

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Use of mechanical systems during construction.

**1.2 USE OF SYSTEMS**

.1 Use of new permanent heat and ventilating systems for supplying temporary heat and ventilation are permitted only under the following conditions:

- .1 Entire system is complete, pressure tested, cleaned, flushed out.
- .2 Building has been closed in; areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
- .3 There is no possibility of damage.
- .4 Supply ventilation systems are protected by approved filters, inspected daily, changed every 2 weeks or more frequently as required.
- .5 Return systems have approved filters over openings, inlets, outlets.
- .6 Systems will be:
  - .1 Operated as per manufacturer's recommendations and instructions.
  - .2 Operated by Contractor.
  - .3 Monitored continuously by Contractor.
- .7 Warranties and guarantees are not relaxed.
- .8 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Contract Administrator.
- .9 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

.2 Exhaust systems are not included in approvals for temporary heating and ventilation.

**1.3 NOT USED**

.1 Not Used.

**Part 2            Execution**

**2.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 The supply and installation of pipework.

**1.2 REFERENCES**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 CONNECTIONS TO EQUIPMENT**

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

**3.2 CLEARANCES**

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

**3.3 DRAINS**

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

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

### **3.4 AIR VENTS**

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

### **3.5 DIELECTRIC COUPLINGS**

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

### **3.6 PIPEWORK INSTALLATION**

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .6 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .7 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .8 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .9 Group piping wherever possible and as indicated.
- .10 Ream pipes, remove scale and other foreign material before assembly.
- .11 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

- .12 Provide for thermal expansion as indicated.
- .13 Valves:
  - .1 Install in accessible locations.
  - .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless otherwise indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Install globe valves in bypass around control valves.
  - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
  - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.

### **3.7 SLEEVES**

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: Terminate flush with finished surface.
  - .2 Other floors: Terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
  - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.

- .4 Ensure no contact between copper pipe or tube and sleeve.

### **3.8 ESCUTCHEONS**

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

### **3.9 PREPARATION FOR FIRESTOPPING**

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

### **3.10 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 22 42 01, Section 22 42 02, and 22 11 18.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

### **3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Contract Administrator 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Division 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Division 23.
- .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 Contract Administrator.
- .6 Pay costs for repairs or replacement, retesting, and making good. Contract Administrator to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Contract Administrator.

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- .8 Preparation for Testing
- .1 Coordinate the time of leak tests with the City and Contract Administrator so that tests can be conducted in the presence of the Contract Administrator. Failure to do so will require the retesting of the systems at no cost to the City or Contract Administrator.
  - .2 All joints including welds shall be left uninsulated and exposed for examination during the test
  - .3 Expansion joints that cannot sustain the reactions due to test pressure shall be provided with temporary restraint, or they may be isolated from testing
  - .4 Equipment that is not subject to the test pressure shall be isolated from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damaging the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
  - .5 If the test pressure is to be maintained for an extended period of time during the leakage inspections and the test fluid may be subject to thermal expansion
- .9 Hydrostatic Testing
- .1 Water at the space ambient temperature shall be used as the test medium.
  - .2 Vents shall be provided at high points in the system to release trapped air while filling the system. Drains shall be provided at low points for complete removal of the test liquid.
  - .3 The system shall be examined to see that all equipment and parts that cannot withstand the test pressure are properly isolated. Test equipment shall be examined to ensure that it is tight and that low pressure filling lines are disconnected.
  - .4 The piping system shall be subjected to a hydrostatic test pressure which is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum test pressure for any vessel, pump, valve or other component in the system under test. A check shall be made to verify that the stress due to pressure at the bottom of vertical runs does not exceed either the 90% of specified minimum yield strength or 1.7 times the SE value as outlined in ASME B31.9.
  - .5 Following the application of hydrostatic test pressure for at least 10 minutes, examination shall be made for leakage of the piping, and at all joints and connections. If leaks are found, they shall be eliminated by tightening, repair or replacement, as appropriate, and the hydrostatic test repeated until no leakage is found.
- .10 Pay costs for repairs or replacement, retesting, and making good. Contract Administrator to determine whether repair or replacement is appropriate.
- .11 Insulate or conceal work only after approval and certification of tests by Contract Administrator.

