

Part 1 General

1.1 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
- .2 Electrical Equipment Manufacturers' Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA)
 - .1 CAN/CSA-C22.2 No. 100, Motors and Generators
 - .2 CAN/CSA-C747, Energy Efficiency for Single- and Three-Phase Small Motors
 - .3 CAN/CSA-C390, Energy Efficiency Test Methods for Three-Phase Induction Motors
- .4 Underwriter's Laboratories of Canada (ULC)
- .5 SMACNA
 - .1 HVAC Air Duct Leakage Test Manual
 - .2 HVAC Duct Construction Standards – Metal and Flexible

1.2 Regulatory Requirements

- .1 Refer carefully to other parts of the specifications.
- .2 Conform to the requirements and recommendations of all local municipal, provincial and federal codes, by-laws and ordinances.
- .3 Do not reduce the quality of work specified and/or shown on the drawings because of the Regulatory requirements.

1.3 Applicable Codes And Standards

- .1 In general and as applicable, the physical and chemical properties, the characteristics and the performance of items in this Division shall be as noted in the following:
 - .1 Canadian Standards Association.
 - .2 American National Standards Institute.
 - .3 Provincial Building Code.
 - .4 Civic Building By-Laws.
 - .5 Civic Water Works By-Laws and Sewer By-Laws.
 - .6 Provincial Fire Code.
 - .7 Worker's Compensation Board Requirements.
 - .8 American Society for Testing and Materials.
 - .9 Canadian Government Specifications Board.
 - .10 National Fire Protection Association.

- .11 Canadian Council of Ministers of the Environment Codes.
- .12 Underwriters' Laboratories of Canada.

1.4 Latest Editions

- .1 The latest edition of all codes and standards, of the date of tender submission, shall apply; except for specific editions referenced by overriding codes.

1.5 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 specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province where work is taking place.
 - .2 Drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 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.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.6 Authorities Having Jurisdiction (Ahj)

- .1 Comply with all requirements of Authorities with competent jurisdiction, AHJ, including authorized inspectors, without additional compensation.

1.7 Permits, Fees And Certificates

- .1 In addition to the requirements in Division 01, obtain all required Certificates of Inspection for the work and deliver same to the Departmental Representative before request for substantial performance. These include but are not limited to:
 - .1 Equipment start-up reports.
 - .2 Fire, smoke, and combination fire/smoke damper test reports.
- .2 Correct installed work as directed by the local Authorized Inspector of the Regulatory body without extra compensation.

1.8 Equipment List

- .1 Compile a complete list of HVAC equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .2 Submit for review within ten (10) days after award of contract.

1.9 Specified Equipment Availability

- .1 If specified equipment is not available (due to delays in delivery) at scheduled installation time an acceptable alternate shall be installed AT THE CONTRACTOR'S EXPENSE and replaced with the specified equipment when the specified equipment becomes available with no additional compensation.

1.10 Electrical Work

- .1 Division 23 is responsible for the supply, physical installation, and operation of all electric motors, temperature and humidity controls systems, combustion controls systems, and other electrical devices and systems specified under its portion of the work. Bear full responsibility for factory installed wiring and equipment on packaged equipment, be responsible where detailed in equipment requirements for controlling devices such as, but not restricted to, pump and liquid level controls, multi-speed motor controllers, boiler controls, etc., which are necessarily integrally mounted on packaged equipment.
- .2 Submit detailed composite wiring diagrams for all control systems as specified and as required for the HVAC work for review by the Departmental Representative . Distribute copies of reviewed drawings to the Electrical Division for their reference.
- .3 Provide all wiring in approved rigid conduit to suit temperature and moisture conditions of area through which wire is to run. All wiring is in accordance with the relevant Electrical Codes, and in no case smaller than #12 AWG. Comply fully with the electrical specifications for all electrical work.

1.11 Electrical Characteristics

- .1 Check with the electrical trade and provide all mechanical items with correct electrical characteristics to suit the electrical work.
- .2 If correct characteristics are not available from the specified equipment manufacturer, contact the Departmental Representative prior to the close of tenders.
- .3 At time of ordering HVAC equipment, confirm electrical characteristics with the electrical contractor, and ensure that they have been confirmed with the power authority.
- .4 No additional compensation will be paid for problems arising from incorrect electrical characteristics.

1.12 Cutting, Patching, Repairing, Making Good

- .1 In addition to the requirements in Division 01, each trade requiring such work shall be responsible for necessary cutting. Patching by appropriate trade. All work to be performed by experienced tradesmen.
- .2 Neatly perform cutting and patching work to blend smoothly with surrounding surfaces.

- .3 Patch and make good disturbed surfaces to match existing adjacent work. Leave finished, neat, to Departmental Representative 's approval.
- .4 Perform X-ray examination of wall and floors prior to making openings, where required to avoid damage to structural reinforcements and electrical conduits.

1.13 Tests

- .1 In addition to the requirements in Division 01, carry out all tests hereinafter noted, as required by the regulatory agencies and as requested by the Departmental Representative and furnish all labour and equipment required for such tests without extra compensation.
- .2 Before activating systems, recheck equipment, check all connections, set all controls for proper start-up, obtain necessary clearances from the electrical division, etc.
- .3 Submit to the Departmental Representative, legible report for all tests conducted, within one week of the test.
- .4 Notify the Departmental Representative at least two (2) working days ahead of all tests, so that the tests can be witnessed on a random basis.

1.14 Trial Usage

- .1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

1.15 Functional Testing

- .1 Test all HVAC equipment, devices and systems. Test as required by the AHJ and Departmental Representative, submitting comprehensive reports. Example forms are available from the Departmental Representative.
- .2 Ensure all tests demonstrate compliance with the specified and manufacturers' shop drawing and catalogued performance, as well as compliance with applicable standards.

1.16 Demonstration And Operating And Maintenance Instructions

- .1 In addition to the requirements in Division 01, 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.
- .2 Manufacturers, or expert suppliers, to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Departmental Representative or Owner may record these demonstrations on videotape for future reference.
- .6 Submit training schedule and scope description to the Departmental Representative for review and approval for each training topic. Training shall not commence until approval of training schedule and scope if given by the Departmental Representative.

1.17 Spare Parts

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals and as follows:
 - .1 2 spare valves per type use in project.

1.18 Special Tools

- .1 Provide one set of special tools required to service equipment in accordance with Section 01 78 00 - Closeout Submittals and as recommended by manufacturers.
- .2 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.19 Closeout Submittals

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 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 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 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.
 - .4 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.
 - .5 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.
- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. 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 reproduces, revising reproduces to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT 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 as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.20 Maintenance Material Submittals

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

1.21 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.22 Substantial Completion / Certification By Engineer / Life Safety Submissions

- .1 Provide minimum notice of ten (10) working days to the Departmental Representative prior to request to declare project substantially complete. Failure to do so may result in site review by Engineer being delayed.
- .2 In addition to the requirements of Division 01 submit the following (as applicable) a minimum of five (5) working days ahead of required proposed date of substantial completion (unless a longer period of time is dictated by Authorities Having Jurisdiction):
 - .1 All certificates and documentation required by Authorities Having Jurisdiction.
 - .2 Fire and smoke damper test reports.
 - .3 Smoke exhaust/management systems commissioning reports
 - .4 Equipment start-up reports.
 - .5 Control systems commissioning reports pertaining to equipment/systems required for life safety system operation (i.e. ventilation interlocks/unit operation, CO detection/exhaust systems, etc.).
 - .6 Test reports for backflow prevention devices with test taps.
 - .7 Written confirmation that propane system is approved by the utility and/or Authority Having Jurisdiction, and turned on.
 - .8 Record ('As-Built') drawings.
 - .9 Operation and Maintenance Manuals, complete with revisions as directed.
 - .10 Written confirmation that all life safety and health systems are fully functional, including but not limited to ventilation, both supply and exhaust.
 - .11 Written confirmation that all HVAC equipment is operational and under control, indicating exceptions and temporary controls/arrangements.
 - .12 All other life safety and health reports and certificates.
- .3 Confirm, in writing, systems are ready for occupancy and use for intended purpose in every respect.
- .4 Before certification date submit detailed written confirmation of completion of deficient life safety work noted in the documentation listed above, including date completed.
- .5 Before certification date submit detailed written confirmation of completion of deficient non-life safety work, including that noted in Departmental Representative reports, listing each deficient item. Submit schedule for completion of all deficient non-life safety work that will not be completed prior to the certification date, listing each deficient item for consideration.
- .6 These requirements apply to each phase of a phased project.

