coil
 - .1 The evaporator section shall include an evaporator coil, thermostatic expansion valve and filter-drier.
 - .2 The evaporator coil shall have 2.44 ft² (.23m²) face area, 4 rows deep. It shall be constructed of copper tubes and aluminum fins and have a maximum face velocity of 356 FPM (1.8m/s) at 870 CFM (1478CMH). An externally equalized thermostatic expansion valve shall control refrigerant flow. The evaporator coil shall be factory-charged with R-407C refrigerant and sealed. The coil shall be provided with a galvanized steel drain pan. The evaporator unit can be coupled directly with a water/glycol condensing unit or mounted remote to the indoor or outdoor condensing unit.

2.5 OUTDOOR AIR-COOLED PROP FAN CONDENSING UNIT

- .1 Condensing unit components shall include a condenser coil, a direct-drive propeller-type fan, a scroll compressor, high-pressure switch, receiver and head pressure control valve, hot gas bypass system and liquid line solenoid valve. A hot gas bypass system shall be provided to reduce compressor cycling and improve operation under low-load conditions.
- .2 All components shall be factory-assembled, charged with R-407C refrigerant and sealed. No internal piping, brazing,

dehydration or charging shall be required. Condensing unit shall be designed for 95°F (35°C) ambient and be capable of operation to -30°F (-34.4°C).

2.6 FACTORY-INSTALLED OPTIONS

.1 Electric Reheat

- .1 The electric reheat shall be low-watt density, tubular element and shall include agency approved safety switch to protect the system from overheating. The capacity of the reheat coil shall be 9215 Btu/hr, 2.7 kW, controlled in one stage.
- .2 Steam Generating Humidifier
- .3 The environmental control system shall be equipped with a steam generating humidifier that is controlled by the microprocessor control system. It shall be complete with disposable canister, all supply and drain valves, 1" (25.4mm) air gap on fill line, inlet strainer, steam distributor and electronic controls. The need to change the canister shall be annunciated on the microprocessor wall box control panel. The humidifier shall have a capacity of 3 lb./hr. (1.4kg/h). An LED light on the humidifier assembly shall indicate cylinder full, overcurrent detection, fill system fault and end of cylinder life conditions.

2.7 SHIP-LOOSE ACCESSORIES

.1 Condensate Pump

- .1 The condensate pump shall have the capacity of 60 GPH (227 l/h) at 10 ft. head (30 kPa). It shall be complete with integral float switch, discharge check valve, pump, motor assembly and reservoir. A secondary float switch shall be provided to permit field wiring to the unit control to shut down the evaporator upon a high water level condition.

.2 Refrigerant Line Sweat Adapter Kit

- .1 Provide a sweat adapter kit to permit field brazing of refrigerant line connections for application to split systems.

Part 3 Execution

3.1 GENERAL

- .1 Install as indicated, to manufacturer's recommendations, and in accordance with EPS 1/RA/2.
- .2 Manufacturer to certify installation.
- .3 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain.

3.2 EQUIPMENT PREPARATION

- .1 Provide services of manufacturer's field engineer to set and adjust equipment for operation as specified.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Product data to include:
 - .1 Filters, fan accessibility.
 - .2 Suspension of cabinet.
 - .3 Physical size.
 - .4 Thermostat, transformer, controls where integral.
 - .5 Finish.
 - .6 kW rating, voltage, phase.
 - .7 Cabinet material thicknesses.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
 - .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

Part 2 Products

2.1 GENERAL

- .1 This applies to AC-1 and CU-1 serving the ECC. The heat pump system shall be a packaged air source split system with variable compressor speed inverter technology. The outdoor unit shall be pre-charge with R-410A refrigerant. The system shall consist of a ceiling concealed evaporator section with wired controller and a horizontal discharge, single phase power, matching outdoor condensing unit.

2.2 PERFORMANCE

- .1 Refer to Schedules for capacities.
- .2 Each system shall perform in accordance to ARI 210/240 confirmed specification ratings shown in the table 1.
- .3 Cooling performance shall be based on 67°F (19.4°C) WB, 80°F (26.7°C) DB for the indoor unit and 75°F (24°C) WB, 95°F (35°C) DB, for the outdoor unit.
- .4 Heating performance shall be based on 60°F (15.6°C) WB, 70°F (21°C) DB for the indoor unit and 43°F (6°C) WB, 47°F (6°C) DB, for the outdoor unit.