**3.12            EXISTING SYSTEMS**

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

**END OF SECTION**



**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Electrical motors, drives and guards for mechanical equipment and systems.
  - .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
  - .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Submittals: in accordance with Specification E3 – Shop Drawings.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Specification E3 – Shop Drawings. Include product characteristics, performance criteria, and limitations.
  - .2 Shop Drawings: submit drawings stamped and signed by a Contract Administrator registered or licensed in the Province of Manitoba.
- .3 Quality Control: in accordance with Section C11.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals
  - .1 Provide maintenance data for motors for incorporation into manual specified in Section E4.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturers recommendations and Section E4.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2 Products**

**2.1 GENERAL**

- .1 Motors: high efficiency, in accordance with local electric utility 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°C, 3 phase, 208V, unless otherwise indicated.

**2.3 TEMPORARY MOTORS**

- .1 If delivery of specified motor will delay completion or commissioning work, install motor reviewed by Contract Administrator 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.
- .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 E4.

## **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.

### **3.3 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section C11 and submit report as described in PART 1 - SUBMITTALS.
  - .1 Bump motors to insure proper rotation.
  - .2 Confirm amperage and voltage draws for each leg.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 22 42 01 and Section 22 42 02.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
- .1 The supply and installation of hangers and supports for HVAC piping and equipment.

**1.2 REFERENCES**

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
- .1 ANSI/ASME B31.9, Building Service Piping.
- .2 American Society for Testing and Materials International (ASTM)
- .1 ASTM A125, Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563, Specification for Carbon and Alloy Steel Nuts.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
- .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 ANSI/MSS SP69, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

**1.3 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 B31.9 or MSS SP58.
  - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

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

#### **1.4 SUBMITTALS**

- .1 Submittals: in accordance with Section E3.
- .2 Submit shop drawings and product data for following items:
  - .1 Bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.
- .3 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in Section E4.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section E4.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.9 and MSS SP58.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

#### **2.2 PIPE HANGERS**

- .1 Finishes:
  - .1 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.

- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
  - .2 Hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip to MSS SP69.
  - .2 Hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut.
- .4 Shop and field-fabricated assemblies:
  - .1 Trapeze hanger assemblies: fabricated from material complying with ASTM A-36.
- .5 Hanger rods: threaded rod material to MSS SP58:
  - .1 Ensure that hanger rods are subject to tensile loading only.
  - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .6 Pipe attachments: material to MSS SP58:
  - .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.
- .7 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
  - .1 Ensure "U" has hole in bottom for riveting to insulation shields.

## **2.3 INSULATION PROTECTION SHIELDS**

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

#### **2.4 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel.

#### **2.5 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

#### **2.6 HOUSEKEEPING PADS**

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section E17 - Structural Concrete.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

#### **3.2 GENERAL**

- .1 Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

#### **3.3 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

#### **3.4 HANGER SPACING**

- .1 Plumbing piping: to Manitoba Amendments of the National Plumbing Code and the authority having jurisdiction.
- .2 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.



- .3 Copper piping: up to NPS ½: every 1.5m.
- .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .5 Within 300 mm of each elbow.
- .6 Pipework greater than NPS 122: to MSS SP69.
- .7

Maximum Pipe Size: NPS	Maximum Spacing Copper
up to 1-1/4	1.8 m
1-1/2	2.4 m
2	2.7 m
2-1/2	3.0 m
3	3.3 m
4	3.6 m

### 3.5 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.
- .4 For pipe attachment to steel joints support piping from upper joist chord only.

### 3.6 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.

### 3.7 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.

- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 The testing, adjusting and balancing for HVAC systems.

**1.2 REFERENCES**

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

- .1 HVAC Applications Handbook, 2011, Chapter 38 – Testing, Adjusting and Balancing

.2 Associated Air Balance Council (AABC)

- .1 AABC National Standards for Total System Balance, 2002

- .2 AABC Test and Balance Procedures

.3 Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)

- .1 Manual for the Balancing and Adjustment of Air Distribution Systems

**1.3 SCOPE OF WORK**

.1 The mechanical contractor will contract with an independent testing, adjusting, and balancing (TAB) agency to test, adjust, and balance the HVAC systems.

- .2 The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

**1.4 QUALIFICATIONS**

- .1 Agency Qualifications: The TAB Agency shall be a current member of the Associated Air Balance Council (AABC).

**1.5 SUBMITTALS**

- .1 Qualifications: The TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer (TBE) certificate.

- .2 Submit names of personnel to perform TAB to Contract Administrator within 30 days of award of contract.

- .3 Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.
- .4 Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

## **1.6 TAB PREPARATION AND COORDINATION**

- .1 Shop drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to the start of TAB work.
- .2 System installation and equipment start-up to be complete prior to the TAB agency's being notified to begin.
- .3 The building control system shall be complete and operational. The Building Control System contractor shall install all necessary components and software, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.
- .4 All test points, balancing devices, identification tags, etc. shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.
- .5 Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

## **1.7 REPORTS**

- .1 Final TAB Report - The TAB agency shall submit the final TAB report for review by the Contract Administrator. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.

