

PART 1 - GENERAL

- 1.1 USE OF SYSTEMS .1 Use of new and/or existing permanent heating and ventilating systems for supplying temporary heat or ventilation is permitted only under following conditions:.
- .1 There is no possibility of damage.
 - .2 Supply & return ventilation systems are protected by 60% filters, inspected daily, changed every week or more frequently as required.
 - .3 Warranties and guarantees are not relaxed.
 - .4 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters required in this Section are over and above those specified in other Sections of this project.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

- 3.1 NOT USED .1 Not Used.

PART 1 - GENERAL

- 1.1 REFERENCES .1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
.2 National Fire Code of Canada (NFCC 2010)
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 MATERIAL .1 Paint: zinc-rich to CAN/CGSB-1.181.
.1 Primers & Paints : in accordance with manufacturer's recommendations for surface conditions.
.2 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

PART 3 - EXECUTION

- 3.1 APPLICATION .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- 3.2 CONNECTIONS TO EQUIPMENT .1 In accordance with manufacturer's instructions unless otherwise indicated.
.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- 3.3 CLEARANCES .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.
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3.4 DRAINS

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

3.5 AIR VENTS

- .1 Install manual 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.

3.6 DIELECTRIC
COUPLINGS

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

3.7 PIPEWORK
INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible.

**3.7 PIPEWORK
INSTALLATION**
(Cont'd)

- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Use ball valves at branch take-offs for isolating purposes except where specified.

3.8 SLEEVES

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

3.9 ESCUTCHEONS

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

**3.10 PREPARATION
FOR FIRE STOPPING**

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

**3.11 FLUSHING OUT
OF PIPING SYSTEMS**

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

**3.12 PRESSURE
TESTING OF
EQUIPMENT AND
PIPEWORK**

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

**3.13 EXISTING
SYSTEMS**

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

PART 1 - GENERAL

- 1.1 REFERENCES .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
.1 ASHRAE 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

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

- 2.2 MOTORS .1 Provide motors for mechanical equipment as specified.
.2 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
.3 Motors 373 W and larger: 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: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
.4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
.5 Correct size of sheave determined during commissioning.

- 2.4 BELT DRIVES (Cont'd)
- .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.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS .1 Section 23 05 53.01 - Mechanical Identification

1.2 REFERENCES .1 American Society of Mechanical Engineers (ASME)
.1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.
.2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
.2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 GENERAL .1 Design point to be at mid-point of scale or range.

2.2 DIRECT READING THERMOMETERS .1 Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length: to CAN/CGSB-14.4 & ASME B40.200.
.1 Resistance to shock and vibration.

2.3 THERMOMETER WELLS .1 Copper pipe: copper or bronze.
.2 Steel pipe: brass or stainless steel.

2.4 PRESSURE GAUGES .1 112 mm, dial type: to ASME B40.100, Grade 2A, phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
.2 Provide:
.1 Snubber for pulsating operation.
.2 Diaphragm assembly for corrosive service.
.3 Gasketed pressure relief back with solid front.

PART 3 - EXECUTION

- 3.1 GENERAL .1 Install thermometers and gauges so they can be easily read from floor or platform.
.2 Install between equipment and first fitting or valve.

- 3.2 THERMOMETERS .1 Install in wells on piping. Include heat conductive material inside well.
.2 Install in locations as indicated and on inlet and outlet of:
.1 Heat exchangers.
.2 Water heating and cooling coils.
.3 DHW tanks.
.3 Use extensions where thermometers are installed through insulation.

- 3.3 PRESSURE GAUGES .1 Install in locations as follows:
.1 Inlet and outlet of coils.
.2 In other locations as indicated.
.2 Use extensions where pressure gauges are installed through insulation.

- 3.4 NAMEPLATES .1 Install engraved lamicaid nameplates in accordance with Section 23 05 53.01 - Mechanical Identification, identifying medium.

PART 1 - GENERAL

- 1.1 REFERENCES**
- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .2 ASTM International
 - .1 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS**
- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 MATERIALS**
- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
 - .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ASME B1.20.1.
 - .2 Copper tube systems: solder ends to ASME B16.18.
 - .3 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125.
 - .3 Connections: screwed ends to ASME B1.20.1 and with hexagonal shoulders solder ends to ASME.
 - .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.
 - .4 Butterfly Valves:
 - .1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
 - .1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - .2 Disc: elastomer coated ductile iron with integrally cast stem.
 - .3 Operator: lever.
- 2.2 CIRCUIT BALANCING VALVES (CBV)**
- .1 General:
 - .1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter.

- 2.2 CIRCUIT
BALANCING VALVES
(CBV)
(Cont'd)
- .2 Accuracy:
 - .1 Readout to be within plus or minus 2% of actual flow at design flow rate.
 - .3 Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.
 - .1 Flow control: At least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
 - .4 Insulation:
 - .1 Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.
 - .5 Drain connection:
 - .1 NPS 3/4 valved and capped, suitable for hose socket.
 - .2 Incorporated into valve body or provided as separate item.
 - .6 Size:
 - .1 Valve to be sized for a minimum pressure drop of 6 kPa at design flow at mid range. Provide pipe reducers as required.