1.23 Fan Connections

- .1 Inlet and discharge conditions are critical to proper fan performance. Review proposed fan installations and ensure that proper conditions are provided; add straightening vanes or turning vanes where required.
- .2 In general, provide a minimum of three (3) wheel diameters of straight duct immediately upstream of the fan inlet.

- .3 Review special cases with the Departmental Representative and TAB Contractor prior to installation.

Part 2 Products

2.1 Motors

- .1 Motors to be high efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1.
- .2 Comply with all Canadian Electrical Code requirements, and in particular CSA C22.2 No. 100, c/w CSA label, unless otherwise specified.
- .3 Motors included in the scope of CAN/CSA-C747 shall have a nominal full-load efficiency not less than the minimum specified in that standard. Efficiency ratings of motors included in the scope of this standard shall be based on a statistically valid quality control procedure conforming to the standard. Nameplates shall list the nominal full-load motor efficiency.
- .4 Motors included in the scope of CAN/CSA-C390 shall have a nominal full-load efficiency not less than the minimum specified in that standard. Efficiency ratings of motors included in the scope of this standard shall be based on a statistically valid quality control procedure conforming to the standard. Nameplates shall list the nominal full-load motor efficiency.
- .5 In general, motors are EEMAC Class B (for standard torque applications), 1,800 RPM, continuous duty, open drip proof, ball bearing, 40°C temperature rise above 40°C ambient, 1.15 service factor. Motors are squirrel cage induction unless specifically noted otherwise. Special motors are specified with the equipment driven.
- .6 Single-phase motors shall be equipped with integral thermal overload protection.
- .7 Provide adequate capacity on each motor to operate the associated driven device under all conditions of load and service without overloading and be of at least the power specified.
- .8 Refer to Division 26 and provide motor characteristics within +5% of power source, or get written approval from the Departmental Representative.
- .9 Co-operate with Division 26 during start-up and provide all necessary assistance in commissioning.
- .10 Acceptable motor manufacturers may be listed under the Section 23 05 03 – Acceptable HVAC Manufacturers/Contractors.
- .11 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

2.2 Coupling For Direct Drive Equipment

- .1 Couplings shall be sized such that it will endure an infinite number of starts when equipment is fully loaded. All couplings shall be covered with a removable safety guard.

2.3 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 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave to be determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed.

2.4 Guards

- .1 Provide guards for all drives as specified and required by Authorities Having Jurisdiction.
- .2 Guards for belt drives (minimum requirements):
 - .1 Expanded galvanized metal screen welded to galvanized steel frame.
 - .2 Minimum 1.2 mm thick galvanized sheet metal tops and bottoms.
 - .3 Prime coat for painting.
 - .4 38 mm diameter holes on both shaft centres for insertion of tachometer.
 - .5 Allow movement of motors for adjusting belt tension.
- .3 Guards for flexible couplings (minimum requirements):
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Prime coat for painting.
- .4 Guards are to be readily removable to permit servicing of equipment.
- .5 Provide means to permit lubrication and use of test instruments with guards in place.
- .6 Ensure that all guards are securely fastened in place, sufficiently sturdy to provide the required safety and free of rattles and excess vibration.

2.5 Fire Separation Repair

- .1 Refer to Section 07 84 00 – Firestopping.
- .2 Cooperate fully with other trades to ensure maintenance of the rating of fire separations that are penetrated, in strict compliance with the manufacturer's recommendations and requirements of the AHJ.

2.6 Accessibility

- .1 Refer to Section 10 90 00 – Miscellaneous Specialties for access door specification.
 - .1 Standard Type:
 - .1 Door and Trim: 14 gauge steel. Trim 1-1/2 inches wide.
 - .2 Return Frame: 18 gauge steel. Depth 1-3/4 inches.

- .3 Hinges: Fully-concealed. Opens 170 degrees. On long side of door.
Number of hinges
- .4 varies with size of door.
- .5 Latches: Flush, stainless steel cam-operated with screwdriver.
Positioned opposite hinge
- .6 and at top and bottom on larger sizes.
- .7 Finish: Electrostatically-applied, baked grey enamel coat over rust-inhibiting phosphate
- .8 treated steel.
- .9 Masonry Anchor Straps: Minimum of 4 straps per door, where required
- .10 Cylinder Lock: Keyed alike with 2 keys per lock.
- .11 Gaskets: Weather-resistant and air-tight neoprene gaskets.
- .2 Fire Rated Type:
 - .1 UL Listed: rating to match assembly being installed in, 250 degrees C (450 degrees F) maximum temperature rise in 30 minutes for vertical wall installations.
 - .2 Frame: 16 gauge steel, 2 ½ inches deep.
 - .3 Insulation: 2 inches thick mineral wool in between 2 pieces of 22 gauge steel.
 - .4 Hinge: Continuous piano hinge allows opening to 180 degrees. Hinge is on long side of door.
 - .5 Latches: Specially designed Ultra Lock-self-latching keyed cylinder paddle latch opposite hinge.
 - .6 Automatic panel closer on all doors. Vertical position only. Ceiling position has self-assisted closing.
 - .7 Inside panel release on all doors.
 - .8 rust-inhibiting phosphate treated steel. This coating can be used as a finish or as a prime coat.
 - .9 Finish: Electrostatically-applied, baked grey enamel coat over rust-inhibiting phosphate treated steel.
 - .10 Hot smoke seal gasketing for 4 sides.
- .2 Be responsible for supplying and locating all access panels in the ceiling, wall, partitions, etc., where openings are necessary for the inspection, servicing and/or removal of equipment, valves and other items that require periodic access. Panel type to suit the construction of the ceilings, walls, partitions, etc., in which they are located. Determine the location subject to the approval of the Departmental Representative. Access panels to be installed by trade experienced in work with surface in which the panel is to be installed.
- .3 Mark mechanical access points in accessible ceilings with distinctive but inconspicuous tags properly attached to the ceiling grid. Obtain sample approval before purchase and installation. Indicate on record drawings.
- .4 Accessibility shall be defined as:
 - .1 Ability to place both hands on equipment or device, with no duct, pipe or other equipment in the way.

- .2 Must be accessible while standing on maximum 2400 mm high stepladder.
- .3 Must be in plain view.
- .5 Mark mechanical access points in accessible ceilings with distinctive but inconspicuous tags properly attached to the ceiling grid. Obtain sample approval before purchase and installation. Indicate on record drawings.