## **1.8 DEFICIENCIES**

- .1 Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the Contract Administrator.
- .2 The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

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**Part 2 Products**

**2.1 INSTRUMENTATION**

- .1 All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

**Part 3 Execution**

**3.1 GENERAL**

- .1 The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards. Adjustment tolerances shall be  $\pm 10\%$  unless otherwise stated.
- .2 Equipment settings, including manual valve indicators and similar controls and devices shall be marked to show final settings.
- .3 All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for work required, as listed in this section, are a guide to the minimum information needed.
- .4 Preconstruction Plan Check and Review:
  - .1 The TAB agency shall review the project documents and contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within 30 days of document review.
- .5 Job Site Inspections:
  - .1 During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two times. (Typically, these are performed when 60% of the total system is installed and again when 90% of the total system is installed, prior to insulation of the piping). The TAB agency shall submit a written report of each inspection.
- .6 Verification of HVAC Controls:
  - .1 The TAB agency shall be assisted by the building control systems contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:
    - .1 Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, and other safety devices.
    - .2 Verify that all controlling instruments are calibrated and set for design operating conditions.

.7 TAB Report Verification:

- .1 At the time of final inspection, the TAB agency will be required to recheck, in the presence of the Contract Administrator, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Contract Administrator. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed one day on site.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

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

**1.2 SUBMITTALS**

- .1 Submittals in accordance with Specification E3 – Shop Drawings.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section E4.

### **1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials in accordance with Section D13.

## **Part 2 Products**

### **2.1 TUBING**

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

### **2.2 FITTINGS**

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
  - .1 Fittings: wrought copper to ASME B16.22.
  - .2 Joints: silver solder, 15% Ag-80% Cu-5% P and non-corrosive flux.
- .3 Flanged:
  - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
  - .2 Gaskets: suitable for service.
  - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
  - .1 Bronze or brass, for refrigeration, to ASME B16.26.

### **2.3 PIPE SLEEVES**

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



## **2.4 VALVES**

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

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 GENERAL**

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

### **3.3 BRAZING PROCEDURES**

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

### **3.4 PIPING INSTALLATION**

- .1 General:
  - .1 Soft annealed copper tubing: bend without crimping or constriction.
- .2 Hot gas lines (if required):
  - .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°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 Contract Administrator.
- .7 Charging:
  - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
  - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report measurements to Contract Administrator.

### **3.7 DEMONSTRATION**

.1 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section E4 and CSA B52.

### **3.8 CLEANING**

.1 Perform cleaning operations in accordance with manufacturer's recommendations.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).  
.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

**1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section E3.

**Part 2 Products**

**2.1 SEAL CLASSIFICATION**

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed

.2 Seal classification:

- .1 Class C: transverse joints and connections made air tight with sealant or combination thereof. Longitudinal seams unsealed.  
.2 Unsealed seams and joints.

**2.2 SEALANT**

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

**2.3 DUCT LEAKAGE**

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

**2.4 FITTINGS**

.1 Fabrication: to SMACNA.

**2.5 ALUMINUM**

- .1 Ductwork Material: Al 3003 H14 per ASTM B209 with dimensional tolerances of ANSI Standard H 35.2.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

**2.6 HANGERS AND SUPPORTS**

- .1 Hangers and Supports:
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: 6061T6 aluminum angle with stainless steel rods to ASHRAE and SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6

**Part 3 Execution**

**3.1 GENERAL**

- .1 Work in accordance with ASHRAE and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.

**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 as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000

**3.3 SEALING AND TAPING**

- .1 Apply sealant to outside of joint to manufacturer's recommendations.

**3.4 LEAKAGE TESTS**

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

- .2 Make trial leakage tests as instructed to demonstrate workmanship.
- .3 Complete test before performance insulation or concealment Work.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Fans, motors, accessories and hardware for commercial use.

**1.2 REFERENCES**

.1 Air Conditioning and Mechanical Contractors (AMCA)

- .1 AMCA Publication 99, Standards Handbook.  
.2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.  
.3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

- .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

**1.3 SYSTEM DESCRIPTION**

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.  
.2 Capacity: flow rate, total static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.  
.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.  
.4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.  
.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

## **1.4 SUBMITTALS**

- .1 Shop Drawings:
  - .1 Submit shop drawings and product data in accordance with Section E3.
- .2 Provide:
  - .1 Fan performance curves showing point of operation, kW and efficiency.
  - .2 Sound rating data at point of operation.
- .3 Indicate:
  - .1 Motors, sheaves, bearings, shaft details.
  - .2 Minimum performance achievable with [variable speed controllers] [and] [variable inlet vanes] [as appropriate].
- .4 Quality assurance submittals: submit following in accordance with Section E3.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Closeout Submittals:
  - .1 Provide operation and maintenance data for incorporation into manual specified in Section E4.

