

**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 two 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, and 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, and 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, and 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 – Plumbing Specialties and Accessories, Section 22 42 02 – Plumbing Fixtures, and 22 11 18 – Domestic Water Piping Copper.
- .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.
- .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 ten 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 E3 – Shop Drawings.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with 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:
  - .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 E5 – Additional Submittals.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturers recommendations and E5 – Additional Submittals.
- .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 centerline adjustment.

- .8 Supply one set of spare belts for each set installed in accordance with E5 – Additional Submittals.

## **2.5 DRIVE GUARDS**

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

## **Part 3 Execution**

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

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

### **3.2 INSTALLATION**

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

### **3.3 FIELD QUALITY CONTROL**

- .1 Site Tests:
- .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 above 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 – Plumbing Specialties and Accessories and Section 22 42 02 – Plumbing Fixtures.
- .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 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
  - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 ANSI/MSS SP69, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC).

**1.3 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 E3 – Shop Drawings.

- .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 Specification E5 – Additional Submittals.

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

- .1 Packing, shipping, handling and unloading:
  - .1 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.

## **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 1/2: 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.

### **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 four 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 labour, 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.

## **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.

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**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 SUMMARY**

.1 Section Includes:

- .1 The supply and installation thermal insulation for ducting.

**1.2 REFERENCES**

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

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

.2 American Society for Testing and Materials International, (ASTM):

- .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
- .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.

.3 Canadian General Standards Board (CGSB):

- .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).

.5 Underwriters Laboratories of Canada (ULC):

- .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S701, Thermal Insulation Polystyrene, Boards and Pipe Covering.

**1.3 DEFINITIONS**

.1 For purposes of this section:

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

**1.4 SHOP DRAWINGS**

- .1 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

**1.5 MANUFACTURERS' INSTRUCTIONS**

- .1 Installation instructions to include procedures used and installation standards achieved.

**1.6 QUALIFICATIONS**

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

**1.7 DELIVERY, STORAGE AND HANDLING**

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

**Part 2 Products**

**2.1 FIRE AND SMOKE RATING**

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

**2.2 INSULATION**

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

**2.3 JACKETS**

- .1 VentureGuard 1574CW.

**Part 3 Execution**

**3.1 PRE-INSTALLATION REQUIREMENTS**

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

**3.2 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
- .1 Hangers, supports to be outside vapour retarder jacket.
- .4 Fasteners: At 300 mm o/c in horizontal and vertical directions, minimum two rows each side.

**3.3 DUCTWORK INSULATION SCHEDULE**

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

Application	TIAC Code	Jacket	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Exhaust duct between dampers and louvres	C-1	yes	50

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Submittals in accordance with E3 – Shop Drawings.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
  - .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturer's Field Reports: manufacturer's field reports specified.
- .7 Closeout submittals: submit maintenance and engineering data for incorporation into O&M manual.

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**Part 2 Products**

**2.1 GENERAL**

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

**2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame 1.3 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
- .1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at -40°C to 90°C, density of 1.3 kg/m<sup>2</sup>.

**2.3 ACCESS DOORS IN DUCTS**

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene or foam rubber.
- .4 Hardware:
- .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
- .2 301 to 450 mm: four sash locks complete with safety chain.
- .3 451 to 1000 mm: piano hinge and minimum two sash locks.
- .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
- .5 Hold open devices.
- .6 300 x 300 mm glass viewing panels.

**2.4 TURNING VANES**

- .1 Factory or shop fabricated single thickness without trailing edge, to recommendations of SMACNA and as indicated.

**2.5 INSTRUMENT TEST**

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

**2.6 SPIN-IN COLLARS**

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.
  - .4 Install in accordance with recommendations of SMACNA.
  - .5 When fan is running:
    - .1 Ducting on sides of flexible connection to be in alignment.
    - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 600 x 600 mm for person size entry.
    - .2 300 x 300 mm for servicing entry.
    - .3 150 x 150 mm for viewing.
    - .4 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Reheat coils.
    - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
  - .1 General:

- .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .2 Locate to permit easy manipulation of instruments.
- .3 Install insulation port extensions as required.
- .4 Locations:
  - .1 For traverse readings:
    - .1 Ducted inlets to roof and wall exhausters.
    - .2 Inlets and outlets of other fan systems.
    - .3 Main and sub-main ducts.
    - .4 And as indicated.
  - .2 For temperature readings:
    - .1 At outside air intakes.
    - .2 In mixed air applications in locations as approved by Contract Administrator.
    - .3 At inlet and outlet of coils.
    - .4 Downstream of junctions of two converging air streams of different temperatures.
    - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### 3.3 CLEANING

- .1 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 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals:
  - .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 to manufacturer's specifications and written instructions.

