

PART 1 - GENERAL

- | | |
|--|---|
| <u>1.1 RELATED REQUIREMENTS</u> | <ul style="list-style-type: none">.1 Section 01 01 00 - General Instructions..2 Section 01 33 00 - Submittal Procedures..3 Section 01 35 29.06 - Health and Safety Requirements..4 Section 01 78 00 - Closeout Submittals..5 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC. |
| <u>1.2 ACTION AND INFORMATIONAL SUBMITTALS</u> | <ul style="list-style-type: none">.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures..2 Shop drawings to show:<ul style="list-style-type: none">.1 Mounting arrangements..2 Operating and maintenance clearances..3 Shop drawings and product data accompanied by:<ul style="list-style-type: none">.1 Detailed drawings of bases, supports, and anchor bolts..2 Acoustical sound power data, where applicable..3 Points of operation on performance curves..4 Manufacturer to certify current model production..5 Certification of compliance to applicable codes..4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number..5 Closeout Submittals:<ul style="list-style-type: none">.1 Provide operation and maintenance data for incorporation into manual..2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection..3 Manual to include:<ul style="list-style-type: none">.1 Binder labelled on cover and binder edge with; building name and address, project name, project number and date completed..2 Title page c/w building name, address, date, general contractor information: name, address and phone number and consultant: name, address and phone number..3 Signed letter of warranty: dated, identifying project by name, project number, location and warranty period..4 Contact information for all sub-contractors and suppliers..5 CMMS data sheets for all equipment to be deleted, removed, added or replaced from site..4 Operation data to include:<ul style="list-style-type: none">.1 Control schematics for systems including environmental controls..2 Description of systems and their controls including sequence of operation..3 Description of operation of systems at various loads together with reset schedules and seasonal variances..4 Operation instruction for systems and component..5 Description of actions to be taken in event of equipment failure..6 Valves schedule and flow diagram..7 Colour coding chart. |

Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

- 1.5 DELIVERY, STORAGE, AND HANDLING .1 Waste Management and Disposal:
.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 01 00 - General Instructions.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

- 3.1 CLEANING .1 Clean interior and exterior of all systems including strainers.
- 3.2 DEMONSTRATION .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- 3.3 PROTECTION .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
- 1.2 REFERENCES .1 National Fire Code of Canada (NFCC 2005)
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 NOT USED .1 Not used.

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.
- 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.

-
- | | | |
|--------------------------------------|----|---|
| 3.4 DRAINS
<u>(Cont'd)</u> | .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
<u></u> | .1 | Install air vents to 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
<u></u> | .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
<u></u> | .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. |
| | .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. |
-

3.7 PIPEWORK
INSTALLATION
(Cont'd)

- .13 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 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 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
- 1.2 REFERENCES .1 American Society of Mechanical Engineers (ASME).
.1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Submittals 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 Low light compatible solar powered display, 90 mm stem, durable NEMA-5 ABS case, 32 mm UNF swivel nut, 19 mm, NPT with brass thermowell, 6 sec. read interval, -45°C to 160°C range, accurate to 0.1 degree, switchable metric/imperial scale, vari-angle connection, +/- 1% accuracy, 4-20 mA output, 90 mm stem, one (1) year warranty.
- 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, stainless steel or 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.
.4 Bronze stop cock.

PART 3 - EXECUTION

- 3.1 GENERAL** .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.
- 3.2 THERMOMETERS** .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
.1 unit heaters.
- .3 Use extensions where thermometers are installed through insulation.
- 3.3 PRESSURE GAUGES**1 Install in following locations:
.1 Inlet and outlet of unit heaters
- .2 Use extensions where pressure gauges are installed through insulation.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
- 1.2 REFERENCES .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
.1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
.2 ANSI/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.
- 1.3 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 ANSI/ASME B1.20.1.
.2 Copper tube systems: solder ends grooved ends to ANSI/ASME B16.18.
.3 Lockshield Keys:
.1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
.4 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: solder ends to ANSI.
.4 Stem: tamperproof ball drive.
.5 Stem packing nut: external to body.
.6 Ball and seat: replaceable stainless steel hard chrome solid ball and Teflon seats.
.7 Stem seal: TFE with external packing nut.
.8 Operator: removable lever handle.

2.1 MATERIALS
(Cont'd)

- .5 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 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.

