

PART 1 **GENERAL**

1.1 **REFERENCES**

- .1 Abbreviations and Acronyms:
 - .1 CRI: Carpet and Rug Institute; www.carpet-rug.org.
 - .2 HVAC: Heating, Ventilating and Air Conditioning.
 - .3 IAQ: Indoor Air Quality.
 - .4 MERV: Minimum Efficiency Reporting Value.
 - .5 RFCI: Resilient Floor Covering Institute; www.rfci.com.
 - .6 SCAQMD: South Coast Air Quality Management District; www.aqmd.gov.
 - .7 VOC: Volatile Organic Compound.

1.2 **SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings; submit drawings stamped and signed for approval by the Consultant.
- .3 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .4 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .5 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, the Consultant before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.

- .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
- .4 Operation instruction for systems and component.
- .5 Description of actions to be taken in event of equipment failure.
- .6 Colour coding chart.
- .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings or AutoCAD files. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour for each service.
 - .4 Make available for reference purposes and inspection.
- .9 Record drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of Record drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

- .3 Submit to Departmental Representative for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible record drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.3 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 70 12 Safety Requirements.

1.4 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
 - .2 Belts for belt-driven motors.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 SCOPE OF WORK

- .1 Include in mechanical section, provision of labour, new materials, tools, transportation, services and facilities for a complete mechanical installation. The installation shall be left complete in all respects and ready for operation. Final installation shall be to the complete satisfaction of the responsible professional engineer.
- .2 The successful mechanical contractor shall be responsible for all sub-trades providing services to complete this project.
- .3 New Construction:
 - .1 Provide for the complete installation of new heating, ventilation, and air conditioning (HVAC) systems, including but not limited to; galvanized steel duct

air distribution and fittings; grilles, louvers, registers and diffusers; air cooled condensing units, heat recovery ventilators, furnace units.

- .2 Provide restraint on all piping, ductwork, equipment and machinery which is part of the building mechanical service systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake. Restraints shall comply with the requirements of Manitoba.

1.7 GENERAL REQUIREMENTS

- .1 All drawings and all sections of the specifications apply to and form an integral part of this section.
- .2 Provide fully operational mechanical systems in complete accordance with applicable codes and bylaws.
- .3 Contract documents of this section are diagrammatic and approximate to scale. Do not scale from the drawings, for dimensions refer to architectural and structural drawings. The drawings and specifications establish scope for material and installation quality and are not detailed installation instructions. Follow manufacturers' recommendations for installation supplemented by contract documents, unless otherwise specified by the Departmental Representative.
- .4 Drawings and specifications are complementary each to the other, what is called for by one shall be binding as if called for by both.
- .5 Specification sections are not provided to define trade work scope. Trade work scope is the responsibility of the contractor responsible for this project and covering the entire scope of work included in this project is the responsibility of the contractor.
- .6 Should any discrepancy appear between the drawings and specifications, which leave the contractor in doubt as to the true intent and meaning of the plans, and specifications, the contractor shall obtain a ruling from the Departmental Representative. If this is not done it will be assumed that the most appropriate alternative has been allotted for. For any ruling to become binding, the Departmental Representative must issue the new direction in a published form.
- .7 Examine all contract documents, including all drawings, specifications and work of other trades to ensure that work is co-ordinated and satisfactorily carried out without changes to the building or contract value.
- .8 The drawings for mechanical work are performance drawings. They are generally diagrammatic and are not to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions showing every offset, fitting, valve or every difficulty encountered during execution of work and will not be used as an excuse for deficiencies or omissions.
- .9 In addition to all of the requirements in the contract documents, include recommended installation details and procedures for equipment as found in manufacturers' technical data.

- .10 As work progresses and before installing piping, ductwork, fixtures or equipment interfering with interior treatment and use of building, contact Departmental Representative for comment. If the contractor fails to perform above checking and fails to inform Departmental Representative of such interference, the contractor to bear all subsequent expense to make good the installation.
- .11 Install piping, ductwork, etc., generally in the locations and routes shown on the drawings, close to the building structure to minimize furring and interference with other services or free space. Remove piping, wiring, ductwork, etc. That is not properly installed and replace to the satisfaction of the Departmental Representative at no cost to the Owner.
- .12 Equipment, materials and work shall comply with the requirements of generally recognized agencies, including but not limited to CSA, ULC, CGA, NBFU, NFPA, TSSA, and the requirements of Authorities Having Jurisdiction.
- .13 Be completely responsible for the acceptable condition and operation of systems and equipment components forming part of the installation or associated with it. Promptly replace defective materials, parts and equipment and repair related damage.
- .14 The drawings are intended to convey the scope of work and indicate general arrangement and approximate location of apparatus and fixtures, and indicate the general location and route to be followed by pipes and ducts. Where required installations are not shown on plans or are only shown diagrammatically, install in such a way as to conserve headroom and interfere as little as possible with free use or space through which they pass, while there adequate space is allowed for service, maintenance, repair, or replacement for all equipment.
- .15 All serviceable items, such as valves, controls, bearings, filters and similar items, must be installed in such a manner as to be accessible for service, maintenance, repair and replacement without the removal of other material or equipment, and without the need for specialized equipment such as lifts, harnesses, or other safety items. All work to be installed to allow easy equipment isolation and servicing functions while all surrounding systems continue to operate.
- .16 Refer to architectural drawings for roof and other construction details. These shall relate to roof supports, piping penetrating roofs, etc. As indicated on mechanical detail sheets.
- .17 Misinterpretation of requirements of plans or specifications shall not relieve contractor of responsibility of properly completing work to approval of Departmental Representative.
- .18 Confirm on the site the exact location and mounting elevation of outlets and fixtures as related to existing mechanical & electrical components as well as architectural & structural details.
- .19 As work progresses and before installing piping, ductwork, wiring, fixtures and equipment interfering with interior treatment and use of building, consult Departmental Representative for appropriate action before proceeding. This applies to all levels and proper grading of piping. If contractor fails to perform above checking and fails to

inform Departmental Representative of such interference, contractor to bear all subsequent expense to make good the installation.

- .20 Spaces reserved for equipment noted as future or allowances made for future extension to buildings, to be left clear so that future connections can be made. Provide adequate clear space for Owner supplied equipment and connections for such equipment. Provide detailed layouts for checking and approval by Departmental Representative before commencing work.
- .21 Install ceiling mounted or exposed components (e.g. Diffusers, sprinkler heads, grilles) in accordance with reflected ceiling drawings or floor plans.
- .22 Prepare interference and coordination drawings for all areas, wherever there is possible conflict and/or obstruction due to the positioning of mechanical equipment, piping, wiring, ductwork, or other work of this division relative to other trades.
- .23 Prepare drawings in conjunction with other trades.
- .24 Show all sleeves and openings for passage through structure, and all inserts, equipment bases, sumps, pits and supports, and relate these to suitable grid lines and elevation datum.
- .25 Submit drawings for acceptance by the Departmental Representative.
- .26 Drawings shall be to a scale sufficient to show the necessary details. Submit to the Departmental Representative for review and distribute drawings after review to trades concerned.
- .27 Prepare fully dimensioned detail drawings of shafts, duct spaces, pipe spaces and tunnels. Show holes and sleeves, and include information pertaining to access, clearances, tappings, drains and electrical connections.
- .28 Base information used to prepare drawings on certified shop drawings.
- .29 Prepare, and submit for review, scale drawings of equipment bases, anchors and their relationship to structure, inertia slabs, floor and roof curbs, which pertain to Division 21, 22, 23, 25 work and which are not shown on architectural or structural drawings.
- .30 Cutting, coring, drilling, patching and repairs to existing surfaces required as a result of the removal and/or relocation of existing equipment and piping, and/or installation of new equipment and piping to be included by mechanical in tender price. Mechanical to employ and pay appropriate sub-trade whose work is involved, for carrying out work described above.
- .31 The cutting of openings not requiring lintels or other structural support will be the responsibility of the trade requiring the opening, the opening size will be the minimum required, and that patching will be the responsibility of the trades normally engaged in working with the finishing materials required to restore the opening to the original or specified conditions.