PART 3 - EXECUTION

- 3.1 INSTALLATION
- .1 Remove internal parts before soldering.
 - .2 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS** .1 Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.
- 1.2 REFERENCES** .1 American Society of Mechanical Engineers (ASME)
.1 ASME B31.1-2014, Power Piping.
.2 ASTM International
.1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.
.2 ASTM A563-07a(2014), Standard Specification for Carbon and Alloy Steel Nuts.
.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
.1 MSS SP 58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
.4 Underwriter's Laboratories of Canada (ULC)
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS** .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 SYSTEM DESCRIPTION** .1 Design Requirements:
.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.
.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 SP 58.
- 2.2 GENERAL** .1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58 and ANSI B31.1.
.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process or hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment 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 SP 58.
- .3 Shop and field-fabricated assemblies:
 - .1 Sway braces for seismic restraint systems: to Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.
- .4 Hanger rods: threaded rod material to MSS SP 58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .5 Pipe attachments: material to MSS SP 58:
 - .1 Attachments for steel piping: carbon steel black.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .6 Adjustable clevis: material to MSS SP 58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .7 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 58.
- .8 U-bolts: carbon steel to MSS SP 58 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion plastic coated.
- .9 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 58.

**2.4 INSULATION
PROTECTION SHIELDS**

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP 58, 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 SP 58.

**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
ANCHOR BOLTS AND
TEMPLATES**

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

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 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .3 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

3.2 INSTALLATION
(Cont'd)

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

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .6 Pipework greater than NPS 12: to MSS SP 58.

**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.

PART 1 - GENERAL

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| <u>1.1 RELATED REQUIREMENTS</u> | .1 | Section 21 13 13 - Wet Pipe Sprinkler Systems. |
| <u>1.2 DEFINITIONS</u> | .1 | Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity. |
| | .2 | SRS: acronym for Seismic Restraint System. |
| <u>1.3 DESCRIPTION</u> | .1 | SRS fully integrated into, and compatible with: <ul style="list-style-type: none">.1 Noise and vibration controls specified elsewhere..2 Structural, mechanical, electrical design of project. |
| | .2 | Systems, equipment not required to be operational during and after seismic event. |
| | .3 | During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position. |
| | .4 | Designed by Professional Engineer specializing in design of SRS and registered in Province of Ontario. |
| <u>1.4 ACTION AND INFORMATIONAL SUBMITTALS</u> | .1 | Submittals: in accordance with Section 01 33 00 - Submittal Procedures. |
| | .2 | Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada. |

PART 2 - PRODUCTS

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| <u>2.1 SRS MANUFACTURER</u> | .1 | SRS from one manufacturer regularly engaged in SRS production. |
| <u>2.2 GENERAL</u> | .1 | SRS to provide gentle and steady cushioning action and avoid high impact loads. |
| | .2 | SRS to restrain seismic forces in every direction. |
| | .3 | Fasteners and attachment points to resist same load as seismic restraints. |
| | .4 | SRS of Piping systems compatible with: <ul style="list-style-type: none">.1 Expansion, anchoring and guiding requirements..2 Equipment vibration isolation and equipment SRS. |
| | .5 | SRS utilizing cast iron, threaded pipe, other brittle materials not permitted. |

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| <u>2.2 GENERAL
(Cont'd)</u> | .6 | Attachments to RC structure: <ul style="list-style-type: none">.1 Use high strength mechanical expansion anchors..2 Drilled or power driven anchors not permitted. |
| | .7 | Wet pipe sprinkler systems: refer to Section 21 13 13 - Wet Pipe Sprinkler Systems. |
| | .8 | Seismic control measures not to interfere with integrity of firestopping. |

PART 3 - EXECUTION

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| <u>3.1 MANUFACTURER'S
INSTRUCTIONS</u> | .1 | Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet. |
| <u>3.2 FIELD QUALITY
CONTROL</u> | .1 | Inspection and Certification: <ul style="list-style-type: none">.1 SRS: inspected and certified by Seismic Engineer upon completion of installation..2 Provide written report to Departmental Representative with certificate of compliance. |

PART 1 - GENERAL

- 1.1 REFERENCES .1 Canadian Standards Association (CSA).
- .2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
.1 NFPA (Fire) 13, Standard for the Installation of Sprinkler Systems, 2013 Edition.
.2 NFPA (Fire) 14, Standard for the Installation of Standpipe and Hose Systems, 2013 Edition.

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

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 EXISTING IDENTIFICATION SYSTEMS .1 Apply existing identification system to new work.

- 2.3 PIPING SYSTEMS GOVERNED BY CODES .1 Identification:
.1 Sprinklers: to NFPA (Fire) 13.
.2 Standpipe and hose systems: to NFPA (Fire) 14.

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

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| <u>2.5 VALVES,
CONTROLLERS</u> | .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. |
| <u>2.6 CONTROLS
COMPONENTS
IDENTIFICATION</u> | .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. |
| <u>2.7 LANGUAGE</u> | .1 | Identification in English and French. |
| | .2 | Use one nameplate and label for each language. |

PART 3 - EXECUTION

- | | | |
|--|----|--|
| <u>3.1 MANUFACTURER'S
INSTRUCTIONS</u> | .1 | Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet. |
| <u>3.2 INSTALLATION</u> | .1 | Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise. |
| | .2 | Provide ULC and/or CSA registration plates as required by respective agency. |
| | .3 | Identify systems, equipment to conform to PWGSC PMSS. |
| <u>3.3 NAMEPLATES</u> | .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. |
| | .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. |