2.7 Sleeves And Penetrations

- .1 Install sleeves for all piping passing through floors and walls.
- .2 Sleeves as specifically noted, or through structural walls shall be Schedule 40 steel. All other sleeves are 6 mm galvanized sheet steel.
- .3 Fit sleeves flush on either side of the wall through which they pass, extend sleeves through floors and terminate 50 mm above finished floor. Adjust as necessary to accommodate the requirements of through-penetration fire-stopping systems.
- .4 Where passing through walls, make sleeves a minimum 6 mm clear of the piping, through floors make sleeves a minimum of 20 mm clear of the piping. Pack for full depth with fiberglass insulation & finish with a lagging compound. Penetrations through fire separations shall be repaired to maintain rating.
- .5 Provide escutcheon plates with setscrews to completely cover openings for all exposed pipes passing through walls, subject to the approval of the Departmental Representative. Provide chrome-plated plates in finished areas unless otherwise approved.
- .6 Be responsible for maintaining integrity of building envelope when making penetration to install equipment or devices. Enlist services of qualified trade to make openings in and/or repairs to building envelope.
- .7 Sleeving through steel beams shall be permitted only where approved by the Departmental Representative in writing or where expressly indicated on the Contract Documents. Sleeves are NOT permitted in concrete beams.
- .8 Seal all sleeves to make watertight.

2.8 Counter Flashings

- .1 In addition to the requirements in Division 01, provide watertight, non-corroding, counter flashings for all penetrations of the building envelope, painted to match adjacent materials after proper preparation and painting. Refer to drawings, including building drawings, for additional information.
- .2 Installation to allow for movement and accommodate high temperatures where necessary.
- .3 For short pipes, the flashing may overlap the end, in lieu of attachment to the pipe. Minimum 300 mm high above the roof, c/w water break above maximum water level on the roof, to negate wind effects.
- .4 All galvanized material to be 0.7 mm thick minimum.
- .5 In exposed locations, flashings must be aesthetically acceptable to the Departmental Representative.
- .6 Co-ordinate with all other trades including roofer and metal wall panel installer.
- .7 For copper pipe use 0.82 mm sheet copper, soldered to pipe end c/w solder joints.

- .8 For galvanized ducts use galvanized sheet metal soldered to the duct and c/w soldered joints.
- .9 For cast iron and steel pipes at normal temperature, use manufactured stretch fit heavy neoprene flashings c/w galvanized protective layer.
- .10 For hot pipes clamp galvanized to the pipe with a temperature rated gasket and stainless steel worm gear clamp.
- .11 For aluminum and stainless steel, use the same materials for the flashing.
- .12 For manufactured hoods, fans and rooftop unit mounting, apply a low density neoprene gasket all around and fasten securely.

Part 3 Execution

3.1 General

- .1 All Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Do not scale the Drawings. Consult the Architectural Drawings and details for exact locations of fixtures and equipment; where some are not definitely located, obtain this information from the Departmental Representative.
- .2 Follow Drawings as closely as possible in laying out work and check Drawings of all other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. When headroom or space conditions appear inadequate, notify the Departmental Representative before proceeding with the installation.
- .3 Make reasonable modifications in the layout as needed without extra compensation to prevent conflicts with work of other trades or for proper execution of the work. This shall include, but not necessarily be confined to, offsets in piping or ducts, transformation in ductwork and relocation of ducts and piping up to 3.0 m either way on each item as required to suit on site job conditions.
- .4 Where variances occur between the Drawings and Specifications or within either document itself, include in the contract, the item or arrangement of better quality, greater quantity, and higher cost or clarify before tenders close. The final decision on the item and manner in which work is installed rests with the Departmental Representative.
- .5 Provide, with all trades involved, marked-up drawings, when requested, of mechanical spaces indicating all dimensions for all installations prior to the work being done. Report any discrepancies to the Departmental Representative. Any conflicts arising that may have been resolved by laying the work out in this manner will be resolved WITHOUT ADDITIONAL COMPENSATION.
- .6 Provide 48 hours minimum notice to Departmental Representative and Owner of all work before it is concealed. Expose concealed work for inspection, upon request, when proper notice was not provided and pay all costs therefore, including making good other trades' work.

3.2 Surveys And Measurements

- .1 Base all measurements, both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. Verify all measurements

shown on the Drawings at the site, and check the correctness of same as related to the work.

- .2 Notify the Departmental Representative if any discrepancy is discovered between the actual measurements and those indicated which prevent following good practice or the intent of the Drawings & Specifications. Do not proceed with the work until receiving instructions from the Departmental Representative.

3.3 Co-Ordination

- .1 Give full co-operation to those doing work under other Divisions of the specifications and furnish in writing with copies to the Departmental Representative any information necessary to permit the work of all Divisions to be installed satisfactorily and with least possible interference or delay.
- .2 Discuss work with other Divisions prior to installation. Confirm proposed locations for equipment installed by this Division will not interfere with work installed by others.
- .3 If work is installed before coordinating with other trades or so as to interfere with work of other trades, make necessary changes in the work to correct the conditions without extra compensation.
- .4 When requested, provide marked up drawings indicating required clearances for installation of plumbing equipment. Provide section drawings indicating location of other equipment not installed by Division 23, such as other equipment and piping,, cable trays, etc. Report any discrepancies to the Departmental Representative.

3.4 Accessibility

- .1 Locate all equipment that must be serviced, operated or maintained in fully accessible positions, with minimum interference and maximum usable space. If required for better accessibility, furnish access doors for this purpose. Make deviations from Drawings to allow for good accessibility, obtaining prior approval for changes of magnitude.

3.5 Scaffolding, Rigging, Hoisting

- .1 Unless otherwise specified, furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment apparatus furnished. Remove same from the premises when no longer required.
- .2 Take precautions not to overload the structure in any manner nor provide inadequate scaffolding and rigging so as to endanger the safety of personnel on the site whether under this Division's employ or otherwise.

3.6 Cutting And Patching

- .1 Cutting shall be performed neatly by this trade. No hammering or other methods are permitted without approval of the Departmental Representative and other trades affected. Utilize a rebar detector and stud finder to ensure cutting does not damage other elements.
- .2 Patching is to be done by the appropriate trade. Arrange and pay for all patching not specifically specified elsewhere in these specifications, including fire rated patching at fire separations.
- .3 Fill voids around pipes and ducts with fiberglass batt insulation and sheet metal closure strips. For fire separations, install fire stop material in accordance with

manufacturer's details as required to meet the UL classification and to match separation rating. Ventilate adequately during curing. Provide adequate structural support in larger spaces. Install slightly above floors to provide positive drainage away from pipe or duct.

- .4 Provide a structural shop drawing stamped by a Professional Engineer showing all reinforcements required for openings through the structure. Allow for all costs of the reinforcement.

3.7 Supports

- .1 Provide all necessary and recommended supports for all equipment furnished under this Division. Co-ordinate and facilitate all necessary and recommended foundations, pads, bases and piers provided under other Divisions for equipment furnished or installed under this Division.

3.8 Waterproofing

- .1 Obtain approval for the installation method employed where any work pierces waterproofing concrete and waterproofing. Furnish all necessary grout rings sleeves, caulking, curbs, counter flashing and flashing required to make openings through roofs, walls, floors, etc., absolutely watertight. This applies to, but is not restricted to, roof exhausters, relief vents, penthouses, ducts, grilles, pipes, etc. Work involving the roofing is done in conjunction with the roofing Division. Work passing through roofing is to be done in accordance with applicable C.R.C.A. "FL" Series details.

3.9 Protection

- .1 Protect the work and material of all other sections from damage and make good all damage thus caused, to the satisfaction of the Departmental Representative.
- .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

3.10 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.11 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.

3.12 System Cleaning

- .1 Clean interior and exterior of all systems including strainers.