## **1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section D22.
    - .1 Spare parts to include:
      - .1 Matched sets of belts.
    - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
      - .1 Bearings and seals.
      - .2 Addresses of suppliers.
      - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.



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**Part 2 Products**

**2.1 FANS GENERAL**

- .1 Motors:
  - .1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
  - .2 For use with variable speed controllers.
  - .3 Size: as indicated.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable motor bases, belt guards, coupling guards fan inlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

**2.2 CENTRIFUGAL FANS**

- .1 Fan wheels:
  - .1 Welded aluminum construction.
  - .2 Maximum operating speed of centrifugal fans not more than 50 % of first critical speed.
  - .3 Backward inclined blades, as indicated.
- .2 Bearings: flange mounted grease lubricated ball or roller self-aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 hours.
- .3 Housings:
  - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, aluminum, for smaller wheels, braced, and with welded supports.
  - .2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
  - .3 Provide bolted airtight access doors with handles.

**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 FAN INSTALLATION**

- .1 Install fans as indicated. Where fan control is not indicated, provide local switch adjacent to room light switch for on/off control of fan.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

**3.3 ANCHOR BOLTS AND TEMPLATES**

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Supply, return and exhaust grilles and registers, and diffusers and linear grilles, for commercial use.

**1.2 SYSTEM DESCRIPTION**

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

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section E3. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate following:
    - .1 Capacity.
    - .2 Throw and terminal velocity.
    - .3 Noise criteria.
    - .4 Pressure drop.
    - .5 Neck velocity.
- .2 Quality assurance submittals: submit following in accordance with Section E3.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Section E4.
  - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section E4.
  - .2 Include:
    - .1 Keys for volume control adjustment.
    - .2 Keys for air flow pattern adjustment.

**Part 2 Products**

**2.1 GENERAL**

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

**2.2 MANUFACTURED UNITS**

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

**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 manufacturer's instructions.
- .2 Install with stainless steel screws in countersunk holes where fastenings are visible.
- .3 DG-1: direct 30 degrees downwards from horizontal.
- .4 EG-1: direct XX degrees downwards from horizontal.

**3.3 CLEANING**

- .1 Proceed in accordance with Section D13.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

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

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section E3.
- .2 Indicate major components and accessories including sound power levels of units.
- .3 Type of refrigerant used.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide operation and maintenance data for incorporation into manual specified in Section D22.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Specification D13 - Construction/Demolition Waste Management and Disposal.

**1.5 WARRANTY**

- .1 For refrigeration compressors, the warranty period is as prescribed in Specification D13.

**Part 2 Products**

**2.1 GENERAL**

- .1 Integrated package: to CAN/CSA-C656.
- .2 System type:
  - .1 Air flow arrangement: up- flow.
  - .2 Cooling: direct expansion.
  - .3 Condensing: air cooled.
- .3 Cooling capacity, with fan heat extracted: based on 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 13°C.
- .4 Unit capacity: as indicated.

**2.2 CONDENSER**

- .1 Air cooled: free standing, welded steel unit construction, corrosion protected.
  - .1 Circuited to provide separate refrigerant circuit for each compressor/evaporator combination.
  - .2 Aluminum fins, mechanically bonded to copper tubes, tested to 3.1MPa.
  - .3 Propeller type fan(s), direct drive.
  - .4 Electrical and control components housed in weather-tight access panels with electrical disconnect switch and control cable for control interconnection.
  - .5 Vibration isolation: providing at least 95% isolation efficiency.
  - .6 Capacity: as indicated.

**2.3 REFRIGERANT PIPING, VALVES, FITTINGS AND ACCESSORIES WITHIN UNIT**

- .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.
- .6 Liquid refrigerant receiver.

**2.4 ENVIRONMENTAL CONTROLS**

- .1 Solid state electronic control system.

**2.5 REFRIGERANT CHARGE**

- .1 Charge refrigerant system at factory, seal and test.
- .2 Holding charge of refrigerant applied at factory.

**Part 3 Execution**

**3.1 GENERAL**

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

**3.2 EQUIPMENT PREPARATION**

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

**END OF SECTION**