3.4 LOCATION OF
IDENTIFICATION ON
PIPING AND DUCTWORK
SYSTEMS
(Cont'd)

- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 VALVES,
CONTROLLERS

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

PART 1 - GENERAL

- | | | |
|--|----|--|
| <u>1.1 PURPOSE OF TAB</u> | .1 | Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads |
| | .2 | Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions. |
| | | |
| <u>1.2 EXCEPTIONS</u> | .1 | TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction. |
| | | |
| <u>1.3 CO-ORDINATION</u> | .1 | Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project. |
| | .2 | Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems. |
| | | |
| <u>1.4 PRE-TAB REVIEW</u> | .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 proposed procedures which vary from standard. |
| | .3 | During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings. |
| | | |
| <u>1.5 START-UP</u> | .1 | Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise. |
| | .2 | Follow special start-up procedures specified elsewhere in Division 23. |
| | | |
| <u>1.6 OPERATION OF SYSTEMS DURING TAB</u> | .1 | Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports. |
| | | |
| <u>1.7 START OF TAB</u> | .1 | Notify Departmental Representative 7 days prior to start of TAB. |
| | .2 | Start TAB when building is essentially completed, including: |
| | .3 | Installation of ceilings, doors, windows, other construction affecting TAB. |
| | .4 | Application of weatherstripping, sealing, and caulking. |

<u>1.7 START OF TAB (Cont'd)</u>	.5	Pressure, leakage, other tests specified elsewhere Division 23.
	.6	Provisions for TAB installed and operational.
	.7	Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
	.1	Proper thermal overload protection in place for electrical equipment.
	.2	Air systems:
	.1	Filters in place, clean.
	.2	Duct systems clean.
	.3	Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
	.4	Correct fan rotation.
	.5	Fire, smoke, volume control dampers installed and open.
	.6	Access doors, installed, closed.
	.7	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.
<u>1.8 APPLICATION TOLERANCES</u>	.1	Do TAB to following tolerances of design values:
	.1	HVAC systems: plus 5%, minus 5%.
	.2	Hydronic systems: plus or minus 10%.
<u>1.9 ACCURACY TOLERANCES</u>	.1	Measured values accurate to within plus or minus 2% of actual values.
<u>1.10 INSTRUMENTS</u>	.1	Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
	.2	Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.
<u>1.11 ACTION AND INFORMATIONAL SUBMITTALS</u>	.1	Submit, prior to commencement of TAB:
	.1	Proposed methodology and procedures for performing TAB if different from referenced standard.
<u>1.12 TAB REPORT</u>	.1	Format in accordance with referenced standard.
	.2	TAB report to show results in SI units and to include:
	.1	Project record drawings.
	.2	System schematics.
	.3	Submit electronic copy of TAB Report to Departmental Representative for verification and approval, in English.

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- 1.13 VERIFICATION .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.
- 1.14 SETTINGS .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.
- 1.15 COMPLETION OF TAB .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.
- 1.16 AIR SYSTEMS .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA & ASHRAE.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB & qualified to standards of AABC or NEBB.
- .3 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurements: to include as appropriate:
- .1 Diffusers, VAV boxes, FPMB & other equipment causing changes in conditions.
- .2 At controllers, controlled device.
- .6 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).
- 1.17 HYDRONIC SYSTEMS .1 Air Cooling Coils and Glycol Cooled Condensers:
- .1 Fluid used. Identify fluid used; water, % water/ethylene glycol mixes, steam, etc.
- .2 Fluid flow rate.
- .3 Fluid Specific Heat, at mean temperature.
- .4 Fluid Specific Gravity, at mean temperature.
- .5 Fluid entering and leaving temperatures and pressures.
- .6 Fluid side heat transfer rate.
-

- 1.18 OTHER TAB REQUIREMENTS .1 General requirements applicable to work specified this paragraph:
.1 Qualifications of TAB personnel: as for air systems specified this section.
.2 Quality assurance: as for air systems specified this section.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

- 3.1 NOT USED .1 Not used.

PART 1 - GENERAL

- 1.1 REFERENCES .1 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
.1 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

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 before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 10 days before start of tests.
- .5 Re-calibrated every six months thereafter.

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.

PART 1 - GENERAL

1.1 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 ASTM International Inc.
 - .1 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .2 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .4 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
 - .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

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

<u>2.2 INSULATION (Cont'd)</u>	.4	TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
<u>2.3 ACCESSORIES</u>	.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	Outdoor Vapour Retarder Mastic: .1 Vinyl emulsion type acrylic, compatible with insulation. .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m ² .
	.5	Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
	.6	Contact adhesive: quick-setting.
	.7	Tie wire: 1.5 mm stainless steel.
	.8	Banding: 19 mm wide, 0.5 mm thick stainless steel.
	.9	Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
	.10	Fasteners: 2 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.
<u>2.4 FIRE RATED INSULATION</u>	.1	Fire resistant duct insulation - totally encapsulated, soluble-fibre (non-refractory ceramic fibre) product meeting the 25/50 flame spread and smoke development ratings as required in the applicable Canadian Building Code.

PART 3 - EXECUTION

<u>3.1 APPLICATION</u>	.1	Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
<u>3.2 PRE- INSTALLATION REQUIREMENTS</u>	.1	Pressure test ductwork systems complete, witness and certify.
	.2	Ensure surfaces are clean, dry, free from foreign material.
<u>3.3 INSTALLATION</u>	.1	Install in accordance with TIAC National Standards and ULC rating.
	.2	Apply materials in accordance with manufacturers instructions and as indicated.
	.3	Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

3.3 INSTALLATION
(Cont'd)

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

3.4 DUCTWORK
INSULATION SCHEDULE

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

	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
Acoustically lined ducts	none		

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

PART 1 - GENERAL

- 1.1 REFERENCES**
- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .2 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C547-12, Mineral Fiber Pipe Insulation.
 - .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
 - .3 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
 - .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S702-09, Thermal Insulation, Mineral Fibre, for Buildings
- 1.2 DEFINITIONS**
- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
 - .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS**
- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