- .32 Where openings require lintels or other structural support, or roofing work, such openings will be specified under other divisions of this specification.
- .33 Protect equipment and materials in storage, on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
- .34 Protect equipment with polyethylene covers and crates.
- .35 Operate, drain and flush out bearings and refill with new charge of lubricant, before final acceptance.
- .36 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances. Disconnect, clean and reconnect whenever necessary for purpose of locating and removing obstructions. Repair work damaged in course of removing obstructions.
- .37 Vacuum clean and remove debris from the inside of air handling systems, fans, heat pumps, ducts, coils, terminal units, etc.
- .38 Clean exposed surfaces of mechanical equipment, ductwork, piping, etc., and polish plated work.
- .39 Comb all bent fins to proper configuration on all coils in ductwork, fan coil units, entrance heaters, condensing units, and other heating and cooling equipment.
- .40 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install extended nipples to outside of bearing enclosures for lubrication purposes.
- .41 Remove tools, surplus, and waste material from the building site upon completion of work. Clean grease, dirt, and excess material from walls, floors, ceilings, surfaces, and fixtures for which this contractor was responsible, and leave the premises suitable for immediate use.
- .42 Verify that materials and equipment can be delivered to the place of the work and that sufficient space and access is available to permit installation thereof in locations shown on the drawings.
- .43 Check locations and inverts of service lines leaving and entering building to ensure their proper function prior to commencing work.
- .44 Verify location and elevation of existing services (water, electrical, sanitary, storm sewers, equipment, natural gas, voice and data cabling, ductwork and piping), which may affect the work of this division. Repair any damage to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .45 Refer also to room finish schedules to determine finished, partially finished and unfinished areas of the building.

- .46 Visit site to determine access route for bringing equipment into the building.
- .47 Location routing and depth of sanitary sewers, water mains, natural gas, and other utilities shown on drawings are based on available information and are approximate only. Contractor and his site services subtrades shall carry out following verification procedure prior to installing the site services:
 - .1 Reconfirm information noted on contract drawings, by comparing with the local utility's most current records.
 - .2 Referring to same benchmarks used by contractor; take invert readings at nearest manholes and check for discrepancies with contract drawings.
 - .3 Prior to installation of piping, advise Departmental Representative of any discrepancy found during above procedure. Revised drawings or instructions will be given to contractor.
 - .4 Avoid damaging or displacing existing services where exact position is not known. Should any damage occur, advise Departmental Representative in writing for remedial instructions.
- .48 Permanent HVAC systems and/or equipment shall not be used during construction period.

1.8 SUBSTANTIAL COMPLETION INSPECTION

- .1 Advise Departmental Representative seven (7) days prior to the date inspection is desired. All systems to be fully operational and any deficiencies should be noted to the Contract Administrator.
- .2 All deficiencies shall be completed within a timely manner after substantial completion and a letter submitted to Departmental Representative within that time advising that the work is complete with comments on work done.
- .3 The following shall be an outline checklist of the minimum requirements to be met by the contractor prior to the Departmental Representative Substantial Performance by the contractor.

Inspection:

- .1 Complete Testing and Balancing Reports
- .2 Complete Commissioning Checklists
- .3 Final Plumbing Inspection Certificate from local plumbing inspector
- .4 Final Sprinkler Materials and Test Certificate (via Division 21)
- .5 Final Backflow Prevention test reports for all backflow devices
- .6 Controls Commissioning, Checklist and 15 day trend logs for all major equipment (furnace/condensing units, HRVs)
- .7 Fire alarm test certificate (via Division 28)
- .8 Fire Stopping and Fire Damper test letter
- .9 Vibration isolation supplier's inspection report
- .10 Sprinkler Contractors Engineer of record inspection and letter of assurance

- .11 Potable water main's flushing and chlorination test certificate
- .12 Sound level tests reports (as required)
- .13 Final As-Built Drawings ready for review

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT APPROVALS

- .1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.
- .2 Requests for approval for tendering purposes of equivalent materials or equipment shall not be permitted.
- .3 Equipment approved as equivalents in the specifications shall, in every respect, operate as intended, meet the space, capacity, and noise requirements outlined.
- .4 The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras / changes / variations will not be approved to cover such work.

2.2 PIPE SLEEVES

- .1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum 0.61 mm (24 ga) galvanized sheet metal. Sleeves shall extend 25 mm (1 in) on either side of the wall.
- .2 In mechanical rooms, service rooms, and in all wet areas, 100mm high concrete curbs shall be provided for all group piping penetrations.
- .3 Pipe sleeves not permitted at fire rated partitions.

2.3 VERTICAL DUCT PENETRATIONS

- .1 In mechanical rooms, service rooms, and in all wet areas, 100mm high concrete curbs shall be provided for all vertical duct riser penetrations.

2.4 FIRE-STOPPING

- .1 Refer to Specification Section 07 84 00 – Firestopping.

2.5 ELECTRICAL MOTORS

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors

intended for use with a variable speed drill (variance frequency drill) shall be inverter only rated.

- .3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.
- .4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.
- .5 Motors less than ½ hp shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage. Coordinate with electrical prior to ordering.
- .6 All motors shall be 1800 rpm unless indicated otherwise.
- .7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
- .8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.
- .9 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.
- .10 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.
- .11 The NEMA Premium™ efficiency electric motor program scope is single-speed, polyphase, 1-500 horsepower, 2, 4, and 6 pole, squirrel cage induction motors, NEMA Design A or B, continuous rated. Products must meet or exceed the nominal energy efficiency levels contained in NEMA Standards Publication MG 1.
- .12 Motors 50 hp or above shall include a soft starter.

2.6 ACCESS DOORS

- .1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:
 - .1 Valves
 - .2 Mixing/Tempering valves
 - .3 Volume and splitter dampers
 - .4 Fire dampers
 - .5 Cleanouts and traps
 - .6 Controls, coils and terminal units
 - .7 Expansion joints
 - .8 Filters
 - .9 Strainers

- .2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.
- .3 Mark removable ceiling tiles used for access with colour coded dots.
- .4 Sizes to be *200 mm x 200 mm (8 in x 8 in)* for cleanout, *300 mm x 300 mm (12 in x 12 in)* for hand and *600 mm x 600 mm (24 in x 24 in)* for body access minimum.
- .5 Provide ULC-listed fire rated access doors installed in rated wall and ceilings. Refer to architectural drawings for ratings.

PART 3 **EXECUTION**

3.1 **PAINTING, REPAIRS AND RESTORATION**

- .1 Do painting in accordance with Section 09 91 23 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.2 **CLEANING**

- .1 Clean interior and exterior of all systems including strainers. Protect open ends of ducts, diffusers, grilles and registers during construction to prevent ingress of dust and dirt into interior of ducts. If dust or dirt is detected prior to startup, vacuum interior of all ducts and air handling units. Prior to vacuuming use video camera to record condition of ductwork. Also use video camera to record condition of ducts after cleaning.