- .2 Duct Cleaning:
 - .1 Applicable to systems within the area of work and systems that may be affected by the work taking place in this project.
 - .1 Isolate all systems exterior to the area of work where possible.
 - .2 Thoroughly clean all new and existing ductwork.
 - .3 Segregate points of access to fan chambers, plenums, larger diameter ducting etc. from adjacent occupied areas.
 - .4 Supply and install access doors in ductwork, plenums, etc. at locations required to complete work specified.
 - .5 Work shall include the cleaning of plenums, diffusers, air handling units, fans and all other mechanical equipment which combined forms part of the buildings ventilation system. This shall include, but not limited to the following:
 - .1 Interior surfaces of all ductwork
 - .2 Interior surfaces of air handling units to include but not limited to plenums, fan(s), fan chambers, coils, dampers, filters, motor(s), louvres, etc.
 - .3 Surfaces of coils, dampers, louvres, turning vanes, diffusers, registers, grilles and all other equipment present with or which forms part of the air systems
 - .6 Provide drop sheet beneath all points where access to ducting or equipment will be made.
 - .7 Seal openings in ducting and equipment using polyethylene and tape to prevent the spread of dust and to assist in establishing negative pressure.
 - .8 Ensure each branch line is cleaned from each diffuser or grill, along with the entire length of the duct back to the main inclusive.
 - .9 Portable vacuum system may only be used on ducting with a circumference less than 48 in or less; use truck mounted vacuum system on ducting with larger circumference.
 - .10 Coils, fan blades, etc. shall be pressure washed with non toxic, non corrosive approved detergent germicide solution applied with low volume, high pressure wash unit. In addition, coils will be brushed, scraped and vacuumed as necessary.
 - .11 Dust and film build-up shall be cleaned from all surfaces of the building ventilation system which come into contact with circulating air.
 - .12 Provide necessary access openings in ductwork at locations required to complete the work. Repair openings following completion of work as follows:
 - .1 Access holes smaller than 10"x10" shall be re-sealed in an airtight manner using 24 gauge cross broken sheet metal, sheet metal screws and duct sealant.
 - .2 Supply and install specified access doors to re-seal openings greater than 12"x12".
 - .13 Establish negative pressure within system prior to and throughout the cleaning process.
 - .14

- .15 Schedule work following the complete of all work by other trades that may generate airborne construction debris. Ensure work of this section is completed prior to starting or testing of building systems.
- .16 Ensure electrical power supply to all air handling equipment is locked out and tagged. System to remain inoperable during cleaning process
- .17 Use of compressed air to aid the cleaning process is only permitted where access by the worker is not possible and the use can safely be controlled by the worker from the exterior of the ducting. Use of compressed air by a worker or while a worker is present within larger diameter ducting, air handler, plenums, etc is prohibited for safety reasons.

3.13 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report.
- .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.
 - .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.

3.14 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.15 Protection

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

3.16 Equipment Start-Up

- .1 HVAC contractor shall ensure that all electrical/HVAC components match and that it is safe to start-up HVAC equipment.
- .2 All support such as electrical contractor, controls contractor, etc., shall be arranged by the mechanical and all trades directly involved in equipment being started shall be present for start-up.

3.17 Manufacturers' Recommendations

- .1 Install, adjust, test, start-up, and maintain all equipment in strict accordance with the manufacturer's recommendations. If in conflict with the drawings and specifications, contact the Departmental Representative for clarification.
- .2 Ensure that the manufacturer recommends the product for its intended use. If in doubt, contact the Departmental Representative.

3.18 Personnel Protection

- .1 In addition to the requirements in Division 01, provide visual warning signs and/or markers and mechanical protection devices for all mechanical items mounted below the minimum limits listed below and suspended more than 1500mm clear of the floor.
 - .1 Occupied spaces 2286 mm (7'-6").
 - .2 Service spaces 2133 mm (7'-0").
 - .3 Crawl spaces 1524 mm (5'-0").
- .2 Visual warning devices to be yellow tape with black stripes adhered to the entire perimeter of the item infringing on the occupied space. This will include but not be limited to:
 - .1 Length of pipes or equipment below specified height.
- .3 Mechanical protection devices to be 7 mm (1/4") wire mesh guard and/or 25 mm thick 'Armaflex' type insulation. This will include but not be limited to:
 - .1 Pipe and equipment hangers.
 - .2 Valves.

END OF SECTION

Part 1 General

1.1 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B139, Installation Code for Oil Burning Equipment.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-11-, 2nd Edition, Environmental Standard for Paints and Coatings.
- .4 National Fire Code of Canada (NFCC 2005)
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113, Architectural Coatings.
 - .2 SCAQMD Rule 1168, Adhesive and Sealant Applications.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

Part 2 Products

2.1 Material

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
- .3 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 Application

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

3.2 Connections To Equipment

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

3.3 Clearances

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 Drains

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

3.5 Air Vents

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

3.6 Dielectric Couplings

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

3.7 Pipework Installation

- .1 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Install ball valves for glycol service.
 - .9 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 Sleeves

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

3.9 Escutcheons

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

3.10 Preparation For Fire Stopping

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.

- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.11 Flushing Out Of Piping Systems

- .1 Flush system.
- .2 Before start-up, clean interior of piping systems.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 Pressure Testing Of Equipment And Pipework

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

3.13 Existing Systems

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

3.14 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General**1.1 References**

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1, Power Piping.
- .2 ASTM International
 - .1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

Part 2 Products**2.1 System Description**

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
 - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 General

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.
- .2 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .3 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: 9mm.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL/ULC listed to MSS-SP69.
- .4 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, ULC listed 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 ULC listed.
- .5 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 ULC listed to MSS SP69.
- .6 Shop and field-fabricated assemblies.

- .1 Trapeze hanger assemblies: steel, sized to suit load.
- .2 Steel brackets: sized to suit load.
- .7 Hanger rods: threaded rod material to MSS SP58.
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Size based on the following schedule:
 - .1 10 mm rod for pipes up to 50 mm diameter.
 - .2 12 mm rod for 65 mm and 75 mm diameter.
 - .3 16 mm rod for 100 mm diameter.
 - .4 20 mm rod for 150 mm diameter.
 - .5 22 mm rod for 200 mm to 300 mm diameter.
- .8 Pipe attachments: material to MSS SP58.
 - .1 Attachments for steel piping: carbon steel, galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .9 Adjustable clevis: material to MSS SP69, ULC listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .10 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .11 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.
- .12 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.
- .13 For refrigerant piping use a manufactured support system consisting of:
 - .1 U-shaped channel of gauge and size as recommended by manufacturer to support the load.
 - .2 Thermoplastic elastomer cushion that surrounds piping and hinges open for easy insertion of piping.
 - .3 Clamp with electro chromate finish that secures cushion to channel by means of shaped end tabs that fit into the U-shaped channel and a tightening bolt at the top.

2.3 Wall Support

- .1 For piping supported off wall, roof or floor, use a manufactured support system consisting of:
 - .1 U-shaped channel of gauge and size as recommended by manufacturer to support the load.
 - .2 Thermoplastic elastomer cushion that surrounds piping and hinges open for easy insertion of piping.

- .3 Clamp with electro chromate finish that secures cushion to channel by means of shaped end tabs that fit into the U-shaped channel and a tightening bolt at the top.
- .2 Spacing shall be as recommended by manufacturer for load being supported.
- .3 For groups of piping that are arranged perpendicular to wall, install Unistrut to form a triangular angle bracket.

2.4 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, ULC listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.5 Insulation Protection Shields

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 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.

2.7 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.

2.8 Equipment Supports

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

2.9 Equipment Anchor Bolts And Templates

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

2.10 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.

2.11 Other Equipment Supports

- .1 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, and 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 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: to National Plumbing Code of Canada and t Provincial 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 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

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

- .7 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.

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.

3.7 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

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 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 Installation of Standpipe and Hose Systems.

1.3 Action And Informational Submittals

- .1 Product Data:
- .2 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.
- .4 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 35 29.06 - Health and Safety Requirements.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Replace defective or damaged materials with new.

Part 2 Products

2.1 Manufacturer's Equipment Nameplates

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

2.2 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, 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)
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: 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.
 - .2 Propane gas: to CSA/CGA B149.1.
 - .3 Sprinklers: to NFPA 13.
 - .4 Standpipe and hose systems: to NFPA 14.