<u>2.1 FIRE AND SMOKE RATING</u>	.1	In accordance with CAN/ULC-S102. .1 Maximum flame spread rating: 25. .2 Maximum smoke developed rating: 50.
<u>2.2 INSULATION</u>	.1	Mineral fibre specified includes glass fibre, rock wool, slag wool.
	.2	Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
	.3	TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket. .1 Mineral fibre: to CAN/ULC-S702 & ASTM C547. .2 Maximum "k" factor: to CAN/ULC-S702.
	.4	TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket. .1 Mineral fibre: to CAN/ULC-S702 & ASTM C547. .2 Jacket: to CGSB 51-GP-52Ma. .3 Maximum "k" factor: to CAN/ULC-S702 & ASTM C547.
<u>2.3 INSULATION SECUREMENT</u>	.1	Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
	.2	Contact adhesive: quick setting.
	.3	Canvas adhesive: washable.
	.4	Tie wire: 1.5 mm diameter stainless steel.
	.5	Bands: stainless steel, 19 mm wide, 0.5 mm thick.
<u>2.4 CEMENT</u>	.1	Thermal insulating and finishing cement: .1 Hydraulic setting on mineral wool, to ASTM C449.
<u>2.5 VAPOUR RETARDER LAP ADHESIVE</u>	.1	Water based, fire retardant type, compatible with insulation.
<u>2.6 INDOOR VAPOUR RETARDER FINISH</u>	.1	Vinyl emulsion type acrylic, compatible with insulation.

- 2.7 JACKETS .1 Polyvinyl Chloride (PVC):
- .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: White.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.015 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.

PART 3 - EXECUTION

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

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

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

- 3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES .1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: PVC.

**3.5 INSTALLATION OF
ELASTOMERIC
INSULATION**

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

**3.6 PIPING
INSULATION
SCHEDULES**

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

Applica- tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1-1/4 to 2	2-1/2 to 4	5 to 6	8 & over
Domestic HWS		A-1	25	25	25	38	38	38
Chilled Water	4 - 13	A-3	25	25	25	25	25	25
Glycol		A-3	25	25	25	25	25	25
Domestic CWS		A-3	25	25	25	25	25	25

- .5 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: PVC jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS** .1 Section 23 05 23.01 - Valves - Bronze.
- 1.2 REFERENCES** .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
.1 ANSI/AWS A5.8/A5.8M-11, AMD1 Specification Filler Metals for Brazing and Braze Welding.
.2 ASME
.1 ASME B16.4-2011, Gray-Iron Threaded Fittings Classes 125 and 250.
.2 ASME B16.15-2013, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
.3 ASME B16.18-2012, Cast Copper Alloy, Solder Joint Pressure Fittings.
.4 ASME B16.22-2013, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
.3 ASTM International
.1 ASTM B32-08, Standard Specification for Solder Metal.
.2 ASTM B88M-13, Standard Specification for Seamless Copper Water Tube Metric.

PART 2 - PRODUCTS

- 2.1 TUBING** .1 Type L hard drawn copper tubing: to ASTM B88M.
- 2.2 FITTINGS** .1 Cast bronze threaded fittings: to ASME B16.15.
.2 Wrought copper and copper alloy solder joint pressure fittings: to ASME B16.22.
.3 Cast iron threaded fittings: to ASME B16.4.
.4 Cast copper alloy solder joint pressure fittings: to ASME 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 Refer to Section 23 05 23.01 - Valves - Bronze.

PART 3 - EXECUTION

3.1 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.

3.2 VALVE
INSTALLATION .1 Install ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

3.3 FLUSHING AND
CLEANING .1 Flush and clean in presence of Departmental Representative.

.2 Flush after pressure test for a minimum of 4 hours.

.3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.

.4 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.

.5 Refill system with clean water. Circulate for at least 2 hours. 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 approval.

3.4 FILLING OF
SYSTEM .1 Refill system with clean water adding water treatment as specified or glycol as indicated.

PART 1 - GENERAL

- 1.1 REFERENCES .1 ASTM International
.1 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 AUTOMATIC AIR VENT .1 Standard float vent: brass body and NPS 1/8 connection and rated at 620 kPa working pressure.
.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
.3 Float: solid material suitable for 115 degrees C working temperature.

- 2.2 PIPE LINE STRAINER .1 NPS 1/2 to 2: bronze body to ASTM B62, solder end or screwed connections, Y pattern.
.2 Blowdown connection: NPS 1.
.3 Screen: stainless steel with 1.19 mm perforations.
.4 Working pressure: 860 kPa.

PART 3 - EXECUTION

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

- 3.2 GENERAL .1 Run drain lines and blow off connections to terminate above nearest drain.
.2 Maintain adequate clearance to permit service and maintenance.

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

3.4 AIR VENTS

- .1 Install at high points of systems.
- .2 Install ball valve on automatic air vent inlet. Run discharge to nearest drain.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS** .1 Section 23 05 05 - Installation of Pipework.
- 1.2 REFERENCES** .1 ASME
- .1 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-2011, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-2013, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-2013, Refrigeration Piping and Heat Transfer Components.
- .2 ASTM International
- .1 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .2 ASTM B280-13, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 CSA Group
- .1 CSA B52-13, B52 Package, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
- .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS** .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

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, 45% Ag-15% 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.