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,

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS** .1 Section 01 33 00 - Submittal Procedures.
- 1.2 REFERENCES** .1 American Society of Mechanical Engineers (ASME)
.1 ANSI/ASME B31.1-2012, Power Piping.
.2 ASTM International
.1 ASTM A125-96(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
.2 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
.3 Factory Mutual (FM)
.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
.1 ANSI/MSS SP 58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
.5 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 ANSI/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 ANSI/MSS SP 58.
- 2.2 GENERAL** .1 Fabricate hangers, supports and sway braces in accordance with ANSI/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 hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are 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 & FM approved to ANSI/MSS SP 58.
- .3 Hanger rods: threaded rod material to ANSI/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.
- .4 Pipe attachments: material to ANSI/MSS SP 58:
- .1 Attachments for steel piping: carbon steel black galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .5 Adjustable clevis: material to ANSI/MSS SP 58, UL listed & FM approved, 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.
- .6 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to ANSI/MSS SP 58.
- .7 U-bolts: carbon steel to ANSI/MSS SP 58 with 2 nuts at each end to ASTM A563.
- .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, epoxy coated.
- .8 Pipe rollers: cast iron roll and roll stand with carbon steel rod to ANSI/MSS SP 58.

2.4 INSULATION PROTECTION SHIELDS .1

- Insulated cold piping:
- .1 4 kg/m³ density insulation plus insulation protection shield to ANSI/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 ANSI/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.

- 2.5 CONSTANT SUPPORT SPRING HANGERS .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- (Cont'd) .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

PART 3 - EXECUTION

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

- 3.2 INSTALLATION .1 Install in accordance with:
- .1 Manufacturer's instructions and recommendations.
 - .2 Vibration Control Devices:
 - .1 Install on piping systems at unit heaters.
 - .3 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
 - .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
 - .5 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.

- 3.3 HANGER SPACING .1 Copper piping: up to NPS 1/2: every 1.5 m.
- .2 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.
- .3 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	

- .4 Pipework greater than NPS 12: to ANSI/MSS SP 58.

- | | |
|------------------------------------|---|
| <u>3.4 HANGER
INSTALLATION</u> | <ul style="list-style-type: none">.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. |
| <u>3.5 HORIZONTAL
MOVEMENT</u> | <ul style="list-style-type: none">.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. |
| <u>3.6 FINAL
ADJUSTMENT</u> | <ul style="list-style-type: none">.1 Adjust hangers and supports:<ul style="list-style-type: none">.1 Ensure that rod is vertical under operating conditions..2 Equalize loads..2 Adjustable clevis:<ul style="list-style-type: none">.1 Tighten hanger load nut securely to ensure proper hanger performance..2 Tighten upper nut after adjustment. |

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
- 1.2 DEFINITIONS .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.
- 1.3 DESCRIPTION .1 SRS fully integrated into, and compatible with:
- .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.
- 1.4 ACTION AND INFORMATIONAL SUBMITTALS .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 SRS MANUFACTURER .1 SRS from one manufacturer regularly engaged in SRS production.
- 2.2 GENERAL .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:
- .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.

- 2.2 GENERAL (Cont'd)
- .6 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.
 - .7 Seismic control measures not to interfere with integrity of firestopping.
- 2.3 SRS FOR VIBRATION ISOLATED EQUIPMENT
- .1 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system.
 - .2 Brace back to structure via vibration isolators and snubbers.
- 2.4 SLACK CABLE RESTRAINT SYSTEM (SCS)
- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
 - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
 - .3 Hanger rods to withstand compressive loading and buckling.

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 Attachment points and fasteners:
 - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
 - .2 Slack Cable Systems (SCS):
 - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
 - .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
 - .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
 - .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
 - .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
 - .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
 - .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
 - .3 Install SRS at least 25 mm from equipment, systems, services.

3.2 INSTALLATION
(Cont'd)

- .4 Miscellaneous equipment not vibration-isolated:
 - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.
- .6 Vertical tanks:
 - .1 Anchor through house-keeping pad to structure.
 - .2 Provide steel bands above centre of gravity.
- .7 Horizontal tanks:
 - .1 Provide at least two straps with anchor bolts fastened to structure.

3.3 FIELD QUALITY CONTROL
CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 Upon completion of installation.
 - .3 Submit manufacturer's reports stamped by seismic engineer to Departmental Representative within 3 days of manufacturer representative's review.

PART 1 - GENERAL

- 1.1 REFERENCES .1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-24.3-92, Identification of Piping Systems.