3.3 **FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
 - .1 Submit tests as specified in other sections of this specification.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

.3 Site Tests and Inspections:

- .1 Indoor Air Quality Control Requirements: Perform work in accordance with IAQ requirements specified in Section 01 35 46 and as follows:
 - .1 Protect building materials from damage by:
 - .1 fully covering stored materials.
 - .2 elevating stored materials off ground.
 - .3 disposing of materials with evidence of moisture damage.
 - .2 Reduce dust contamination by:
 - .1 ensuring adjacent HVAC ducts are sealed prior to cutting.
 - .2 collecting and bagging dust from tools.
 - .3 isolating cutting areas from adjacent workspaces.
 - .4 sweeping and/or vacuuming daily.
 - .3 Reduce gypsum board dust contamination by:
 - .1 ensuring adjacent HVAC ducts are sealed prior to cutting.
 - .2 using dust-control gypsum board compounds.
 - .3 isolating sanding areas from adjacent workspaces.
 - .4 sweeping and/or vacuuming daily.
 - .4 Prevent contamination to HVAC systems by:
 - .1 ensuring opening in HVAC ductwork are capped during installation.
 - .2 ensuring HVAC equipment is sealed prior to operation.
 - .3 installing new unused MERV = 8 (or higher) ANSI/ASHRAE 52.2-1999 rated filters at return/exhaust grilles/inlets leading to HVAC units operating during construction.

3.4 DEMONSTRATION

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Contractor to supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Departmental Representative may record these demonstrations on video tape for future reference.

3.5 PROTECTION

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system

3.6 FIRE STOPPING

- .1 It is the intent to have the general contractor be responsible for all of the fire-stopping of all openings in all fire separations and rated enclosures. This work shall be performed by a specialist fire-stopping subtrade.
- .2 All Fire-stopping locations must have a permanently fixed label within 12" (300mm) of the fire-stop denoting the Fire-stop material (brand) plus the ULC detail reference that the specific fire-stop has been constructed to. The project maintenance manual must contain a complete listing of fire-stop materials along with the ULC details and references for each type of fire-stop used on the project.
- .3 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The contractor is required to coordinate with the architectural drawings to contractual rated wall types and installation details.
- .4 Fire-stopping materials to meet ULC CAN 2S115. Acceptable Materials: Tremco, National Firestop, Hilti, 3M.
- .5 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.
- .6 Provide permanent fixed labels at all fire-stopped penetrations, denoting ULC detail, and Fire-stop brand/material. Labels shall be fixed to pipe, duct or on wall beside penetration.

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Use of HVAC systems during construction.

1.2 **USE OF SYSTEMS**

- .1 Use of new permanent heating and/or ventilating systems for supplying temporary heat and ventilation is not permitted.

PART 2 **PRODUCTS (NOT USED)**

PART 3 **EXECUTION (NOT USED)**

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 specified in Division 26. Control wiring 50V or less for systems specified in Division 21, 22, 23 and 25 is by Division 25.

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 Model National Energy Code for Buildings (MNECB).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Electrical Manufacturers Association (NEMA).

1.3 **SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Shop Drawings: Submit drawings stamped and signed for approval by Departmental Representative.
 - .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 (one) copy of systems supplier's installation instructions.
 - .4 Closeout Submittals

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with Canadian Environmental Protection Act (CEPA), Canadian Environmental Assessment Agency (CEAA), Transportation of Dangerous Goods Act (TDGA) and applicable Provincial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Motors to be premium efficiency, in accordance with local hydro company standards and the requirements of ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 1/2 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 1/2 HP and larger: NEMA, Class B, squirrel cage induction, premium efficiency, speed as indicated, continuous duty, enclosure as indicated, ball bearing, maximum temperature rise 40 °C, 3 phase, 575 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

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

2.5 DRIVE GUARDS

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

PART 3 **EXECUTION**

3.1 **MANUFACTURER'S INSTRUCTIONS**

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

3.2 **INSTALLATION**

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

3.3 **FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
 - .1 As specified in other sections of this specification.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 **CLEANING**

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Section Includes:
 - .1 Bronze – valves.

1.2 **REFERENCES**

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch.)
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings
 - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A 276, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM A536, Specification for Ductile Iron Castings.
 - .3 ASTM B 16, Specification for Free-Cutting Brass Rod Bar and Shapes for Use in Screw Machines.
 - .4 ASTM B 62, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B 283, Specification for Copper and Copper Alloy Die Forgings (Hot Pressed)
 - .6 ASTM B 505/B505M, Specification for Copper-Base Alloy Continuous Castings.
 - .7 ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B242, Groove and Solder Type Mechanical Pipe Couplings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-80, Bronze Gate, Globe, Angle and Check Valves.
 - .3 MSS SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 **SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS – Material Safety Data Sheets in accordance with Section 02 62 00.01 – Hazardous Materials.

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 Submit data for valves specified this section.
 - .3 Grooved joint couplings and fittings to be indicated on product submittals and to be specifically identified with the applicable style or series designation.
- .3 Closeout Submittals
- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 –Safety Requirements.
- .2 All grooved joint couplings, fittings, valves, and specialties to be the products of a single manufacturer. Grooving tools to be of the same manufacturer as the grooved components.

1.5 DELIVERY, STORAGE AND DISPOSAL

- .1 Waste Management and Disposal
 - .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
 - .2 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.6 MAINTENANCE

- .1 Extra Materials
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size. Minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
 - .6 Grooved couplings: IPS and copper-tube dimensioned, one for every 10 (ten) grooved joints.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Except for specialty valves, to be single manufacturer.

- .2 All products to have Canadian registration numbers (CRN).
- .3 End Connections
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems.
 - .1 Solder ends ANSI/ASME B16.18.
 - .2 Grooved ends to copper tube dimensions and CSA B242.
 - .3 Push-to-connect ends to ANSI/ASME B16.22 and manufacturer's standards.
 - .4 Lockshield Keys
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

2.2 GATE VALVES

- .1 Requirements common to all gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: with hex. shoulders.
 - .3 Connections: with hex. shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .8 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel
- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel

.6 NPS 2 and under, rising stem, solid wedge disc, Class 150:

- .1 Body: with long disc guides, screwed bonnet.
- .2 Operator: Handwheel

2.3 GLOBE VALVES

.1 Requirements common to all globe valves, unless specified otherwise:

- .1 Standard specification: MSS SP-80.
- .2 Bonnet: union with hex. shoulders.
- .3 Connections: screwed with hex. shoulders.
- .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
- .5 Packing: non-asbestos.
- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .8 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG.

.2 NPS 2 and under, composition disc, Class125:

- .1 Body and bonnet: screwed bonnet.
- .2 Disc and seat: renewable rotating PTFE disc regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
- .3 Operator: Handwheel.

.3 NPS 2 and under, composition disc, Class 150:

- .1 Body and bonnet: union bonnet.
- .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
- .3 Operator: Handwheel

.4 NPS 2 and under, plug disc, Class 150, screwed ends:

- .1 Body and bonnet: union bonnet.
- .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
- .3 Operator: Handwheel

.5 Angle valve, NPS 2 and under, composition disc, Class 150:

- .1 Body and bonnet: union bonnet.
- .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
- .3 Operator: Handwheel.

2.4 CHECK VALVES

.1 Requirements common to all check valves, unless specified otherwise:

- .1 Standard specification: MSS SP-80.

- .2 Connections: with hex agonal shoulders.
- .3 Glass 125, WP=860 kPa steam, 1.4 mPa WOG
- .4 Class 150 WP=1.03 mPa steam, 2.07 mPa WOG
- .5 Class 200 1.4 mPa CWP
- .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45°, screw-in cap with hex. head.
 - .2 Disc: renewable rotating disc, of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
- .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex. shoulders, cap.
 - .2 Disc: renewable PTFE for steam, #6 composition rotating disc for water, oil or gas service in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 NPS 2 and under, vertical or horizontal, lift type, 1380 kPa CWP.
 - .1 Disc: 301 stainless steel, center guided.