<u>2.2 FITTINGS (Cont'd)</u>	.4	Flared: .1 Bronze or brass, for refrigeration, to ASME B16.26.
<u>2.3 PIPE SLEEVES</u>	.1	Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.
<u>2.4 VALVES</u>	.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.
<u>2.5 INSULATION</u>	.1	TIAC Code A-6: 13 mm (½") thickness flexible unicellular tubular elastomer. .1 Insulation: to CAN/CGSB-51.40 with vapour retarder jacket.
<u>2.6 INSULATION SECUREMENT</u>	.1	Tape: Self-adhesive, reinforced, 50 mm wide minimum to insulation manufacturer's recommendation.
<u>PART 3 - EXECUTION</u>		
<u>3.1 MANUFACTURER'S INSTRUCTIONS</u>	.1	Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
<u>3.2 GENERAL</u>	.1	Install in accordance with CSA B52, EPS1/RA/1, ASME B31.5 and Section 23 05 05 - Installation of Pipework.
<u>3.3 BRAZING PROCEDURES</u>	.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.
<u>3.4 PIPING INSTALLATION</u>	.1	General: .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.

3.4 PIPING
INSTALLATION
(Cont'd)

- .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 m³ /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 2 MPa and 1 MPa 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 5 Pa 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 hours.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 hours.
 - .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.

3.6 FIELD QUALITY
CONTROL
(Cont'd)

.8

Checks:

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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS .1 Section 23 05 94 - Pressure Testing of Ducted Air Systems.

1.2 REFERENCES .1 ASTM International
.1 ASTM A653/A653M-13, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
.2 National Fire Protection Association (NFPA)
.1 NFPA (Fire) 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2012 Edition.
.2 NFPA (Fire) 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems, 2012 Edition.
.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
.2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

PART 2 - PRODUCTS

2.1 SEAL CLASSIFICATION .1 Classification as follows:

<u>Maximum Pressure Pa</u>	<u>SMACNA Seal Class</u>
500	A
250	A
125	A

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

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

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

2.4 DUCT LEAKAGE .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS .1 Fabrication: to SMACNA.

2.5 FITTINGS
(Cont'd)

- .2 Radiused elbows:
 - .1 Rectangular: standard radius, 1.5 times width of duct.
 - .2 Round: 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 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation.
- .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.

2.12 HANGERS AND SUPPORTS

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

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

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

PART 3 - EXECUTION

- 3.1 GENERAL**
- .1 Do work in accordance with NFPA (Fire) 90A, NFPA (Fire) 90B & SMACNA.
 - .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct.
 - .3 Install breakaway joints in ductwork on sides of fire separation.
 - .4 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
 - .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 as follows:

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500
- 3.3 SEALING AND TAPING**
- .1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.
 - .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.
- 3.4 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.

PART 1 - GENERAL

- 1.1 REFERENCES .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

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

- 2.2 FLEXIBLE CONNECTIONS .1 Frame: galvanized sheet metal frame 0.6 mm thick with fabric clenched by means of double locked seams.
.2 Material:
.1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

- 2.3 ACCESS DOORS IN DUCTS .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
.3 Gaskets: neoprene.
.4 Hardware:
.1 Up to 300 x 300 mm: two sash locks complete with safety chain.
.2 301 to 450 mm: four sash locks complete with safety chain.
.3 451 to 1000 mm: piano hinge and minimum two sash locks.
.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
.5 Hold open devices.

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

PART 3 - EXECUTION

- 3.1 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:
 - .1 450 x 450 mm for person size entry.
 - .2 450 x 450 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 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 Main and sub-main ducts.
 - .2 And as indicated.
 - .2 For temperature readings:
 - .1 At inlet and outlet of coils.
 - .2 And as indicated.

PART 1 - GENERAL

- 1.1 REFERENCES .1 Sheet Metal and Air Conditioning National Association (SMACNA)
.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2005.

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 GENERAL .1 Manufacture to SMACNA standards.

- 2.2 SINGLE BLADE DAMPERS .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
.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.

- 2.3 MULTI-BLADED DAMPERS .1 Factory manufactured of material compatible with duct.
.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
.3 Maximum blade height: 100 mm.
.4 Bearings: self-lubricating nylon.
.5 Linkage: shaft extension with locking quadrant.
.6 Channel frame of same material as adjacent duct, complete with angle stop.
.7 Maximum leakage : 0.07% at 750 Pa.

PART 3 - EXECUTION

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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS .1 Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCES .1 National Fire Protection Association (NFPA)
.1 NFPA (Fire) 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 Edition.
.2 Underwriters Laboratories of Canada (ULC)
.1 CAN/ULC-S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 FIRE DAMPERS .1 Fire dampers: arrangement Type B OR C, listed and bear label of ULC, meet requirements of NFPA (Fire) 90A & authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.
.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
.3 Top hinged: offset single damper, round or square; interlocking type; sized to maintain full duct cross section as indicated.
.4 Fusible link actuated, weighted to close and lock in closed position when released.
.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
.6 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

PART 3 - EXECUTION

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

PART 1 - GENERAL

- 1.1 REFERENCES**
- .1 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2012 Edition.
 - .2 NFPA (Fire) 90B, Standard for Installation of Warm Air Heating and Air-Conditioning Systems, 2012 Edition.
 - .2 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2008.
 - .3 Underwriters' Laboratories (UL)
 - .1 UL 181-2005, Standard for Factory-Made Air Ducts and Air Connectors.
 - .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-2007, Standard Methods of Tests for Air Ducts.
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS**
- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

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 - INSULATED**
- .1 Spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl aluminum jacket.
 - .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Maximum length: 1.5 m.