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 Where existing identification system does not cover for new work, use identification system specified this section.
.3 Before starting work, obtain written approval of identification system from Departmental Representative.
- 2.3 IDENTIFICATION OF PIPING SYSTEMS .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
.2 Pictograms:
.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
.3 Legend:
.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
.4 Arrows showing direction of flow:
.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
.3 Use double-headed arrows where flow is reversible.
.5 Extent of background colour marking:
.1 To full circumference of pipe or insulation.
.2 Length to accommodate pictogram, full length of legend and arrows.
.6 Materials for background colour marking, legend, arrows:
.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

**2.3 IDENTIFICATION
OF PIPING SYSTEMS**
(Cont'd)

- .6 (Cont'd)
- .2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

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

Contents	Background colour marking	Legend
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS

**2.4 VALVES,
CONTROLLERS**

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

**2.5 CONTROLS
COMPONENTS
IDENTIFICATION**

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.6 LANGUAGE

- .1 Identification in English.

PART 3 - EXECUTION

- 3.1 MANUFACTURER'S INSTRUCTIONS** .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 INSTALLATION** .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
.2 Provide ULC and/or CSA registration plates as required by respective agency.
- 3.3 NAMEPLATES** .1 Locations:
.1 In conspicuous location to facilitate easy reading and identification from operating floor.
.2 Standoffs:
.1 Provide for nameplates on hot and/or insulated surfaces.
.3 Protection:
.1 Do not paint, insulate or cover.
- 3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS** .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more specified in this section. frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
.2 Adjacent to each change in direction.
.3 At least once in each small room through which piping or ductwork passes.
.4 On both sides of visual obstruction or where run is difficult to follow.
.5 On both sides of separations such as walls, floors, partitions.
.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
.7 At beginning and end points of each run and at each piece of equipment in run.
.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
.9 Identification easily and accurately readable from usual operating areas and from access points.
.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

- 3.5 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 Number valves in each system consecutively.

PART 1 - GENERAL

- 1.1 CO-ORDINATION** .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.
- 1.2 PRE-TAB REVIEW** .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.
- 1.3 START-UP** .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.
- 1.4 OPERATION OF SYSTEMS DURING TAB** .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.
- 1.5 START OF TAB** .1 Provisions for TAB installed and operational.
- .2 Hydronic systems flushed, filled, vented.
- 1.6 APPLICATION TOLERANCES** .1 Do TAB to following tolerances of design values:
- .1 Hydronic systems: plus or minus 10%.
- 1.7 ACCURACY TOLERANCES** .1 Measured values accurate to within plus or minus 2% of actual values.
- 1.8 INSTRUMENTS** .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.

- 1.9 TAB REPORT .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
- .1 Project record drawings.
- .2 System schematics.
- .3 Submit one (1) electronic copy of TAB Report to Departmental Representative for verification and approval, in English, complete with index tabs.
- 1.10 SETTINGS .1 After TAB is completed to satisfaction of Departmental Representative permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.
- 1.11 COMPLETION OF TAB .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.
- 1.12 HYDRONIC SYSTEMS .1 Hydronic Systems: Include both specified and measured data.
- .1 Unit and Cabinet Heater:
- .1 Start unit and check for noise or vibration.
- .2 Check unit performance for each fan speed:
- .1 Air flow and temperature rise.
- .2 Water temperature drop.
- .3 Fluid flow rate.
- .2 Measurements: to include, but not limited to, following as appropriate for systems, static pressure.

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 American Society for Testing and Materials International (ASTM)
- .1 ASTM C335-10e1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C449/C449M-07, 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 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting 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-AM1, Thermal Insulation, Mineral Fibre, for Buildings

PART 2 - PRODUCTS

- 2.1 FIRE AND SMOKE RATING** .1 In accordance with CAN/ULC S102.
- .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.
- 2.2 INSULATION** .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-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.
- 2.3 INSULATION SECUREMENT** .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

- 2.4 CEMENT .1 Thermal insulating and finishing cement:
.1 Hydraulic setting or air drying on mineral wool, to ASTM C449/C449M.
- 2.5 VAPOUR RETARDER LAP ADHESIVE .1 Water based, fire retardant type, compatible with insulation.
- 2.6 INDOOR VAPOUR RETARDER FINISH .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: to match adjacent finish paint by Departmental Representative.
.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 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.