2.5 SILENT CHECK VALVES

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

2.6 BALL VALVES

- .1 NPS 2 and under:

- .1 Body and cap: cast high tensile bronze to ASTM B16 or ASTM B62.
- .2 Pressure rating: Class 125, 860 MPa steam.
- .3 Connections: Screwed ends to ANSI B1.20.1 and with hex. shoulders. Push-to-connect, Pressfit ends.
- .4 Stem: tamperproof ball drive.
- .5 Stem packing nut: external to body.
- .6 Ball and seat: replaceable stainless steel or hard chrome, plated brass solid ball and teflon seats.
- .7 Stem seal: TFE, EPDM, Nitrile, Fluoroelastomer with with external packing nut.
- .8 Operator: removable lever handle with extension for insulated pipe.
- .9 Cap and drain for drain service.

2.7 ACCEPTABLE PRODUCT

- .1 Acceptable Product: Crane, Newman Hattersley, Kitz, Red White, Nibco, Victaulic.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Adjoining tube, couplings, and fittings with grooved joint valves shall be copper-tube dimensioned. Flaring tube or fitting ends to accommodate IPS sized valves is not permitted.
- .4 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
 - .1 Unions are not required in installations using grooved mechanical couplings. The couplings shall serve as unions.

3.2 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Section includes:
 - .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

1.2 **REFERENCES**

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .2 American Society for Testing and Materials (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 Factory Mutual (FM)
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS).
 - .1 Materials Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP-69, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 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 MSS SP58 or ASME B31.1.
 - .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 all 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 to be in accordance with MSS SP58.
- .2 Performance Requirements
 - .1 Design supports, platforms, catwalks, hangers, to withstand seismic events for location as per the National Building Code

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 **PRODUCTS**

2.1 **GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP-58 and SP-89.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 **PIPE HANGERS**

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
 - .2 Use electro-plating galvanizing process or hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: Suspension from lower flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed, 13 mm FM approved.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed, FM approved where required to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: Suspension from upper flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved where required to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed, FM approved where required.
- .4 Upper attachment to concrete.
 - .1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved where required to MSS SP-69.

- .5 Shop and field-fabricated assemblies.
 - .1 Trapeze hanger assemblies: MSS SP-89.
 - .2 Steel brackets: MSS SP-89.
 - .3 Sway braces for seismic restraint systems: to MSS SP-89.
- .6 Hanger rods: threaded rod material to MSS SP-58.
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP-58.
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation saddles for hot pipework.
 - .4 Oversize pipe hangers and supports for insulated pipes.
- .8 Adjustable clevis: material to MSS SP-69, UL listed FM approved, where required clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-69.
- .10 U-bolts: carbon steel to MSS SP-69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-69.

2.3 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized black carbon steel to MSS SP-58, type 42, UL listed FM approved where required.
- .2 Copper pipe: carbon steel copper plated to MSS SP-58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP-69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:

- .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP-69.

2.5 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/- 5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report(CMTR).
- .2 Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

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

2.7 EQUIPMENT SUPPORTS

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

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 HOUSE-KEEPING PADS

- .1 For base-mounted equipment: Concrete, at least 100 mm high, 50 mm larger all around than equipment, and with chamfered edges.

- .2 Concrete: to Section 03 30 00 - Cast-in-place Concrete by Division 3.

2.10 OTHER EQUIPMENT SUPPORTS

- .1 From structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .2 Submit structural calculations with shop drawings.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to be to industry standards.
 - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: Install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 vertical movement of pipework is 13 mm or more,
 - .2 transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Within 300 mm of each elbow.
- .6 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
 - .2 Sustainable requirements for construction and verification.

1.2 **REFERENCES**

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
 - .2 CSAZ7396.1 Medical Gas pipeline Systems – Part 1: Pipelines for medical gases and vacuum.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14, Standard for the Standpipe and Hose Systems.

1.3 **SUBMITTALS**

- .1 Product Data:
 - .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product data to include paint colour chips, other products specified in this section.
 - .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 **QUALITY ASSURANCE**

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 –Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 – Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer’s written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Dispose of unused paint coating material at official hazardous material collections site approved by Departmental Representative.
 - .3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

PART 2 PRODUCTS

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers to be raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: Manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

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

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: Use size # 5.

.2 Equipment in Mechanical Rooms Roof, Ceiling Spaces: Use size # 9.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

.3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1, authority having jurisdiction.

2.5 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

- .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
- .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 All other pipes: Pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows, to following table:

Background colour	Legend, arrows
Yellow	BLACK
Green	WHITE
Red	WHITE

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

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Secondary Colour
Domestic Cold Water	D.C.W.	Light Blue	None
Domestic Hot Water Supply	D.H.W.S.	Light Blue	None
Domestic Hot Water Recirculation	D.H.W.R.	Light Blue	None
Indirect Drain	I.D.	Green	None
Storm Drain	ST.D.	Black	None
Sanitary Drain	San. D.	Black	None
Vent (Plumbing)	V.P.	Black	None
Vent	V.	Yellow	Black
Refrigeration – Suction	Ref. S. (No.)	Yellow	Black
Refrigeration – Liquid	Ref. L. (No.)	Yellow	Black
Natural Gas	Natural Gas	Yellow	Black

2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.
- .3 Identify system : e.g. Supply AHU-1,Exhaust F-7.

2.7 VALVES, CONTROLLERS

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

2.8 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in section 25 05 54 – EMCS: Identification. If no EMCS included in project, identification as per this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position, component ID name.

2.9 LANGUAGE

- .1 Identification to be in English.

PART 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

- .1 Provide identification only after all painting specified in Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and/or CSA registration plates as required by respective agency.

3.4 NAMEPLATES

- .1 Locations:

- .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection
 - .1 Do not paint, insulate or cover in any way.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: At not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

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

3.7 CLEANING

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this Section.

1.2 **QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel certified to AABC to perform TAB to Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience. TAB contractor shall have a minimum of 5 years experience to AABC or SMACNA.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.
 - .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems – Testing, Adjusting and Balancing.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in the TAB standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures and requirements are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC or SMACNA), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

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

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

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

1.6 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in other Divisions.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

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

1.10 APPLICATION TOLERANCES

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

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

- .1 Submit, prior to commencement of TAB:

- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 3 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

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

1.17 SETTINGS

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

1.18 COMPLETION OF TAB

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

1.19 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC.
- .2 Do TAB of systems, equipment, components, controls specified in other Divisions.
- .3 Qualifications: personnel performing TAB to be qualified to standards of AABC.
- .4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration, amperage and volts for each stage of electrical heating coils.
- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions during winter and summer design conditions.
- .3 Zone pressure differences:
 - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with all systems in all possible combinations of normal operating modes.
- .4 Measurement of noise and vibration from equipment specified in Mechanical Division.
 - .1 Vibration measurements around each piece of rotating equipment.
 - .2 Sound measurements in each octave band around each piece of rotating equipment.
 - .3 Induct sound measurements in each octave band at each fan inlet and discharge.
 - .4 Induct sound measurements in each octave band at each air handling unit intake, return and discharge.

- .5 Sound measurements in each octave band for each normally occupied room with air handling equipment running.
- .5 Fire damper verification:
 - .1 Provide fire damper verification inspection report including every fire damper present in facility, complete with labelling for identification purposes.

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Section Includes:
 - .1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.

1.2 **REFERENCES**

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

1.3 **SUBMITTALS**

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

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
 - .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

PART 2 PRODUCTS

2.1 TEST INSTRUMENTS

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

2.2 EQUIPMENT LEAKAGE TOLERANCES

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

PART 3 **EXECUTION**

3.1 **MANUFACTURER'S INSTRUCTIONS**

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

3.2 **TEST PROCEDURES**

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

3.3 **SITE TOLERANCES**

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

3.4 **TESTING**

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

3.5 **FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services.

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

3.6 CLEANING

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

END OF SECTION

PART 1 **GENERAL**

1.1 **REFERENCES**

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921, Standard Practice for Determining Properties of Jacketing Materials for 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.
- .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.
- .6 Model National Energy Code of Canada for Buildings (MNECB)

1.2 **DEFINITIONS**

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Commercial Round Ductwork,

.2 CRF: Commercial Rectangular Finish.