PART 3 - EXECUTION

- 3.1 DUCT
INSTALLATION
- .1
- Install in accordance with: CAN/ULC-S110, UL 181, NFPA (Fire) 90A, NFPA (Fire) 90B & SMACNA.

PART 1 - GENERAL

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C158-02(2012), Standard Test Methods for Strength of Glass by Flexure (Determination of Modulus of Rupture).
 - .2 ASTM C177-13, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - .3 ASTM C209-12, Standard Test Methods for Cellulosic Fiber Insulating Board.
 - .4 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .5 ASTM C665-12, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - .6 ASTM C916-85(2007), Standard Specification for Adhesives for Duct Thermal Insulation.
 - .7 ASTM C1071-12, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .8 ASTM C1338-14, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .9 ASTM C1534-14, Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems
 - .10 ASTM E84-14, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .11 ASTM E96/E96M-13, Standard Test Methods for Water Vapor Transmission of Materials.
 - .12 ASTM G21-13, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - .13 ASTM G22-76(1996), Standard Practice for Determining Resistance of Plastics to Bacteria (Withdrawn 2002).
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 Edition.
 - .2 NFPA (Fire) 90B-12, Standard for the Installation of Warm Air Heating and Air Conditioning Systems, 2012 Edition.
- .3 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible-2005.
- .4 Underwriters Laboratories (UL)
 - .1 UL 181, Factory-Made Air Ducts and Connectors.
- .5 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

**1.2 ACTION AND
INFORMATIONAL
SUBMITTALS**

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

PART 2 - PRODUCTS

- 2.1 DUCT LINER
- .1 Insulation materials shall have a closed cell structure to prevent moisture from wicking and effectively retard heat gain to make it an efficient insulation.
 - .2 Insulation materials shall be manufactured without the use of CFC's, HFC's or HCFC's. It is also formaldehyde-free, low VOCs, fiber free, dust free and resists mold and mildew.
 - .3 The insulation material shall conform to meet the requirements as defined in ASTM C1534, Standard "Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems".
 - .4 Shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, the flame shall not be progressive and all materials shall pass simulated end-use fire tests.
 - .5 Materials shall have a maximum thermal conductivity of 0.04 W/m - 0°C at a 24°C mean temperature when tested in accordance with ASTM C177 or ASTM C518, latest revisions.
 - .6 Materials shall have a maximum water vapor transmission of 1.17e-13 kg/Pa x s x m when tested in accordance with ASTM E96, Procedure A, latest revision.
 - .7 Materials shall have a maximum water absorption rate of 0.2% (%by volume), when tested in accordance with ASTM C209.
 - .8 The material shall be manufactured under an independent third party supervision testing program covering the properties for fire performance, thermal conductivity and water vapor transmission.
 - .9 Materials must be approved for air plenums.
 - .10 Materials must meet NFPA (Fire) 90A, NFPA (Fire) 90B and UL 181 Class 1 specification.
 - .11 Materials must meet ASTM C411. Materials to perform up to 120°C.
 - .12 ASTM C1071 - Erosion Resistance.
 - .13 ASTM G21 - Fungi Resistance.
 - .14 ASTM C1338 - Fungi Resistance.
 - .15 ASTM G22 - Bacterial Resistance.
 - .16 ASTM C665 - Non Corrosiveness and no objectionable odors.
 - .17 Dust free and fiber free. Non particulating.

PART 3 - EXECUTION

- 3.1 GENERAL .1 Do work in accordance with SMACNA HVAC Duct Construction Standard.
- .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.
- .2 In systems, where air velocities exceeds 20.3 m/s, install galvanized sheet metal noising to leading edges of duct liner.

PART 1 - GENERAL

- 1.1 REFERENCES .1 National Fire Protection Association (NFPA)
- .1 NFPA (Fire) 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 Edition.
 - .2 Underwriter's Laboratories (UL)
 - .1 UL 181, Factory-Made Air Ducts and Air Connectors.

- 1.2 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 SYSTEM DESCRIPTION .1 Performance Requirements:
- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

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

- 2.3 VARIABLE VOLUME BOXES .1 Pressure independent.
- .2 Sizes, capacities, differential pressures and sound ratings: as indicated.
 - .3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.
 - .4 Sound ratings of assembly not to exceed 30 NC.
 - .5 Complete with:
 - .1 Multiport outlet adapter lined with 25 mm thick acoustic insulation, unless otherwise noted on the drawings. Each outlet shall be equipped with a disk type balancing damper with locking quadrant. Motorized dampers to be provided on outlets for control purposes, refer to Division 25 - Controls.
 - .2 As indicated on drawings.
 - .6 Casing: constructed of 0.8 mm thick galvanized steel, internally lined with 13 mm, 0.7 kg density fibrous glass, to UL 181 and NFPA (Fire) 90A.
 - .7 Damper: heavy gauge 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.