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 SPLITTER DAMPERS**

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

**2.3 SINGLE BLADE DAMPERS**

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

**2.4 MULTI-BLADED DAMPERS**

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

**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 recommendations of SMACNA and in accordance with manufacturer's instructions.
- .2 Locate balancing dampers in each branch duct for supply systems.
- .3 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .4 Dampers: vibration free.

- .5 Ensure damper operators are observable and accessible.
- .6 Corrections and adjustments conducted by the Contract Administrator.

**3.3 FIELD QUALITY CONTROL**

- .1 Tests:
  - .1 Tests to demonstrate that system is functioning as specified.

**3.4 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit in accordance with E3 – Shop Drawings
  - .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
  - .3 Indicate the following:
    - .1 Performance data.
- .2 Quality assurance submittals:
  - .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.
- .3 Closeout Submittals
  - .1 Provide maintenance data for incorporation into manual specified in E5 – Additional Submittals.

**1.3 QUALITY ASSURANCE**

- .1 Certificates:
  - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

**Part 2 Products**

**2.1 MULTI-LEAF DAMPERS**

- .1 Extruded aluminum (6063T5) damper frame shall not be less than 2.03mm (0.080") in thickness. Damper frame to be 101.6mm (4") deep.
- .2 Blades to be extruded aluminum (6063T5) profiles, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.
- .3 Blade and frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions.

- .4 Bearings are to be composed of a Celcon inner bearing fixed to a 11.1mm (7/16") aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
- .5 Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- .6 Dampers are to be designed for operation in temperatures ranging between -40°C (-40°F) and 85°C (185°F).
- .7 Dampers shall be parallel blade action.
- .8 Leakage shall not exceed 15.2 l/s/m<sup>2</sup> (3 cfm/ft<sup>2</sup>) against 250Pa (1" w.g). differential static pressure.
- .9 Leakage shall not exceed 25 l/s/m<sup>2</sup> (4.9 cfm/ft.<sup>2</sup>) against 1kPa (4" w.g). differential static pressure at -40°C (-40°F).
- .10 Pressure drop of a fully open 1220mm x 1220mm (48" x 48") damper shall not exceed 7Pa (0.03" w.g). at 5.08m/s (1000 fpm).
- .11 Dampers shall be made to size required without blanking off free area.
- .12 Dampers shall be "Flanged to Duct".
- .13 See drawings for schedule.

### **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 where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper.
- .5 Ensure dampers are observable and accessible.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Fire and smoke dampers.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
  - .2 Indicate the following:
    - .1 Fire dampers.
    - .2 Operators.
    - .3 Fusible links.
    - .4 Design details of break-away joints.
  - .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .4 Instructions: submit manufacturer's installation instructions.
- .2 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual specified in E5 – Additional Submittals.

**1.4 QUALITY ASSURANCE**

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

**1.5 MAINTENANCE**

- .1 Extra Materials:

- .1 Provide maintenance materials in accordance with E5 – Additional Submittals.
- .2 Provide following:
  - .1 Six fusible links of each type.

## **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.

## **Part 2 Products**

### **2.1 FIRE DAMPERS**

- .1 Fire dampers: arrangement Type [A] [B] [C], listed and bear label of ULC, meet requirements of ANSI/NFPA 90A, and authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation:
  - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
  - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

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

**3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Materials and installation of flexible ductwork, joints and accessories.

**1.2 REFERENCES**

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):

.2 National Fire Protection Association (NFPA):

- .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.  
.2 NFPA 90B, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.

.3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA):

- .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.  
.2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition.

.4 Underwriters' Laboratories Inc. (UL):

- .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.

.5 Underwriters' Laboratories of Canada (ULC):

- .1 CAN/ULC-S110, Fire Tests for Air Ducts.

**1.3 SUBMITTALS**

.1 Samples: submit samples with product data of different types of flexible duct being used.

**1.4 QUALITY ASSURANCE**

.1 Certification of Ratings:

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

**1.5 DELIVERY, STORAGE AND HANDLING**

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

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

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**Part 2 Products**

**2.1 GENERAL**

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

**2.2 METALLIC - UNINSULATED**

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

**2.3 NON-METALLIC - UNINSULATED**

- .1 Type 3: non-collapsible, coated aluminum foil mylar type, mechanically bonded to, and helically supported by, external aluminum wire, as indicated.
- .2 Performance:
  - .1 Factory tested to 2.5 kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: 3.

**Part 3 Execution**

**3.1 DUCT INSTALLATION**

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

**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
- .2 Shop drawings and product data in accordance with E3 – Shop Drawings.
- .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 E3 – Shop Drawings.
  - .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 E5 – Additional Submittals.

## **1.5 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with D22 – Suspension of Work due to Inclement Weather.
    - .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.