1.3 SHOP DRAWINGS

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

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

1.4 SAMPLES

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

.2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

1.5 MANUFACTURERS' INSTRUCTIONS

.1 Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.

.2 Installation instructions to include procedures used and installation standards achieved.

1.6 QUALIFICATIONS

.1 Installer: Licensed and certified in performing work of this section, and have at least 5 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.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction / Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
- .5 Divert unused adhesive material from landfill to official hazardous material collections site approved by Departmental Representative.
- .6 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

PART 2 **PRODUCTS**

2.1 **FIRE AND SMOKE RATING**

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

2.2 **INSULATION**

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 **JACKETS**

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: Compatible with insulation.
- .3 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.40 mm sheet.
 - .3 Finish: Stucco embossed or corrugated.

- .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation.

PART 3 EXECUTION

3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of ductwork systems complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.

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

3.3 DUCTWORK INSULATION SCHEDULE

- .1 Insulation types and thicknesses: Conform to following Table:
- .2

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts (exposed)	C-1	yes	50
Round cold and dual temperature supply air ducts (concealed)	C-2	yes	50
Rectangular warm air ducts (exposed)	C-1	no	25
Round warm air ducts (exposed)	C-1	no	25
Rectangular cold and dual temperature supply air ducts (concealed)	C-2	Yes	25
Round cold and dual temperature supply air ducts (exposed)	C-1	yes	50
Rectangular warm air ducts (concealed)	C-2	No	25
Round warm air ducts (concealed)	C-2	No	25
Supply, return and exhaust ducts exposed in space being served			none
Outside air ducts to mixing plenum	C-1	yes	50
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvers	C-1	no	50
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts	See Section 23 33 53- Duct Liners		

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

.2 Finishes: Conform to following table:

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

END OF SECTION

1.1 GENERAL

1.2 SUMMARY

.1 Section Includes:

- .1 Materials and installation for copper tubing and fittings for refrigerant.

1.3 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 (ASTM)

- .1 ASTM A 307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B 280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA)

- .1 CSA B52, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

- .1 EPS1/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).

.6 CSA B51 – Boiler, Pressure Vessel, and Pressure Piping Code.

.7 Manitoba Ozone Depleting Substances Act

1.4 SUBMITTALS

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

- .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

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

1.5 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.
- .3 Trades people to be journeyperson and Ontario licensed refrigeration and air conditioning mechanic.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers, steel, metal, plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative

PART 2 **PRODUCTS****2.1** **TUBING**

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
 - .1 Hard copper: to ASTM B280, type ACR B (nitrogenized).
 - .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°C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 45% Ag - 80% Cu - 5% P and non-corrosive flux for copper to steel or brass; Silfoss-15 for copper to copper.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300, tongue and groove type.
 - .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 between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 **VALVES**

- .1 7/8 ODS and under: Class 500, 3.5 MPa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moistureproof seal for below freezing applications, brazed connections.
- .2 Over 7/8 ODS: Class 375, 3 MPa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and forged brass bonnet, moisture-proof seal for below freezing applications, brazed connections, non-rotating, self aligning swivel disc, Teflon seat, -40°C - 163°C.
- .3 Ball valves 7 3/8 ODS to 3 1/8 ODS: maximum WP 4MPa, -40°C to 149°C, live loaded stem seal, double "O" ring hermetically sealed body, blowout proof stem, seal cap "O" ring sealed, valve position indicators, forged brass body bonnet, brass cap, triple sealed

plated steel item, Teflon ball seals and gasket, extended copper connections, helium leak test to maximum 0.28 g/yr.

- .4 Check valves 7/8 ODS to 3 1/8 ODS cast bronze body, brass bonnet, Teflon seat, internal parts removable minimum opening pressure 3.5 kPa, maximum WP 3.5 kPa - 29°C to 149°C, UL and CSA approved.
- .5 Check valves 3/8 ODS to 7/8 ODS: brass construction, Teflon seal, removable piston, maximum WP 3.5 kPa, -40°C to 149°C, suitable for high side, low side and hot gas. UL and CSA approved, maximum opening pressure 3.5 kPa.

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.

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, hard drawn copper tubing: do not bend. Minimize use of fittings.
 - .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 1800 mm high and at each 6000 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 above.

- .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 using nitrogen leave for 8 hours.

3.6 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection
 - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines for largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 h.
 - .2 Break vacuum with refrigerant to 14 KPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 h.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
- .7 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging

process.

.8 Checks:

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

.9 Manufacturer's Field Services:

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

3.7 DEMONSTRATION

.1 Instructions:

- .1 Post instructions in frame with glass cover in accordance with Section 01 78 00 – Closeout Submittals and CSA B52.
 - .1 Perform cleaning operations as specified in Section 01 74 11 – Cleaning and 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 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A 635/A635M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A 653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual.
 - .3 IAQ Guideline for Occupied Buildings Under Construction, 1st Edition.

1.3 **SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01-Hazardous Materials for the following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan.
 - .5 Place materials defined as hazardous or toxic in designated containers.
 - .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
- .2 Seal classification:
 - .1 Class C: transverse joints and connections made air tight with gaskets, sealant and tape. Longitudinal seams sealed.

2.2 SEALANT

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

2.3 TAPE

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

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius or five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct or 45° entry on branch.
 - .2 Round main and branch: enter main duct at 45° with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with volume control damper.
- .5 Transitions:
 - .1 Diverging: 20° maximum included angle.
 - .2 Converging: 30° maximum included angle.
- .6 Offsets:
 - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

2.6 FIRESTOPPING

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

2.7 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 HANGERS AND SUPPORTS

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

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25x25x3	6
751 to 1050	40x40x3	6
1051 to 1500	40x40x3	10
1501 to 2100	50x50x3	10
2101 to 2400	50x50x5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.
 - .2 For steel joist: manufactured joist clamp steel plate washer.
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.
 - .3 For steel beams: manufactured beam clamps:
 - .1 Acceptable Product: Myatt, Grinnell, Hunt.

PART 3 EXECUTION

3.1 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.

- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 HANGERS

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

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Dryer exhaust.
 - .2 Fresh air intake.
 - .3 Minimum 3000 mm from duct mounted humidifier in all directions.
 - .4 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served. Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and NPS 1 ½ drain connected, with deep seal trap and valve and discharging to open funnel drain or service sink or as approved by Departmental Representative.

3.4 SEALING AND TAPING

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

3.5 LEAKAGE TESTS/COMMISSIONING

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Install no additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90° elbows.
- .7 Complete test before insulation or concealment.

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

1.3 **SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
 - .2 Submit WHMIS MSDS in accordance with Section 02 62 00.01 – Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .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 manual specified in Section 01 78 00 – Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
 - .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 –Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers steel, metal, and plastic waste in accordance with Waste Management Plan (WMP).
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

PART 2 PRODUCTS

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C, density of 1.3 kg/m².

2.3 ACCESS DOORS IN DUCTS

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

2.4 TURNING VANES

- .1 Factory fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.
- .2 Manufacturers: Ductmate, Durodyne, Dynair

2.5 INSTRUMENT TEST PORTS

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

PART 3 EXECUTION

3.1 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 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.
 - .2 450 x 450 mm for servicing entry.
 - .3 300 x 300 mm for viewing.
 - .4 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument test ports.
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations.
 - .1 For traverse readings:
 - .1 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 FIELD QUALITY CONTROL

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

3.4 CLEANING

- .1 Perform cleaning operations as specified in Section 01 74 11 – Cleaning and in accordance with Manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 **GENERAL**

1.1 **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.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 **SUBMITTALS**

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 Indicate the following:
 - .1 Specifications.
 - .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 – Submittal Procedures.
 - .1 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: Submit manufacturer's installation instructions.