**2.4 FAN POWERED
BOXES**

- .1 General:
 - .1 Primary air assembly, pressure independent.
 - .2 Sound ratings of assembly not to exceed 30 NC.
 - .3 Casing: 0.8 mm thick galvanized steel, internally lined with 25 mm, 0.7 kg density fibrous glass, to UL 181 and NFPA (Fire) 90A. Mount control components inside protective metal shroud.
 - .4 Damper: heavy duty 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.
- .2 Fan Assembly:
 - .1 Forward curved centrifugal type fan. Motor shall be ECM DC brushless motor complete with and operated by a single phase integrated controller/inverter that operates the wound stator and sensor motor position to electronically commutate the stator, designed for synchronous rotation, rotor shall be permanent magnet type with near zero rotor losses, permanently lubricated with ball bearings, maintain a minimum of 70% efficiency over its entire operating range, direct coupled to the blower. Fan motor horsepower shall not exceed the horsepower scheduled for each unit. Fan motors shall be high efficiency in accordance with latest addition of ASHRAE 90.1. Provide isolation between motor and blower assembly. Provide manual fan speed control for field adjustment of fan air flow setpoint. Speed control shall accept as standard a (0 -10VDC) (0-20 mA) signal for remote fan adjustment from a BAS).
 - .2 Provide dry contact for remote start/stop.
 - .3 Internally suspend and isolate fan motor assembly from casing on rubber isolators or resilient rings.
- .3 Controls:
 - .1 Electronic DDC controller supplied & installed by controls contractor to accomplish the specified sequence of operations.
- .4 Performance: refer to schedule on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

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

PART 1 - GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.2 REFERENCES .1 Underwriters Laboratories (UL)
.1 UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

PART 2 - PRODUCTS

2.1 GENERAL .1 To meet capacity as indicated.
.2 Frames:
.1 Full perimeter gaskets.
.2 Plaster frames where set into plaster or gypsum board.
.3 Concealed fasteners.
.3 Colour: off-white.

2.2 MANUFACTURED UNITS .1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.3 SUPPLY DIFFUSERS .1 Type SD1: Annular jet diffuser: ball type air outlet with 60° global rotation easily adjustable by hand. Low noise level and pressure requirements. Face flange and ball to be Thermo Plastic, medium impact "Flame Retardant" grade ABS 94 V-O flame retardance rating per UL 94. Anodised Aluminium Rear flange. Colour: off-white.
.2 Type SD2: aluminum, 1200 mm long, 2 x 25 mm slots - 2-way adjustable aluminum pattern controllers, off-white finish, with insulated plenum, T-bar mounting.
.3 Type SD3: aluminum, 1200 mm long, 3 x 25 mm slots - 2-way adjustable aluminum pattern controllers, off-white finish, with insulated plenum, T-bar mounting.
.4 Type SD4: steel, square diffuser with adjustable pattern 600 mm x 600 mm, T-bar or drywall mounting as indicated, off-white.
.5 Type SD5: Steel supply grilles, double deflection, sizes and mounting types shown on the plans and diffuser schedule. The deflection blades shall be parallel to the short dimension of the grille. Construction shall be of steel with a 32 mm wide border on all sides. Screw holes shall be countersunk for a neat appearance. Blades shall be spaced on 20 mm centers. Blades shall have steel friction pivots on both ends to allow individual blade adjustment without loosening or rattling. Plastic blade pivots are not acceptable. Colour: off-white.

2.4 RETURN AND
EXHAUST GRILLES

- .1 Type RG1: aluminum, 13 mm x 13 mm egg crate type face bars, baked white enamel finish, ducted where indicated, T-bar mounted. Size 600 mm x 150 mm unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install with flat head cadmium plated screws in countersunk holes where fastenings are visible.

PART 1 - GENERAL

- 1.1 REFERENCES
- .1 ASTM International
 - .1 ASTM C547-12, Specification for Mineral Fiber Pipe Insulation.
 - .2 CSA International
 - .1 CSA B52-13, Mechanical Refrigeration Code.
 - .2 CAN/CSA C656-14, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
 - .3 Underwriters Laboratories of Canada (ULC).
- 1.2 ACTION AND INFORMATIONAL SUBMITTALS
- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 GENERAL
- .1 Integrated package: to CAN/CSA C656.
 - .2 System type:
 - .1 As indicated on drawings.
 - .2 Cooling:
 - .1 1st Floor, Electrical room: chilled water A/C 1 unit.
 - .1 (6.8 kW) ceiling mounted, 208/1/60, air distribution plenum (bottom supply and return) with 20% efficient filters, disconnect switch, remote control and thermostat (wall mounted), two way modulating chilled water control/balancing valve, condensate pump. Unit to be provided with a drain pan complete with leak detection system sized for unit as well as for condensate pump. Unit to be interconnected with Building Automation System, refer to Division 25 - Controls. See table "A/C UNIT SCHEDULE" on drawing.
 - .2 1st Floor, Telcom room: glycol cooled split A/C 2 unit.
 - .1 (18.28 kW) evaporator unit and glycol cooled condensing unit 208/3/60, sweat adaptor kit, filter box with 20% efficient filters, 11.5 kW electric reheat coil, 3.6 kg/hr. humidifier, return and supply ducting, disconnect switch, condensate pump, drain pan sized for unit as well as for condensate pump, remote control and thermostat (wall mounted). Unit to be interconnected with Building Automation System, refer to Division 25 - Controls. See table "A/C UNIT SCHEDULE" on drawing.
 - .2 Glycol cooled condensing unit to be provided with two ways modulating control/balancing valve.
 - .3 Cooling capacity, with fan heat extracted: based on computer room environment of 22°C dry bulb and 50% R.H. (plus or minus 1°C and 5% R.H.), with minimum supply air temperature of 14°C.
 - .4 Welded drain pan to be supplied with leak detection wired to the Building Automation System with critical alarm to be sent to building operator via pager.