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

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

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

Contents	Background colour marking	Legend
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	to Codes	
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.6 Identification Ductwork Systems

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

2.7 Valves, Controllers

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

2.8 Controls Components Identification

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

2.9 Language

- .1 Identification in English.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Timing

- .1 Provide identification only after painting specified 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, CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

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.

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, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 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 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

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 to perform TAB to Departmental Representative within 30 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .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 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .3 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 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, NEBB, or TABB), 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 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 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 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 confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

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 Division 23.

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:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

- .1 Proper thermal overload protection in place for electrical equipment.
- .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
- .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 Application Tolerances

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 5 %, minus 5 %.
 - .2 Hydronic systems: plus or minus 10 %.

1.11 Accuracy Tolerances

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

1.12 Instruments

- .1 Prior to TAB, submit to Departmental Representative list of instruments 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 Action And Informational 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 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 6 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 personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 Settings

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

1.18 Completion Of Tab

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

1.19 Air Systems

- .1 Standard: TAB to most stringent of this section.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 and as follows:
 - .1 Existing fan coils.
 - .2 New fan powered terminal units
 - .3 New transfer fans
 - .4 Existing exhaust system for print and kitchenette
 - .5 Test and tag all fire dampers
- .3 Qualifications: personnel performing TAB current member in good standing of AABC and NEBB.

- .4 Quality assurance: perform TAB under direction of supervisor qualified by AABC and NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include 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 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.

1.21 POST-OCCUPANCY TAB

- .1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.
 - .1 During system checks allow for adjustment to air flow to spaces based on occupant feed back.

Part 2 Products

2.1 Not Used

- .1 Not used.

Part 3 Execution

3.1 Not Used

- .1 Not used.

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, 1985.

1.3 Action And Informational 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.
 - .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.

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.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Test Procedures

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

3.3 Site Tolerances

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Small duct systems up to 250 Pa: leakage 2%.
 - .2 VAV box and duct on downstream side of VAV box: leakage 2%.

- .3 Large low pressure duct systems up to 500 Pa: leakage 2%.
- .4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1%.
- .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 Cleaning

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

END OF SECTION

Part 1 General

1.1 Summary

- .1 Section Includes:
 - .1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411, Standard 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 C533, Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547, Mineral Fiber Pipe Insulation.
 - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C921, Standard Practice for Determining the 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.
 - .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 Manufacturer's Trade Associations

- .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .7 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.
 - .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 Definitions

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.4 Action And Informational 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.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .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.

1.5 Quality Assurance

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, member of TIAC.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 Fire And Smoke Rating

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

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702.
- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.

- .2 Jacket: to CGSB 51-GP-52Ma.
- .3 Certified by manufacturer: free of potential stress corrosion cracking
corrodants.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with
special shapes to suit project requirements.
- .1 Insulation: to ASTM C533.
- .2 Design to permit periodic removal and re-installation.

2.3 Insulation Securement

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or Air drying on mineral wool, to ASTM C449/C449M.

2.5 Vapour Retarder Lap Adhesive

- .1 Water based, fire retardant type, compatible with insulation.

2.6 Indoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 Outdoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 Jackets

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

- .7 Special requirements:
 - .1 Outdoor: UV rated material at least 0.5 mm thick.
- .2 ABS Plastic:
 - .1 One-piece moulded type and sheet with pre-formed shapes as required.
 - .2 Colours: white unless otherwise specified
 - .3 Minimum service temperatures: -40 degrees C.
 - .4 Maximum service temperature: 82 degrees C.
 - .5 Moisture vapour transmission: 0.012 perm.
 - .6 Thickness: 0.75 mm.
 - .7 Fastenings:
 - .1 Solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .8 Locations:
 - .1 For outdoor use ONLY.
- .3 Canvas:
 - .1 220 and 120 gm/m2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .4 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
- .5 Stainless steel:
 - .1 Type: 304.
 - .2 Thickness: 0.25 mm.
 - .3 Finish: stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.9 Weatherproof Caulking For Jackets Installed Outdoors

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Pre-Installation Requirement

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

3.3 Installation

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

3.4 Removable, Pre-Fabricated, Insulation And Enclosures

- .1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: high temperature fabric.

3.5 Installation Of Elastomeric Insulation

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

3.6 Piping Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.

- .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .5 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .6 TIAC Code: A-2.
 - .1 Securements: SS wire bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-H.
- .7 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)									
	0 to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8	up to 175	Over 175					
Hot Water Heating	60 - 94	A-1	25	38	38	38	38					
Hot Water Heating	up to 59	A-1	25	25	25	25	38					
Glycol Heating	60 - 94	A-1	25	38	38	38	38					
Glycol Heating	up to 59	A-1	25	25	25	25	38					
Domestic HWS		A-1	25	25	25	38	38					
Chilled Water	4 - 13	A-3	25	25	25	25	25					
Chilled Water or Glycol	below 4	A-3	25	25	38	38	38					
Refrigerated Drinking Water		A-3	25	25	25	25	25					
Domestic CWS		A-3	25	25	25	25	25					
Domestic		C-2	25	25	25	25	25					

CWS with vapour retarder													
RWL and RWP		C-2	25	25	25	25	25						
Cooling Coil cond. drain		C-2	25	25	25	25	25						

.8 Finishes:

- .1 Exposed indoors: PVC jacket.
- .2 Exposed in mechanical rooms: PVC jacket.
- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .5 Outdoors: water-proof aluminum jacket.
- .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General**1.1 Summary**

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
- .2 Related Requirements

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

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 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products**2.1 Cleaning Solutions**

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

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 Cleaning Hydronic And Steam Systems

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol Systems:
 - .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.
- .9 Steam Systems: in addition to general requirements as specified above, perform following:
 - .1 Remove internal components of steam traps until flushing and warm-up have been completed.
 - .2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.
 - .3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.
 - .4 Water hammer: determine source and eliminate cause.

3.3 Start-Up Of Hydronic Systems

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment Systems.

- .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
- .8 Repeat with water at design temperature.
- .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
- .10 Bring system up to design temperature and pressure slowly over a 48 hour period.
- .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .12 Adjust pipe supports, hangers, and springs as necessary.
- .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .16 Check operation of drain valves.
- .17 Adjust valve stem packings as systems settle down.
- .18 Fully open balancing valves (except those that are factory-set).
- .19 Check operation of over-temperature protection devices on circulating pumps.
- .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 Summary

- .1 Section Includes:
 - .1 Materials and installation for:
 - .1 Controls and instrumentation.
 - .2 Energy monitoring and control system.

1.2 References

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

1.3 Definitions

- .1 Average Effectiveness Level (AEL): ratio between a thirty day test period less any system down time accumulated within that period, and the thirty day period.

1.4 Work Included

- .1 Provide DDC controls for under floor fan powered boxes, to match existing on-site control system and connect directly to the existing network(s) and existing web-server operator interface software.
- .2 Fan powered boxes are used in this project to provide additional zoning on to existing fan coil systems.
 - .1 Fan coil controls shall be modified such that heating and cooling modes are determined by polling associated new fan power terminal box thermostats. The decision for heating or cooling will be based on the majority demand.
 - .2 Where existing fan coil thermostats are remaining, or being relocated, the thermostats shall act as a zone thermostat and shall be polled similar to above
 - .3 Existing variable air volume boxes that supply ventilation to fan coil inlet shall be controlled by zone CO2 sensors that integral to fan powered box zone thermostats. VAV boxes shall modulated to satisfy the worst case zone on a fan coil system.
 - .4 During Daytime Mode, the DDC system shall set back temperatures and CO2 levels based lighting system occupancy sensors. Coordinate bacnet signal with lighting controls system.
- .3 Provide new thermostat with integrated CO2 sensor for all new under floor fan powered boxes.
- .4 Provide motorized bypass air damper at each fancoil to control plenum static pressure to neutral. Allow for 18x8" damper for each fancoil.
- .5 Where existing thermostats are not suitable for re-use, replace with new at no additional cost to the project.