1.4 **QUALITY ASSURANCE**

- .1 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 –Safety Requirements.

1.5 **DELIVERY, STORAGE, AND HANDLING**

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

.2 Waste Management and Disposal:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

PART 2 **PRODUCTS**

2.1 **GENERAL**

- .1 Manufacture to SMACNA standards.

2.2 **SINGLE BLADE DAMPERS**

- .1 Factory manufactured, minimum same material as duct, 0.8 mm up to 450 mm wide, 1.6 mm maximum up to 1200 mm wide, V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.
- .6 Manufacturers: Price, Greenheck, Duro-dyne

2.3 **MULTI-BLADED DAMPERS**

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm.
- .4 Bearings: 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: 2 % at 500 Pa.
- .8 Manufacturers: Price, Greenheck, Duro-dyne

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

3.3 **CLEANING**

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

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

1.2 **REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 **SUBMITTALS**

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Performance data.
 - .2 Specifications
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals

1.4 **QUALITY ASSURANCE**

- .1 Health and Safety Requirements: Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.
- .2 Certificates:

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

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 MULTI-LEAF DAMPERS

- .1 Opposed blade type.
- .2 Structurally formed steel or extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Operator: to Section 25 30 02 – EMCS: Field Control Devices.
- .6 Performance:
 - .1 Leakage: in closed position to be less than 2% of rated air flow at 500 Pa differential across damper.
 - .2 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.
- .7 Insulated aluminum dampers (exposed to outdoor air):
 - .1 Frames: extruded aluminum with mounting flanges on both sides of frame.
 - .2 Blades: extruded aluminum air-foil profile, internally insulated with polyurethane foam, thermally broken, minimum R-2.29 (RSI factor of 0.4). Blade seals are extruded EPDM, frame seals are extruded silicone, sealed within integral extruded slot.
 - .3 Bearings: composed of a Celcon inner bearing fixed to an aluminum blade pivot pin, rotating within a polycarbonate outer bearing.

- .4 Adjustable zinc-plated steel drive rod.
- .5 Designed for operation between -40C and 100C.
- .6 Low leakage rate (below 3 cfm/sq.ft at 1"wg (15.2 l/s/m² at 249 Pa) differential.
- .8 Manufactures: Tamco, Nailor, Westvent.

2.2 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum or steel construction with nylon bearings, centre pivoted, spring assisted or counterweighted.
- .2 Manufacturers: Greenheck, Duro-dyne, Westvent

2.3 RELIEF DAMPERS

- .1 Automatic multi-leaf steel or aluminum dampers with ball bearing centre pivoted and counter-weights set to open as indicated.
- .2 Manufacturers: Greenheck, Duro-dyne, Alumavent

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 CLEANING

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Section Includes:
 - .1 Fire and smoke dampers, and fire stop flaps.

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 ANSI/NFPA 80.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN4-S112, Fire Test of Fire Damper Assemblies.
 - .2 CAN4-S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505, Fusible Links for Fire Protection Service.

1.3 **SUBMITTALS**

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.
- .2 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 Section 01 78 00 – Closeout Submittals.
 - .2 Provide the following:
 - .1 6 fusible links of each type.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B or C, blades out of air stream listed and bear label of ULC, meet requirements of provincial fire authority and ANSI/NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN4-S112. Minimum rating 1 ½ hours, dynamically rated; confirm with final fire separation plans for .

- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: offset, round or square; multi-blade hinged or interlocking type; roll door type; or guillotine type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released for vertical position and horizontal airflow, or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow. Fusible link to be rated for 165F.
- .5 Retaining angle iron frame, 40 x 40 x 3 mm, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed to prevent disruption of 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 or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC and in manufacturer's instructions for fire dampers shall be followed.
- .11 Manufacturers: Nailor, Price, Ruskin

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, NFPA 80, and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

- .4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- .5 Coordinate with installer of firestopping to Section 07 84 00 – 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.
- .8 The contractor shall identify, (number) and record location of all fire dampers, sizes, fusible link ratings for inclusion into O & M Manuals.

3.3 CLEANING

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

3.4 COMMISSIONING

- .1 Commission in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.

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 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .3 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.
- .4 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.
- .5 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .6 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110, Fire Tests for Air Ducts.

1.3 **SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 02 60 00.01 - Hazardous Materials for the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

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.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Place materials defined as hazardous or toxic in designated containers.
 - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .6 Ensure emptied containers are sealed and stored safely.
 - .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.6 INDOOR AIR QUALITY (IAQ)

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

PART 2 PRODUCTS

2.1 GENERAL

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

2.2 METALLIC - INSULATED

- .1 Type 1: spiral wound flexible aluminum with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.3 W/m².°C. mean.

2.3 NON-METALLIC - INSULATED

- .1 Type 2: non-collapsible, coated mineral base fabric or aluminum foil mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- .2 Performance:
 - .1 Factory tested to 1000 Pa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.3 W/m².EC mean.

2.4 NON-METALLIC - ACOUSTIC INSULATED

- .1 Type 7: Non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible glass fibre acoustic insulation and encased in aluminum foil and mylar laminate vapour barrier.
- .2 Performance:
 - .1 Factory tested to 3 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Duct Diam:	Frequency (Hz)				
	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

PART 3 EXECUTION

3.1 DUCT INSTALLATION

- .1 Install in accordance with: NFPA 90A and NFPA 90B SMACNA.

- .2 Do leakage test in accordance with Section 23 05 94 - Pressure Testing of Ducted Air System.
- .3 Do trial test to demonstrate workmanship.
- .4 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the contract.
- .5 Flexible ductwork shall be installed taut, and shall not be used to form elbows or bends. Maximum length of flexible duct: 1.0m

END OF SECTION

PART 1 **GENERAL**

1.1 **SECTION INCLUDES**

- .1 Materials and installation for acoustic duct lining.

1.2 **REFERENCES**

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C 916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C 1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C 1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G 21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .3 National Fire Protection Association (NFPA).
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .4 Thermal Insulation Association of Canada(TIAC).
 - .1 National Insulation Standards.
- .5 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - .1 SMACNA, HVAC DCS HVAC, Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings 95.
- .6 Underwriter's Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 **SUBMITTALS**

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

- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 62 00.01 - Hazardous Materials.

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Store and manage hazardous materials in accordance with Section 02 62 00.01 - Hazardous Materials.
- .2 Protect on site stored or installed absorptive material from moisture damage.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA , Regional and Municipal regulations.
- .6 Ensure emptied containers are sealed and stored safely.
- .7 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: air surface coated mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A and NFPA 90B.
 - .3 Fungi resistance: to ASTM C 1338, ASTM G 21.
- .2 Rigid:
 - .1 Use on flat surfaces where indicated

- .2 25 mm thick, to ASTM C 1071, Type 2, fibrous glass rigid board duct liner.
 - .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m².degrees C)/W for 25 mm thickness, 1.15 (m².degrees C)/W for 38 mm thickness, 1.53 (m².degrees C)/W for 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on faced air side: 20.3 m/sec.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C 423.
- .3 Flexible:
- .1 Use on round or oval surfaces.
 - .2 25 mm thick, to ASTM C 1071 Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.37 (m².degrees C)/W for 12 mm thickness, 0.74 (m².degrees C)/W for 25 mm thickness, 1.11 (m².degrees C)/W for 38 mm thickness, 1.41 (m².degrees C)/W to 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
 - .5 Maximum velocity on coated air side: 25.4 m/sec.
 - .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C 423.