- 3.3 INSTALLATION (Cont'd) .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 valves, primary flow measuring elements, flanges and unions at equipment.
.2 Design: 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 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
Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38

- .4 Finishes:
.1 Exposed indoors: PVC jacket.
.2 Exposed in mechanical rooms: PVC jacket.
.3 Finish attachments: SS bands, at 150 mm on centre. Seals: wing or closed.
.4 Installation: to appropriate TIAC code CRF/1 through CPF/5.

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 23 05 23.01 - Valves - Bronze.
.2 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- 1.2 REFERENCES .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
.1 ANSI/AWS A5.8M/A5.8:2011-AMD, Specification Filler Metals for Brazing and Bronze Welding.
.2 American Society of Mechanical Engineers (ASME)
.1 ANSI/ASME B16.4-2011, Gray-Iron Threaded Fittings.
.2 ANSI/ASME B16.15-2011, Cast Bronze Threaded Fittings.
.3 ANSI/ASME B16.18-2012, Cast Copper Alloy, Solder Joint Pressure Fittings.
.4 ANSI/ASME B16.22-2011, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
.3 American Society for Testing and Materials International (ASTM)
.1 ASTM B32-08, Standard Specification for Solder Metal.
.2 ASTM B88M-05(2011), Standard Specification for Seamless Copper Water Tube Metric.

PART 2 - PRODUCTS

- 2.1 PIPING .1 Type L hard drawn copper tubing: to ASTM B88M.
- 2.2 FITTINGS .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
.2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
.3 Cast iron threaded fittings: to ANSI/ASME B16.4.
.4 Cast copper alloy solder joint pressure fittings: to ANSI/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 Ball valves:
.1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

PART 3 - EXECUTION

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

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

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

- 3.4 CIRCUIT BALANCING VALVES .1 Install flow balancing valves as indicated.
.2 Remove handwheel after installation and TAB is complete.

- 3.5 FILLING OF SYSTEM .1 Refill system with clean water adding water treatment as specified.

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

PART 1 - GENERAL

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

PART 2 - PRODUCTS

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

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 GENERAL .1 Run drain lines to terminate above nearest drain.
- 3.3 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 01 - Installation of Pipework.

1.2 REFERENCES .1 American Society of Mechanical Engineers (ASME)
.1 ANSI/ASME B16.22-2011, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
.2 ANSI/ASME B16.24-2011, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
.3 ANSI/ASME B16.26-2011, Cast Copper Alloy Fittings for Flared Copper Tubes.
.4 ANSI/ASME B31.5-2010, Refrigeration Piping and Heat Transfer Components.
.2 American Society for Testing and Materials International (ASTM)
.1 ASTM A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
.2 ASTM B209-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
.3 ASTM B280-08, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
.3 Canadian Standards Association (CSA International)
.1 CSA B52-05(2009), 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.

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 ANSI/ASME B31.5.

2.2 FITTINGS .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
.2 Brazed:
.1 Fittings: wrought copper to ANSI/ASME B16.22.
.2 Joints: silver solder, 45% Ag-15% Cu and non-corrosive flux.
.3 Flanged:
.1 Bronze or brass, to ANSI/ASME B16.24, Class 150 and Class 300.
.2 Gaskets: suitable for service.
.3 Bolts, nuts and washers: to ASTM A307, heavy series.
.4 Flared:
.1 Bronze or brass, for refrigeration, to ANSI/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>2.7 JACKETS</u>	.1	Aluminum on all outdoor piping:
	.1	To ASTM B209.
	.2	Thickness: 0.50 mm sheet.
	.3	Finish: embossed.
	.4	Joining: Longitudinal and circumferential slip joints with 50 mm laps.
	.5	Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
	.6	Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

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 GENERAL</u>	.1	Install in accordance with CSA B52, EPS1/RA/1, ANSI/ASME B31.5 and Section 23 05 01 - 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.

**3.4 PIPING
INSTALLATION**

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
 - .3 Provide inverted deep trap at top of risers.
 - .4 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

**3.5 PRESSURE AND
LEAK TESTING**

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

**3.6 FIELD QUALITY
CONTROL**

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

- 3.6 FIELD QUALITY CONTROL
(Cont'd)
- .7 Charging:(Cont'd)
- .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
- .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
- .2 Record and report measurements to Departmental Representative.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.

1.2 REFERENCES .1 Canadian General Standards Board (CGSB)
.1 CAN/CGSB 51.40-95, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
.2 Canadian Standards Association (CSA)
.1 CSA B52S1-09, Mechanical Refrigeration Code.
.2 CAN/CSA C656-05(R2010), Performance Standard for Split-System and Single-Package Central Air Conditioners and Heat Pumps.