2.3 INDOOR UNIT

- .1 The indoor unit shall be factory assembled, wired and tested.
- .2 Contained within the unit shall be all factory wiring, internal piping, control circuit board and fan motor.
- .3 The indoor unit shall pull room air at the back and dispel conditioned air at the front.
- .4 The unit shall have the option to pull return air from the bottom.
- .5 There shall be an operation and error indication on the wired controller
- .6 Indoor unit shall have capabilities to be installed at a maximum height of 100ft. (30m) above or below the outdoor unit.
- .7 The indoor unit shall have a drain port to extract condensate from under the coil.
- .8 The indoor unit shall be insulated on the exterior to prevent condensation build up.
- .9 CABINET

- .1 The casing shall be hot dipped galvanized steel sheet, pre-coated for rust prevention.
 - .2 There shall be a duct flange at the supply and return air outlet.
- .10 FAN
 - .1 The evaporator shall have min. of two fan directly driven by a single dc motor.
 - .2 The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
 - .3 The indoor fan shall consist of three speeds, Low, Mid and Hi.
- .11 FILTER
 - .1 Return air shall be filtered by means of an easily removed washable filter with a MERV rating of 14.
- .12 COIL
 - .1 The evaporator coil shall be of nonferrous construction with aluminum strake pre-coated fins on copper tubing.
 - .2 All tube joints shall be brazed with phoscopper.
 - .3 A condensate pan and drain shall be provided under the coil.
- .13 ELECTRICAL
 - .1 The unit shall be powered by 208/230Vac, 1 phase, 60 hertz electrical AC power supply.
 - .2 The system shall operate within voltage limits of 198Vac to 253Vac.
 - .3 The outdoor unit shall provide 208/230Vac, 1 phase, 60 hertz electrical AC power to the indoor unit.
- .14 FITTINGS
 - .1 The indoor unit shall have flare brass fittings and meets ANSI B16.26 standards.
- .15 CONTROL
 - .1 The unit shall have a wired controller with micro processor controls to perform input functions necessary to operate the system.
 - .2 There shall be a multi-language large DOT liquid crystal display wired controller.
 - .3 The controller shall have a built in room temperature sensor.
 - .4 Temperature changes shall be by 1° increments.
 - .1 Temp. range shall be 67°F-87°F (19-30°C) in cooling & 63°F-83°F (17°C-28°C), in heating mode.

- .5 The controller shall have the capability to simultaneously control up to a maximum of sixteen systems at a maximum cable distance of 1,500 feet.
- .6 The microprocessor control signal between the indoor and outdoor unit shall be incorporated with the indoor unit's electric supply requiring a minimum of 4 wire (3+gnd.) 14AWG cable.
- .7 The system shall be capable of automatic restart when power is restored after interruption.
- .8 The wired controller shall provide 7 day programmable time schedule with temperature set back and system ON/OFF operation.
- .9 the controller shall have auto change over between heating and cooling modes.
- .10 The controller shall provide system error diagnostic and operation data.
- .11 The wired controller shall have built in lead lag control (operation rotation between two systems, backup operation on failure of working system) between two systems.
- .12 The system shall have the option to be integrated and controlled by BMS (LonWorks, BacNet)
- .13 The system shall provide status and error output signals
- .14 The system shall have remote (control from remote location) ON/OFF control
- .15 There shall be control of external heat device base on room and set temperature difference.

2.4 OUTDOOR UNIT (CEILING MOUNTED)

- .1 The outdoor unit shall be compatible with P-series indoor units. The indoor units must be of the same capacity as the outdoor unit.
- .2 The outdoor unit shall have a holding charge for a max. refrigerant piping of 70ft. one way.
- .3 The outdoor unit shall have a maximum refrigerant piping of 165ft. (50m) one way (100ft. 30m for 12 000 and 18 000 Btu models).
- .4 The outdoor unit shall have a three minute time delay before compressor restart
- .5 The outdoor unit shall have provision for optional system operation data display.
- .6 The outdoor unit shall have sufficient oil return without the use of refrigerant pipe traps.

.7 CABINET

- .1 The casing shall be constructed from galvanized steel plate, treated with rust coating and finished with ivory colour (munsell 3Y 7.8/1.1) acrylic paint.
- .2 The fan grille shall be of polypropylene (PP) plastic.

.8 FAN

- .1 The unit shall be furnished with DC fan motors for direct drive propeller fan.
- .2 The motor bearings shall be permanently lubricated
- .3 The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.

.9 COIL

- .1 The L shaped condenser coil shall be of copper tubing with flat aluminum fins.
- .2 The coil shall be protected with an integral metal guard.

.10 COMPRESSOR

- .1 The compressor shall be hermetic rotary type (PUZ-A42NHA, shall be scroll type) with variable compressor speed inverter technology.
- .2 The compressor crankcase shall be heated by intermittent low speed compressor motor rotation.

- .11 The outdoor unit shall have high pressure and over current protective device.

.12 ELECTRICAL

- .1 The unit electrical power shall be 208/230 Vac, 1 phase, 60 hertz.
- .2 The unit shall operate within voltage limits of 198Vac to 253Vac.
- .3 The unit shall have a power factor of 98%.

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 Hang units.
- .2 Make power and control connections.

- .3 Co-ordinate ducting of fresh air with ERV-1.N and interlocks.

3.3 CLEANING

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

END OF SECTION