2.2 ADHESIVE

- .1 Adhesive: to NFPA 90A and NFPA 90B, ASTM C916.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.
- .3 Water-based fire retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

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

2.5 SEALER

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

PART 3 **EXECUTION**

3.1 **GENERAL**

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

3.2 **DUCT LINER**

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100 % coverage of adhesive to ASTM C 916
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMACNA HVAC, DCS, TIAC.
 - .2 In systems, where air velocities exceed 20.3 m/sec, install galvanized sheet metal nosing to leading edges of duct liner.

3.3 **JOINTS**

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Section Includes:
 - .1 Fans, window ventilators, exterior, wall and ceiling mounted discharge fans for domestic use.

1.2 **REFERENCES**

- .1 Air Conditioning and Mechanical Contractors Association (AMCA)
 - .1 AMCA 201, Fans and Systems.
 - .2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
 - .4 AMCA 302, Application of Sone Ratings for Non-Ducted Air Moving Devices.
 - .5 AMCA 303, Application of Sound Power Level Ratings for Fans.
- .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 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.

1.4 **SUBMITTALS**

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures
- .2 Indicate following: dimensions, performance, sound rating, and installation procedure.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals

1.5 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Belts
 - .3 Addresses of suppliers.
 - .4 List of specialized tools necessary for adjusting, repairing or replacing.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 **PRODUCTS**

2.1 **FANS GENERAL**

- .1 Standard of rating:
 - .1 AMCA 201 for fan application.
 - .2 AMCA 303 for application of sound power ratings for ducted air moving devices.
 - .3 Performance: to ANSI/AMCA 210 and ANSI/ASHRAE 51.
- .2 Pwl sound ratings to comply with AMCA 301, tested to AMCA 300
- .3 Maximum loudness: 4 sones. Continuous duty rated motors.

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 recommendations.

3.3 **ANCHOR BOLTS AND TEMPLATES**

- .1 Supply for installation by other divisions.

3.4 **CLEANING**

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

3.5 **COMMISSIONING**

- .1 Commission in accordance with Section 01 91 13 – General Commissioning (Cx) Requirements.

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

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

1.2 **REFERENCES**

- .1 American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE).
 - .1 ASHRAE 70, Method of Testing for Rating the Performance of Air Ducts and Outlets.

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 manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 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 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

1.5 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 MAINTENANCE

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 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 as indicated.
- .4 Colour: standard or as directed by Departmental Representative.
- .5 Acceptable Product: E. H. Price, Titus, Nailor.

2.2 MANUFACTURED UNITS

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

2.3 GRILLES AND REGISTERS

- .1 Type S1: supply grille:
 - .1 Double deflection, $\frac{3}{4}$ " spacing, front blades in long dimension, white, aluminum construction.
 - .2 Price 620, Titus 300FL, Nailor 51DH .
- .2 Type R1: Egg crate return grille:
 - .1 Aluminim core, $\frac{1}{2}$ " x $\frac{1}{2}$ " grid, aluminum frame, white border.
 - .2 Price 80, Titus 50F, Nailor 51EC.
- .3 Type E1: Egg crate exhaust grille:
 - .1 Aluminim core, $\frac{1}{2}$ " x $\frac{1}{2}$ " grid, aluminum frame, white border.
 - .2 Price 80, Titus 50F, Nailor 51EC.
- .4 Type E: return/exhaust grille:
 - .1 Louvered face, $\frac{3}{4}$ " spacing, white, aluminum construction.
 - .2 Price 630, Titus 350FL, Nailor 5145H .
- .5 Type DG1: Door transfer grille:
 - .1 Steel construction, flat border, countersunk screw hole fastening.
 - .2 Price STG1, Titus T-700, #1 w/aux. frame, Nailor 61DGD`.

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 instructions.
- .2 Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Provide concealed safety chain on each grille, register and diffuser in exposed locations, gymnasiums and similar game rooms and elsewhere.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.

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

END OF SECTION

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 E 90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .5 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 manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Pressure drop.
 - .2 Face area.
 - .3 Free area.

.4 Dimensions

- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Test Reports:
 - .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E 90.

1.5 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 70 12 - Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 PRODUCTS

2.1 GOOSENECK HOODS

- .1 Thickness: to SMACNA.
- .2 Fabrication: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint. Proprietary manufactured flanged duct joint shall be considered to be a class A seal.
- .4 Supports: as indicated.
- .5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and intake.
- .6 Horizontal backdraft dampers.

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 around to ensure weather tightness.

3.3 **CLEANING**

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

END OF SECTION

Part 1 **GENERAL**

1.1 **REFERENCES**

- .1 American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for [electric-resistance furnaces] and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures
 - .2 Indicate following: dimensions, performance, sound rating, and installation procedure.

1.3 **QUALITY ASSURANCE**

- .1 Submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 **PRODUCTS**

2.1 **ELECTRIC FORCED AIR FURNACES**

- .1 Cabinet: die-formed, cold-rolled steel, vertical mount, plenum opening as indicated.

- .2 Heater elements: open coil, individually removable.
- .3 Blower: direct driven centrifugal type with multi-speed motor, lubrication points, capacity as indicated. Motor: variable speed, 1/3 hp. Motor and fan accessible for service, mounted on steel frame secured with resilient mountings. On-Off blower switch prewired and mounted on cabinet.
- .4 Filters: disposable fibreglass type in removable frame.
- .5 Cabinet finish: baked epoxy power coat.

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 furnace.
- .2 Locate furnace allowing accessibility for service and filter change.
- .3 Check for free rotation of fan.
- .4 Ensure alignment of fan and motor pulleys.
- .5 Ensure proper belt tension.
- .6 Make connections to line, thermostat[s], in accordance with manufacturer's instructions.

3.3 **CLEANING**

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and application of electric duct heaters.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA C22.2 No.46-M1998(R2001), Electric Air-Heaters.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Submit product data and include:
 - .1 Element support details
 - .2 Heater: total kW rating, voltage, phase.
 - .3 Number of stages.
 - .4 Rating of stage: rating, voltage, phase.
 - .5 Heater element watt/density and maximum sheath temperature.
 - .6 Maximum discharge temperature.
 - .7 Physical size.
 - .8 Unit support.
 - .9 Performance limitations.
 - .10 Clearance from combustible materials.
 - .11 Internal components wiring diagrams.
 - .12 Minimum operating airflow.
 - .13 Pressure drop [operating] [minimum] airflow.

1.4 QUALITY ASSURANCE

- .1 Health and Safety.
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .6 Ensure emptied containers are sealed and stored safely.
- .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 DUCT HEATERS

- .1 Duct heaters: open coil element.
- .2 Elements:
 - .1 Heating elements will be manufactured from a grade C nickel chrome alloy (NiCr60).
- .3 Staging:
 - .1 Staged heaters: balanced line current at each stage.
 - .2 Each stage: uniform face distribution.
- .4 Controls:
 - .1 Modulating electric heaters will be supplied with an electronic sensor on each side of the heater to measure the temperature and the airflow, and a controller to adjust the output temperature in accordance with the measured parameters. The controller will stop the electric heater when there is no airflow.
- .5 Electrical:
 - .1 Duct heater rating: as noted on drawings.

Part 3 Execution

3.1 INSTALLATION

- .1 Make power and control connections to CSA C22.2 No.46.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements
 - .1 Provide test report and include copy with Operations and Maintenance Manuals.

END OF SECTION

Part 1 **GENERAL**

1.1 **GENERAL**

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 78 00 – Closeout Submittals.
- .3 Section 23 33 00 – Air Duct Accessories.
- .4 Section 23 33 15 – Dampers - Operating.