- .6 Where additional CO2 sensors are required for zone other than those served by under floor fan powered boxes, provide sensor or new thermostat with integral sensor.
 - .1 This generally applies to zones served directly by fan-coils (not through under floor fan powered boxes).
- .7 Components and interconnecting systems to be installed by trained technicians, regularly employed by this Division. Technician must be qualified and approved to work on existing BMS which is Siemens.
- .8 Test all components that are to be re-used prior to modifying or removing. Report any malfunctioning equipment to Departmental Representative immediately.
 - .1 Contractor will be responsible for replacing any equipment that it found damaged that has not been reported previously.

1.5 Design Requirements

- .1 Provide direct digital controls, management, and monitoring for all new equipment to integrate with existing building controls system.
- .2 Monitor new bypass under floor fan powered boxes, transfer fan in equipment closet, and ensure any existing equipment controls are maintained. Including but not limited to existing fan coils and ventilation VAV boxes.
- .3 System to function as Energy Monitoring and Control System (EMCS).
- .4 Provide digital controllers, programmable and independently operable (stand alone). Provide system immune to voltage fluctuations and spikes, radio frequency interference, power failures, and surges.
- .5 Incorporate high speed communications network using industry standard protocol to link independent controllers, local terminals and the command and management centre. Ensure that communications link permits access and information transfer between points within network.

1.6 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet for:
 - .1 Provide for purchased components.
 - .2 Include complete technical information regarding operating ranges, input and output capabilities.
 - .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 Manufacturer's Field Services: submit reports within three days of receipt from manufacturer.
- .7 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 self-contained packaged heating, cooling or ventilation units.
 - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.
 - .3 Submit complete start-up report indicating start-up and system verification sequences.
 - .4 Submit manufacturer's standard warranty, executed by authorized company official.

1.7 Warranty

- .1 For Work of this Section, 12 months warranty period.

1.8 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.

Part 2 Products

2.1 Components

- .1 Sensors: use industry standard digital or analog signal ranges.
- .2 Motors and Relays: electric-electronic type, heavy duty construction, designed for industrial environment.
- .3 Monitoring Software:
 - .1 Integrate with existing system and add menus and graphics as required.

2.2 Controls

- .1 Monitor status of and control following systems:
 - .1 New under floor fan powered boxes,
 - .2 New transfer fan
 - .3 All existing equipment that is currently being monitored shall continue being monitored.

- .2 Thermostats: wall mounted with integral CO2 sensor, equipped with lockable lexan guards. Use remote space temperature sensors in public areas.
- .3 On fan failure, fan alarms will be annunciated at EMCS.

Part 3 Execution

3.1 Sequence Of Operations

- .1 Under Floor Fan Powered Boxes:
 - .1 Cooling
 - .1 On a rise in room temperature, the thermostat will call for cooling and modulate the EC fan motor. The fan motor slowly increases speed to increase the cold air to the room.
 - .2 On fall in room temperature, the thermostat reverses the above action. The EC fan motor slows speed to decrease the cold air to the room.
 - .2 Heating
 - .1 On a drop in room temperature, the thermostat will call for heating and modulate the EC fan motor. The fan motor slowly increases speed to increase the hot air to the room.
 - .2 On fall in room temperature, the thermostat reverses the above action. The EC fan motor slows speed to decrease the hot air to the room.
 - .3 When space temperature is satisfied, run fan at low speed (20%, adjustable) during occupied hours. If space temperature deviates from set point (by more than 3C, adjustable), turn off fan.
 - .4 Provide plenum temperature sensor and lock to minimum speed to prevent supply if plenum temperature is not suitable (i.e. if fan coil is in heating and Under Floor Fan Powered Box calls for cooling).
 - .5 Zone FTU shall be enabled to maintain zone setpoint when associated fancoil is enabled in unoccupied mode.
- .2 Equipment room Transfer Fans:
 - .1 Fans are activated with thermostat.

3.2 Manufacturer's Instructions

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

3.3 Installation

- .1 Install components to manufacturer's written instructions.
- .2 Exposed wiring: run in conduit or EMT.
- .3 Run control pipe and tubing parallel to building structure. Bundle tubing together and run in ladder trays where applicable.

3.4 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 Operate equipment and verify that performance criteria specified in this section has been achieved.
 - .2 Perform periodic site inspection visits by manufacturer's representative to verify that installation complies with manufacturer's instructions:
 - .1 After delivery and storage of products.
 - .2 When preparatory Work upon which product installation depends is complete.
 - .3 Twice during installation progress at 25% and 60% complete.
 - .4 After installation and cleaning is complete.

3.5 Demonstration

- .1 Demonstrate equipment to 01 79 00 - Demonstration and Training.
- .2 Provide instructors to train designated personnel. Include adjustment, operation, maintenance and safety requirements of equipment and system provided, specific to this installation.
- .3 Training Materials: provide training English manual for trainees.

3.6 Commissioning

- .1 Commission equipment of this Section to 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Verify operation of subsystems, including field components.
- .3 Conduct final operational test of not less than 30 consecutive days, 24 hours per day, on entire control system.

- .1 Average effectiveness level (AEL): minimum 99%.
- .2 Extend test period each day until required AEL is reached for 30 consecutive calendar days.
- .4 Advise Departmental Representative when proper system operation is established. Departmental Representative will perform point by point check of hardware and software items including graphics and displayed data.

END OF SECTION

Part 1 General

1.1 Summary

1.2 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE Handbook – Fundamentals.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/ULC-S109M, Standard for Flame Tests of Flame-Resistant Fabrics and Films.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 HVAC Duct Construction Standards - Metal and Flexible.
 - .2 HVAC Air Duct Leakage Test Manual.
 - .3 IAQ guideline for Occupied Buildings under Construction.

1.3 Shop Drawings And Product Data

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

1.4 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

- .4 Develop Construction Waste Management Plan related.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 Galvanized Steel

- .1 Lock forming quality: to ASTM A653/A653M, G90/Z275 zinc coating, with tolerances to ASTM A924/A924M.
- .2 Thickness, fabrication and reinforcement: to SMACNA HVAC Duct Construction Standards.
- .3 Joints: to SMACNA HVAC Duct Construction Standards.

2.2 Pressure Classification

- .1 Pressure Class B.

2.3 Ductwork

- .1 Construction - round and oval.
 - .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA HVAC Duct Construction Standards.
 - .2 Transverse joints up to 900 mm: slip type with tape and sealants.
 - .3 Transverse joints over 900 mm: Vanstone flanges.
- .2 Construction - rectangular:
 - .1 Ducts: factory fabricated to SMACNA HVAC Duct Construction Standards.
 - .2 Transverse joints: to SMACNA HVAC Duct Construction Standards.

2.4 Fittings

- .1 Fabrication: to SMACNA HVAC Duct Construction Standards.
- .2 Radiused elbows:
 - .1 Rectangular: smooth radius. Centreline radius: 1.5 times width of duct.
 - .2 Round and oval: smooth radius or five-piece (for 90 degrees) and three-piece (for 45 degrees). Centreline radius: 1.5 times duct diameter.
- .3 Mitred elbows:
 - .1 To 750 mm duct height in plane of turn: with single-thickness turning vanes.
 - .2 Over 750 mm duct height in plane of turn: with double-thickness turning vanes.
- .4 Branches:

- .1 Rectangular main and branch: connection with 45 degree entry.
- .2 Round main and branch: conical connection.
- .3 Provide volume control damper in branch duct near connection to main duct.
- .5 Transitions:
 - .1 Diverging: 10 degrees maximum angle each side; 20 degrees maximum included angle for symmetrical fittings.
 - .2 Converging: 22.5 degrees maximum angle each side; 45 degrees maximum included angle for symmetrical fittings.
- .6 Offsets:
 - .1 Full radiused or mitred elbows: as specified above.
- .7 Obstruction deflectors: maintain full cross-sectional area of duct.
 - .1 Maximum included angles: as for transitions.