## **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.
- .6 Acceptable Manufacturers: Greenheck, Loren Cook, Soler & Palau.

## **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 E3 – Shop Drawings. 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 E3 – Shop Drawings.

- .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 materials in accordance with manufacturer's written instructions.

**1.5 MAINTENANCE**

.1 Extra Materials:

- .1 Include:
  - .1 Keys for volume control adjustment.
  - .2 Keys for air flow pattern adjustment.

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**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.
- .2 Acceptable Manufacturers: Nailor, Price, Tuttle & Bailey.

**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 D13 – Environmental Protection Plan.
- .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 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA):
  - .1 ANSI/NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 American Society for Testing and Materials International (ASTM):
  - .1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .4 Society of Automotive Engineers (SAE)

**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.

**1.4 SUBMITTALS**

- .1 Product Data:
  - .1 Submit in accordance with E3 – Shop Drawings
  - .2 Submit manufacturer's printed product literature, specifications and datasheet include product characteristics, performance criteria, and limitations.
  - .3 Indicate following:
    - .1 Pressure drop.
    - .2 Face area.
    - .3 Free area.
- .2 Test Reports:
  - .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**1.5 DELIVERY, STORAGE, AND HANDLING**

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

**Part 2 Products**

**2.1 FIXED LOUVRES - ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: factory applied enamel or anodized. Colour: to Contract Administrator's approval.
- .9 Acceptable Manufacturers: Price, Ventex.

**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 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

**3.3 CLEANING**

- .1 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 Materials, components and installation for heat reclaim devices.

**1.2 REFERENCES**

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

- .1 ASHRAE 84, Method of Testing Air-to-Air Heat Exchangers (ANSI approved).

**1.3 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in with E5 – Additional Submittals. Include product characteristics, performance criteria, and limitations.

.2 Quality assurance submittals:

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

.3 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in E5 – Additional Submittals.

.4 Certificates:

- .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

**1.4 MAINTENANCE**

.1 Extra Materials:

- .1 Provide maintenance materials in accordance with E5 – Additional Submittals.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment include:
- .1 Addresses of suppliers.
- .2 List of specialized tools necessary for adjusting, repairing or replacing.

**Part 2 Products**

**2.1 GENERAL**

- .1 Comply with ASHRAE 84.

**2.2 AIR TO AIR DUAL CORE EXCHANGER**

- .1 Casing: 0.8 mm thick galvanized steel.

- .2 Heat transfer surfaces: corrugated aluminum, edge sealed and bonded to casing.
- .3 Cross contamination: not to exceed ASHRAE 62 acceptable cross leakage rate.
- .4 Removable access panels.
- .5 Performance characteristics: refer to equipment schedules.

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

**3.3 FIELD QUALITY CONTROL**

- .1 Tests:
  - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

**3.4 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning 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 E3 – Shop Drawings.
- .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 E5 – Additional Submittals.

**Part 2 Products**

**2.1 GENERAL**

- .1 Integrated package: to CAN/CSA-C656.

- .2 System type:
  - .1 Air flow arrangement: up- flow.
  - .2 Cooling/Heating: 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 14°C.
- .4 Acceptable Manufacturers: Carrier, Daikin, Islandaire, LG, Mitsubishi.

## **2.1 CABINET**

- .1 Free standing, welded steel, unit construction, corrosion protected, 20mm thick acoustic insulation, factory baked on external finish. Colour selected by Contract Administrator.
- .2 Cabinet to house: compressors, condensers, cooling/heating coil, reheat coil, fans, filters, control system, motor starters or contactors.
- .3 Provide adequate access to components for servicing.

## **2.2 COMPRESSORS**

- .1 Hermetic type, with:
  - .1 Vibration isolators.
  - .2 Anti-slug device.
  - .3 Refrigerant service valves.
  - .4 Capacity controls.

## **2.3 COOLING/HEATING 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.
- .2 Direct expansion: with separate refrigerant circuit for each compressor.

## **2.4 REHEAT COIL**

- .1 Electric: CSA or ULC approved, open coil construction.

## **2.5 FILTERS**

- .1 Pleated type, to CAN/CGSB-115.15.
  - .1 Initial Dust Spot efficiency, MERV 7 to ASHRAE 52.

## **2.6 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.

**2.7 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.

**2.8 ENVIRONMENTAL CONTROLS**

- .1 Solid state electronic control system.

**2.9 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.

**3.2 EQUIPMENT PREPARATION**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE):
  - .1 ASHRAE 52.1, Gravimetric and Dust Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .2 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 E3 – Shop Drawings.
- .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 E5 – Additional Submittals.

**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.
- .4 Inverter duty.
- .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 Acceptable Manufacturers: Carrier, Mitsubishi.

## **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.

## **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 engineer to set and adjust equipment for operation as specified.

**END OF SECTION**