1.2 **REFERENCES**

- .1 American Bearing Manufacturer’s Association (ABMA)
 - .1 ANSI/ABMA 9 Load Ratings and Fatigue Life for Ball Bearings.
 - .2 ANSI/ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.
- .2 Air Movement and Control Association (AMCA)
 - .1 AMCA 210, Laboratory Method of Testing Fans for Aerodynamic Performance Rating (ASHRAE).
 - .2 AMCA 300 Reverberant Room Method for Sound Testing of Fans.
- .3 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 430, Central Station Air Handling Units.
- .4 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 68, Laboratory Method of Testing to Determine the Sound Power in a Duct.
 - .2 ASHRAE 84, Method of Testing Air-to-Air Exchangers.
- .5 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .6 National Electrical Manufacturer’s Association (NEMA)
 - .1 NEMA MG1 Motors and Generators
 - .2 NEMA ICS 7-1 Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .7 Provincial Boiler, Pressure Vessel and Compressed Gas Regulations.
- .8 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include following: fan, bearings, motor, damper, air volume, total cooling, sensible cooling, EDB, EWB, OAT.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with specifications.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities. Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .4 Divert unused paint material from landfill to official hazardous material collections site approved by Departmental Representative.
- .5 Do not dispose of unused paint materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.6 EXTRA MATERIALS

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

Part 2 PRODUCTS

2.1 GENERAL

- .1 Heat exchanger, cross-flow type.

- .2 Unit to be self contained with all necessary controls and wiring to facilitate a single point connect. Provide disconnect and vibration isolators.

2.2 CABINET, FANS AND FILTERS

- .1 Casing: galvanized, pre-painted steel with foil faced insulation.
- .2 Provide full size access doors to allow for periodic maintenance and inspection. Door construction, same as unit with compression type handles and resilient gaskets.
- .3 Drain pans to be formed sections, recessed, fabricated from 1.2 mm stainless steel 304.
- .4 Fans: centrifugal type with double blowers and motors rated for single phase 120V. Separate Motor for the supply and exhaust fan.
- .5 Provide with remote wall control with electronic push button for; intermittent, continuous low or continuous high exchange c/w humidistat control; maintenance indicator light; and exchange indicator light.
- .6 Provide with polyester air filters.
- .7 Acceptable: Acceptable manufacturer: Venmar CES, Trane, Carnes, Eneround, Greenheck, Anexair, Life Breath, Nu-Air, Vanee.

Part 3 EXECUTION

3.1 INSTALLATION

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

3.2 FANS

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

3.3 DRIP PANS

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

END OF SECTION

PART 1 **GENERAL**

1.1 **SUMMARY**

- .1 Materials and installation for air cooled DX condensing units.

1.2 **RELATED SECTIONS**

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 70 12 – Safety Requirements
- .3 Section 01 45 00 – Quality Control
- .4 Section 01 74 21 – Construction/Demolition Waste Management and Disposal
- .5 Section 01 78 00 – Closeout Submittals.
- .6 Section 01 91 13 – General Commissioning (Cx) Requirements.
- .7 Section 23 08 02 – Cleaning and Startup of Mechanical Piping Systems

1.3 **REFERENCES**

- .1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)
 - .1 ANSI/ARI 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
 - .2 ARI 270, Sound Rating of Outdoor Unitary Equipment.
- .2 ANSI/UL 1995 B, Standard for Heating and Cooling Equipment.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CSA C22.1, Canadian Electrical Code.
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)]
 - .1 Material Safety Data Sheets (MSDS)
- .5 National Roofing Contractors Association (NRCA)
- .6 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .7 American Bearing Manufacturer's Association (ABMA)
 - .1 ANSI/ABMA 9 Load Ratings and Fatigue Life for Ball Bearings
 - .2 ANSI/ABMA 11 Load Ratings and Fatigue Life for Roller Bearings.

- .8 Air Movement and Control Association (AMCA)
 - .1 AMCA 300 Reverberant Room Method for Sound Testing of Fans.
- .9 National Electrical Manufacturer's Association (NEMA)
 - .1 NEMA MG1 Motors and Generators
 - .2 NEMA ICS 7-1 Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .10 Provincial Boiler, Pressure Vessel and Compressed Gas Regulations.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for packaged rooftop HVAC units.
- .3 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout and dimensions; indicate:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Piping, valves, fittings shipped loose showing final location in assembly.
 - .3 Control equipment shipped loose, showing final location in assembly.
 - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .6 Pump and fan performance curves.
 - .7 Details of vibration isolation.
 - .8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
 - .9 Type of refrigerant used.
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .6 Instructions: submit manufacturer's installation instructions.
- .7 Manufacturer's Field Reports: manufacturer's field reports specified.
- .8 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include data as follows:
 - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.
 - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.5 QUALITY ASSURANCE

- .1 Unit will be rated in accordance with the latest edition of AHRI Standard 210.
- .2 Unit will be certified for capacity and efficiency, and listed in the latest AHRI directory.
- .3 Unit construction will comply with latest edition of ANSI/ ASHRAE and with NEC.
- .4 Unit will be constructed in accordance with UL standards and will carry the UL label of approval. Unit will have c--UL--us approval.
- .5 Unit cabinet will be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500--hr salt spray test.
- .6 Air--cooled condenser coils will be leak tested at 150 psig and pressure tested at 450 psig.
- .7 Unit constructed in ISO9001 approved facility.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Unit will be shipped as single package only and is stored and handled per unit manufacturer's recommendations.

PART 2 PRODUCTS

2.1 AIR COOLED CONDENSING UNIT (CU-1, SERVING F-1)

- .1 GENERAL
 - .1 Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.
 - .2 Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
 - .3 Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - .4 Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.

- .5 Installation, Operation and Maintenance manual shall be supplied within the unit.
- .6 Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
- .7 Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

.2 CONSTRUCTION

- .1 Unit shall be factory assembled, single piece, air-cooled air conditioner unit. Contained within the unit enclosure is all factory wiring, piping, controls, compressor, refrigerant charge Puron (R-410A), and special features required prior to field start-up
- .2 Unit shall be specifically designed for outdoor application.
- .3 Unit cabinet will be constructed of galvanized steel, bonderized, and coated with a powder coat paint.

.3 ELECTRICAL

- .1 Unit shall be provided with standard power block for connecting power to the unit.
- .2 Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
- .3 Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

.4 REFRIGERATION SYSTEM

- .1 Each compressor shall be furnished with a crankcase heater.
- .2 Refrigeration circuit components will include liquid-line shutoff valve with sweat connections, vapor-line shutoff valve with sweat connections, system charge of Puron (R-410A) refrigerant, and compressor oil.
- .3 Unit will be equipped with high-pressure switch, low pressure switch and filter drier for Puron refrigerant.
- .4 The unit shall be capable of stable cooling operation to a minimum of 55°F outdoor temperature.

.5 AIR-COOLED CONDENSER

- .1 Condenser fans shall be vertical discharge, axial flow, direct drive fans.
- .2 Fan motor shall be weather protected, single phase, direct drive, and open drip proof with inherent overload protection.
- .3 Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
- .4 Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
- .5 Coils shall be helium leak tested.

.6 CONTROLS

- .1 Unit shall be provided with a terminal block for field installation of controls.

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 as per manufacturers' instructions on roof curbs provided by manufacturer.
- .2 Manufacturer's representative to certify installation, supervise start-up and commission unit.

3.3 **FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer's representative of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
 - .3 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 25% and 60% complete.
 - .3 Upon completion of work, after cleaning is carried out.
- .2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .3 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .4 Verify accessibility, cleanability, drainage of drain pans for coils, humidifiers.
- .5 Performance Verification:
 - .1 General:
 - .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.

- .2 Start-Up:
 - .1 General: in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - .3 Verify accessibility, serviceability of components including motorized dampers, filters, coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
 - .4 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.
- .6 Commissioning Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx)
Requirements: reports supplemented as specified herein. Include:
 - .1 Report forms as specified Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.

3.4 DEMONSTRATION

- .1 Training: in accordance with Section 01 91 13- General Commissioning (Cx)
Requirements: Training of O&M Personnel, supplemented as specified.

3.5 CLEANING

- .1 Perform cleaning operations as specified in Section 01 74 11 – Cleaning and 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