2.5 Seal Classification

- .1 Seal class:

Systems	Pressure Class (Pa)	Seal class
Supply fan – discharge	+250	B
Exhaust fan – suction	-250	B

- .2 Seal Classification:
 - .1 Class B: longitudinal seams, transverse joints and connections made airtight with sealant and tape or combination thereof.
 - .2 Class C: transverse joints and connections made air tight with sealant and tape or combination thereof. Longitudinal seams unsealed.

2.6 Sealant

- .1 Sealant: oil resistant, water-based, polymer type flame resistant duct sealant.
- .2 Flame spread rating shall not exceed 25 and smoke developed classification shall not exceed 50.
- .3 Operational temperature range of minus 32 degree C to plus 93 degree C. Application temperature range of plus 4 degree C to plus 43 degree C.

2.7 Reinforcing Tape

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
- .2 Meets the flame-resistance requirements of CAN/ULC-S109M.

2.8 Hangers And Supports

- .1 Hangers and Supports:
 - .1 Hanger configuration, design, and construction: to SMACNA HVAC Duct Construction Standards.
 - .2 Strap hangers: Maximum rectangular duct size supported by strap hanger: 500 mm on longest side.
 - .1 Straps of same material as duct but next sheet metal thickness heavier than duct.
 - .2 Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - .3 Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
 - .3 Band hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum round or oval duct size supported by strap hanger: 500mm diameter.
 - .4 Trapeze hangers and Riser Supports: ducts over 500 mm diameter or longest side, to SMACNA HVAC Duct Construction Standards.
 - .1 Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - .2 Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 - .3 Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.
 - .5 Hangers: galvanized steel angle with galvanized steel rods to SMACNA HVAC Duct Construction Standards.
 - .6 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamps.
 - .3 For steel beams: manufactured beam clamps.
 - .7 Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

Part 3 Execution

3.1 General

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standards unless directed otherwise by Engineer.
- .2 First class workmanship is required for fabrication and installation. Submit samples and/or detailed shop drawings of different types of fittings, joints, supports, sealants, etc, when requested by the Engineer.
- .3 Locate ductwork approximately as shown on drawings unless otherwise prevented by jobsite conditions. Carefully coordinate duct layouts with other services, particularly

where exposed in occupied spaces. Conceal all ductwork unless otherwise directed and approved by the Engineer. Report all layout deviations to the Engineer for approval prior to installation.

- .4 Construct ducts in accordance with the dimensions shown on the drawings. Alter the duct dimensions, while maintaining the equivalent round duct diameter, where necessitated by jobsite conditions. Equivalent duct dimensions to be determined using ASHRAE Handbook duct design procedures.
- .5 Duct dimension shown on drawings are inside dimensions. If ducts are internally lined or insulated, increase duct size such that clear dimensions after application of lining/insulation are equal to those shown on drawings.
- .6 Adjust duct dimensions to suit standard control damper sizes.
- .7 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .8 Support risers at each floor penetration. Provide neoprene pads between riser supports and the building structure. On exposed ductwork, provide galvanized angle collars to conceal the above work on both sides of the floor penetration.
- .9 Lap all joints in the direction of air flow wherever possible.
- .10 Provide a smooth interior surface at all seams and joints.
- .11 Provide a straight collar, not less than 300 mm long, at the connection to each diffuser. Where this is not possible provide adjustable multi-blade type flow equalizing grid in the diffuser neck.

3.2 Fittings

- .1 Fitting geometry to be in accordance with specifications and drawing details unless otherwise directed and approved by the Engineer.
- .2 Provide mitred elbows with turning vanes where jobsite conditions prevent installation of radiused elbows.

3.3 Hangers

- .1 Strap and band hangers: install in accordance with SMACNA HVAC Duct Construction Standards.
- .2 Angle hangers: install in accordance with SMACNA HVAC Duct Construction Standards, complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA HVAC Duct Construction Standards.
- .4 Do not break continuity of insulation vapour barrier with hangers or rods.

3.4 Sealing And Taping

- .1 Apply sealant to outside of joint in accordance with SMACNA HVAC Duct Construction Standards and to manufacturer's recommendations.
- .2 Use reinforcing tape on all ducts with seal Class A; ducts with seal Class B or C and a pressure classification in excess of 500 Pa; and for larger gaps.
- .3 Bed reinforcing tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.
- .4 Seal all joints including, but not limited to, at coils, terminal units, grilles and diffusers.
- .5 Eliminate all audible noise caused by air leakage.

3.5 Watertight Duct And Drip Pans

- .1 Provide watertight duct for:
 - .1 Intake and relief air outlets.
 - .1 Ductwork connect from ERV unit to outdoors
 - .2 Outside air intakes.
 - .3 As directed by Engineer.
- .2 Provide watertight evaporative pan below:
 - .1 Intake and relief air outlets.
 - .1 Beneath roof hoods for ERV unit
- .3 Form bottom of horizontal duct or drip pan without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .4 Slope horizontal branch ductwork down towards hoods served.
 - .1 Slope header ducts down toward risers.
- .5 Fit base of riser with 150 mm deep drain sump and 25 mm drain, with deep seal trap and trap primer, discharging to open funnel or hub drain.
- .6 Drip pan to be 75 mm wider all around ductwork or equipment served and complete with 75 mm deep drain sump. Elevated drip pans to be provided with 25 mm drain discharging to open funnel or hub drain. Provide sufficient clearance above drip pan to facilitate access and to permit unimpeded airflow to equipment or intake above.
- .7 Provide angle iron supports under sumps and drip pans adequate to support weight when full.
- .8 Install drip pans level to maximize holding capacity.
- .9 Fill sumps and drip pans with water to demonstrate strength, level and waterproof, when requested by Engineer.

3.6 Leakage Tests

- .1 Conduct tests in accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
- .3 Coordinate testing requirements with the TAB contractor who will perform leakage tests. Provide temporary caps and make duct modifications required to conduct the tests.
- .4 Do leakage tests in sections.
- .5 Leakage testing shall include HVAC equipment and terminal units. Where sections include equipment and terminal units, do not perform leakage testing until final connections have been made.
- .6 Conduct trial leakage tests to demonstrate workmanship.
- .7 Do not install additional ductwork until trial tests have been passed.
- .8 Complete testing before installation of insulation or concealment Work.
- .9 Give seven days' advance notice for testing.

3.7 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 References

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

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 air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
 - .5 Rated Silencers.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

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 thick with fabric clenched by means of double locked seams.

- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m2.

2.3 Access Doors In Ducts

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

2.4 Turning Vanes

- .1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.5 Instrument Test

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

2.6 Spin-In Collars

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

2.7 Rated Silencers And Cross Talk Silencers

- .1 Refer to architectural drawings and wall types for require STC ratings of assemblies. Provide manufactured and rated silencers to match assemblies.
- .2 Provide rated silencers on inlets to fan powered terminal unit boxes where the penetrate STC rated walls. Rating of silencer to meet rating of wall or room.
- .3 Provide rated cross talk silencers on all air transfer openings that penetrate STC rated walls. Rating of silencer to meet rating of wall or room.