1.3 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 Air flow arrangement: wall mounted with bottom return grille.
.2 Cooling: direct expansion with matching air cooled condensing unit.
.3 Unit capacity: see schedule on drawings.
.4 Unit capacity to be sized using indoor air at 22°C and 50% R.H & outdoor air at 35°C.
.5 Unit to be equipped for low ambient operation to -40°C.
.6 Capable of operating with a refrigerant piping length of 50 metres and a height difference of 33.5 metres.

2.2 CABINET .1 Galvanize steel frame, epoxy coated finish. Ready for ceiling mounting complete with white plastic cover.
.2 Cabinet to house: cooling coil, fans, filters and electrical controls.
.3 Provide adequate access to components for servicing.

- 2.3 FILTER HOUSING .1 The filter chamber shall be an integral part of the cabinet and located at the entrance of the return air path and should be serviceable from below.
- .2 Filter shall be a removable and washable.
- 2.4 FAN .1 Direct driven, double width fan wheels with forward curved blades, statically and dynamically balanced.
- 2.5 COMPRESSORS .1 Hermetic type, with: vibration isolators, adjustable high and low pressure switches, anti-slug device, motor overload and overtemperature protection pump down controls, refrigerant service valves and capacity controls.
- 2.6 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 and drain connections.
- .2 Direct expansion: with separate refrigerant circuit for each compressor and shall be split.
- .3 Cooling coil condensate drain pans: designed to avoid any standing water, to be easily cleaned or removable for cleaning.
- 2.7 AIR COOLED CONDENSER .1 Air cooled: free standing, welded steel unit construction, corrosion protected.
- .1 Aluminum fins, mechanically bonded to copper tubes, tested to 3.1 MPa.
- .2 Propeller type fans. Direct drive.
- .3 Electrical and control components housed in weather-tight access panels with electrical disconnect switch and control cable for control interconnection.
- .4 Vibration isolation: providing at least 95% isolation efficiency.
- 2.8 REFRIGERANT PIPING, VALVES, FITTINGS AND ACCESSORIES WITHIN UNIT .1 To CSA B52.
- .2 Include for each refrigerant circuit:
- .1 Orifice type metering device.
- .2 Combination filter-dryer.
- .3 Gas & liquid line insulation: flexible elastomeric unicellar to CAN/CGSB 51.40, 12 mm minimum thickness.
- .4 Liquid refrigerant receiver.
- 2.9 ENVIRONMENTAL CONTROLS .1 The system shall incorporate a programmable temperature controller. The controller shall be shipped loose for field mounting with factory wired air temperature sensor. The controller shall indicate temperature and include the following: fan selector, built-in short cycle protection, night set back and manual override.

2.10 REFRIGERANT CHARGE .1 Charge refrigerant system at factory, seal and test.

PART 3 - EXECUTION

3.1 GENERAL .1 Install as indicated, to manufacturers' recommendation.
.2 Manufacturer to certify installation.
.3 Mount programmable controls and extend 24V wiring to condensing/fan coil unit.

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

PART 1 - GENERAL

- 1.1 RELATED REQUIREMENTS .1 Section 01 33 00 - Submittal Procedures.
- 1.2 REFERENCES .1 Underwriters' Laboratories (UL) Inc.
.1 UL 2021, Fixed and Location-Dedicated Electric Room Heaters.
- 1.3 ACTION AND INFORMATIONAL SUBMITTALS .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

- 2.1 VERTICAL UNIT HEATERS .1 Vertical Unit Heaters: to UL 2021.
- .2 Casing: 1.6 mm thick cold rolled steel, glossed enamel finish, with threaded connections for hanger rods.
- .3 Coils: hydrostatically test to 1 MPa.
.1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.
- .4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish.
- .5 Motor: speed as indicated, continuous duty, ball bearing motor with built-in overload protection, and resilient motor supports.
- .6 Air outlet: adjustable multi-vane diffuser with finish to match casing.
- .7 Capacity: as indicated.

PART 3 - EXECUTION

- 3.1 INSTALLATION .1 Install in accordance with manufacturer's instructions.
- .2 Include double swing pipe joints as indicated.
- .3 Clean finned tubes and comb straight.
- .4 Provide supplementary suspension steel as required.
- .5 Install thermostats in locations indicated.
- .6 Before acceptance, set discharge patterns and fan speeds to suit requirements.