2.1 GENERAL (Cont'd)	.2	System type:(Cont'd)
	.2	Cooling:(Cont'd)
	.3	3rd Floor, Center electrical room: chilled water A/C 3 unit.
	.1	Water cooled unit (7.9 kW vertical unit), 208/1/60, unit mounted control and thermostat, two way modulating chilled water control/balancing valve, 20% efficient disposable filter, disconnect switch, spare filter and belt. Unit to be mounted within a drain pan complete with leak detection system. Unit to be interconnected with Building Automation System, refer to Division 25 - Controls. See table "A/C UNIT SCHEDULE" on drawing.
	.2	Condensate pump for A/C 3 unit: capacity of 1.9 Litres, 6 m head, 115V/1ph/60Hz, complete with stainless steel shaft, removable check valve, thermally protected, fully automatic operation with a built in safety switch.
2.2 CABINET	.1	Welded galvanized steel, unit construction, corrosion protected, 20 mm thick acoustic insulation, factory baked on external finish.
	.2	Cabinet to house: compressors, cooling coil, reheat coil, fans, filters, humidifier, unit environmental control system, motor starters or contactors and electrical disconnect switch. A/C-2 to have separate condensing unit.
	.3	Include adequate access to components for servicing.
2.3 DISCHARGE PLENUM	.1	A/C-1 to be c/w bottom mounted discharge plenum, integral filter and 4- way air distribution.
2.4 FANS	.1	DWDI centrifugal, statically and dynamically balanced, Direct drive, with self-aligning, permanently lubricated, 100,000 hours minimum life ball or roller bearings.
2.5 FAN MOTORS	.1	Drip-proof permanently lubricated bearings for continuous duty, 40°C maximum rise.
2.6 COMPRESSORS	.1	Scroll type, with:
	.1	Vibration isolators.
	.2	Adjustable high and low pressure switches.
	.3	Anti-slug device.
	.4	Motor overload and over temperature protection pump down controls.
	.5	Crank case heater.
	.6	Compressor lead/lag switch.
	.7	Refrigerant service valves.
	.8	Capacity controls.
2.7 COOLING COIL	.1	Aluminum fins, mechanically bonded to copper tubes, tested to 1.7 MPa, maximum face velocity 2.8 m/s, with stainless steel insulated condensate tray.

<u>2.7 COOLING COIL (Cont'd)</u>	.2	Cooling coil condensate drain pans: designed to avoid standing water, easily cleaned or removable for cleaning.
<u>2.8 WATER LEAK DETECTION SYSTEM</u>	.1	Provide, in drip pan, a water leak detection system c/w analog output to BAS and 24 VAC power.
	.2	Wall mounted control panel to include dry contact.
	.3	To be provided for AC-1, AC-2 and AC-3. Refer to Division 25 - Controls.
<u>2.9 REHEAT COIL - A/C-2</u>	.1	Electric: CSA or ULC approved, stainless steel or copper fin-tubular construction. Two stages minimum. .1 Capacity: as indicated. .2 SCR control.
	.2	Coils: located down-stream of cooling coil.
<u>2.10 HUMIDIFIER - A/C-2</u>	.1	Steam generator type: plastic disposable reservoir-boiler, latticed electrode heating elements complete with steam distributor.
	.2	Capacity: 3.6 kg/h.
	.3	Location downstream of cooling coil with water level control, overflow and drain, strainer and automatic flush, CSA or ULC approved.
<u>2.11 CONDENSER - A/C-2</u>	.1	Glycol cooled: coaxial or shell and tube type, sized for each compressor/evaporator combination; complete with head pressure actuated water regulating valve for each refrigerant circuit. .1 Capacity: as indicated.
<u>2.12 REFRIGERANT PIPING, VALVES, FITTINGS AND ACCESSORIES WITHIN UNIT</u>	.1	To CSA B52.
	.2	Include for each refrigerant circuit: .1 Thermal expansion valve, external equalizing type. .2 Combination filter-dryer. .3 Solenoid valves. .4 Liquid sight glass with moisture indicator. .5 Suction line insulation: flexible elastomeric unicellar to ASTM C547, 12 mm minimum thickness.
<u>2.13 ENVIRONMENTAL CONTROLS</u>	.1	Microprocessor based wall or unit mounted c/w LCD display.
	.2	Panel to include following: .1 Manual operation and adjustment: .1 On-Off air conditioning system control. .2 Room temperature set point, indicator and sensitivity adjustment controller.

- 2.13 ENVIRONMENTAL CONTROLS
(Cont'd)
- .2 Panel to include following:(Cont'd)
- .1 (Cont'd)
- .3 Room humidity set point, indicator and sensitivity adjustment controller.
- .4 Alarm silencing switch for each alarm point.
- .5 Two sets of dry contacts for connection to security alarm system.
- .2 Operational: Visual and Audible Alarm:
- .1 Loss of air flow.
- .2 Loss of liquid flow.
- .3 High room temperature.
- .4 Low room temperature.
- .5 High humidity.
- .6 Low humidity.
- .3 Operational: Visual display:
- .1 Cooling each stage.
- .2 Humidification (AC-2).
- .3 Dehumidification (AC-2).
- .4 Change filter.
- 2.14 REFRIGERANT CHARGE
- .1 Charge refrigerant system at factory, seal and test. Refrigerant to be R410A.
- .2 Holding charge of refrigerant applied at factory.

PART 3 - EXECUTION

- 3.1 GENERAL
- .1 Install as indicated, to manufacturer's recommendations, and to EPS 1/RA/2.
- .2 Manufacturer to certify installation.
- .3 Unit to be provided with inputs/outputs for connection to building automation system.
- 3.2 EQUIPMENT PREPARATION
- .1 Provide services of manufacturer's field engineer to set and adjust equipment for operation as specified.