- .4 Silencer performance characteristics, including insertion loss and pressure drop, shall be attained through testing in accordance with the latest ASTM E477 test standard for acoustical duct silencers. Laboratory performance verification in the manufacturer's test facility may be requested, in which case a comparative test report shall be made available to the engineer.
- .5 Silencers shall consist of 22 gauge solid steel casings, 26 gauge solid steel internal noses at inlet and outlet, and ¾ inch dual-density absorptive acoustic fiberglass media.
- .6 Acoustic media shall be shot-free inorganic gl. Acceptable methods of fastening include button lock, Pittsburgh lock and welds. In situations where these methods are not feasible, rivets can be used. Screws or other types of mechanical fasteners will not be acceptable. The silencer perforated liners shall be rigidly fastened to the casing of the silencer on both ends, and attached to the outer casing with a minimum of two stiffeners.
- .7 Combustion ratings for acoustic media shall be equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84, UL723 and NFPA255.
 - .1 Flame Spread Classification: < 25
 - .2 Smoke Development Rating: < 50

2.8 DUCT SECURITY BARS

- .1 Refer to architectural drawings for secure walls. Provide in all duct penetrations in these walls greater than 152x152mm.
- .2 Furnish and install duct / barrier grille of the sizes and mounting types indicated on the plans. 5 mm sleeve with two 25 x 25 x 5mm 4-sided angle frames (one frame welded 25mm from one end, one frame shipped loose for field welding). Barrier bars shall be 13mm hot rolled steel bars located on maximum 152 x 152 mm centers. Bars are to be welded to frame and at all crosspoints. The grille shall be painted with a powder coat process and be finished in white.

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

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:
 - .1 900 x 900 mm for person size entry.
 - .2 600 x 600 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 Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.

- .4 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 References

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible 2013.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 General

- .1 Manufacture to SMACNA standards.

2.2 Splitter Dampers

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.

- .5 Pivot: piano hinge.
- .6 Folded leading edge.

2.3 Single Blade Dampers

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 Multi-Bladed Dampers

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed-blade configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 150 mm.
- .4 Maximum blade length: 1200 mm. Use multi-sectional dampers for applications exceeding 1200 mm.
- .5 Bearings: pin in bronze bushings or self-lubricating nylon.
- .6 Linkage: shaft extension to accommodate insulation thickness with locking quadrant.
- .7 Channel frame of same material as adjacent duct, complete with angle stop.
- .8 Vibration-free operation.

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Installation

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 References

- .1 Air Movement & Control Association International Inc.
 - .1 AMCA Standard 500-D, Laboratory Methods of Testing Dampers for Rating.
 - .2 AMCA Standard 511, Certified Ratings Program for Air Control Devices.
- .2 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
 - .2 ANSI/NFPA 80, Standard for Fire Doors and other Opening Protectives
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.
 - .3 ULC-S505, Standard for Fusible Links for Fire Protection Service.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 Additional Submittals

- .1 Shop drawing submissions shall include the following additional information:
 - .1 Schedule with the following data (as applicable) for each damper:
 - .1 Type and model number.
 - .2 Installed orientation.
 - .3 Size.
 - .4 Air flow rate and pressure drop.
 - .5 Fire resistance rating.
 - .6 Closure type and temperature rating.
 - .7 Smoke damper temperature rating and leakage class.

- .2 Damper actuator details including mounting, failure position, electrical characteristics and wiring diagrams.
- .3 Accessories: including associated electrical data and wiring diagrams.
- .4 Manufacturer's installation instructions for each model.

1.5 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals\.
 - .2 Provide:
 - .1 6 fusible links of each type.

1.6 Certification Of Ratings

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency in adherence to all codes and standards required by the authority having jurisdiction.

1.7 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 Fire Dampers

- .1 Fire dampers: listed and bear label of ULC, assemblies fire tested and rated in accordance with CAN/ULC-S112, meet requirements of authorities having jurisdiction.
- .2 Classified for dynamic closure against maximum design airflow, at 2000 Pa minimum static pressure differential (across closed damper), for installed configurations and locations on systems where fan does not shut down on fire alarm.
- .3 Factory fabricated for fire resistance rating requirement and installation orientation to maintain integrity of fire wall and/or fire separation.
- .4 Curtain-type design: steel frame with reinforced corners, steel interlocking blades, sheet steel mounting sleeve (factory or field installed), transitions to suit connecting

ductwork. Galvanized steel construction where connecting ductwork is galvanized, stainless steel construction where connecting ductwork is stainless steel. Provide sealed high pressure construction where duct pressure class exceeds 500 Pa or Class B or C duct seal is specified.

- .5 Closure type: fusible link actuated, weighted to close and lock in closed position when released or having stainless steel negator-type spring closing operator for damper in horizontal position with vertical air flow. Generally fusible links to be rated at 74EC for exhaust and recirculation applications, and 100EC on supply air applications. Revise, with Engineer's approval, as required to meet the needs of special locations. Fusible links shall be readily removable by hand to facilitate testing.
- .6 Damper types and transition collars to be selected based on the following criteria unless otherwise directed by the Engineer:
 - .1 Duct pressure class less than or equal to 500 Pa, unsealed or Class C duct seal, and face velocities less than or equal to 15 m/s:
 - .1 Type A: square and rectangular ductwork with air velocities less than or equal to 5 m/s and aspect ratios of 2:1 or less.
 - .2 Type B: square and rectangular ductwork with air velocities exceeding 5 m/s or aspect ratios greater than 2:1.
 - .3 Type R: round ductwork.
 - .2 Duct pressure class greater than 500 Pa, Class B duct seal, or face velocities exceeding 15 m/s:
 - .1 Type C: square and rectangular ductwork.
 - .2 Type CO: flat oval ductwork.
 - .3 Type CR: round ductwork.
- .7 Factory tested for proper operation.

2.2 Smoke Dampers

- .1 Smoke dampers: listed and bear label of ULC, assemblies fire tested and rated in accordance with CAN4-S112.1, meet requirements of authorities having jurisdiction, licensed to bear the AMCA seal, assemblies tested and rated in accordance with AMCA Standards 500-D and 511.
- .2 Factory fabricated for installation orientation to maintain integrity of smoke separation.
- .3 Temperature rating: 177EC.
- .4 Leakage rating: Class I - leakage shall not exceed 40 L/s-m² at 1000 Pa minimum static pressure differential (across closed damper).
- .5 Multi-blade design: steel frame with reinforced corners and low profile head and sill, steel blades, square plated steel axles, bronze sleeve type bearings, flexible stainless steel jamb seals, pressure sensitive silicone blade edge seals, plated steel linkage concealed in frame, factory installed steel mounting sleeve, transition collars to suit connecting ductwork. Galvanized steel construction where connecting ductwork is galvanized, stainless steel construction where connecting ductwork is stainless steel. Frame leakage not to exceed that of connecting ductwork.
- .6 Blade style and operation:

- .1 Three-V style with parallel blade operation for face velocities less than or equal to 7 m/s, two-position (fully open or fully closed) operation, and where even airflow distribution is not required downstream of open damper.
- .2 Airfoil-shaped, double-thickness style with opposed blade operation for face velocities exceeding 7 m/s, modulating operation, ducted outlets, or upstream of system components requiring even airflow distribution.
- .7 Actuator: electric, controlled from smoke sensor or smoke detection system, spring return, fail to normally closed position, EEMAC Type 4 enclosure, factory installed on outside of damper mounting sleeve, factory wired to a single junction box for single-point wiring connection. All actuators to be provided by a single manufacturer. Confirm power supply characteristics prior to ordering.
- .8 Accessories: package for remote indication of damper position complete with switch box, two 120 V rated micro switches (one closes when the damper is fully open and the other closes when the damper is fully closed), switch box mounting bracket, blade bracket and connecting hardware.
- .9 Smoke dampers under 400 mm high shall be oversized by 50 mm (width and height) and provided with Type C enclosures with transition collars to suit connecting duct size to maximize free area.
- .10 Factory tested for proper operation.

2.3 Combination Fire/Smoke Dampers

- .1 Combination fire/smoke dampers: listed and bear labels of ULC for both fire and smoke dampers, assemblies fire tested and rated in accordance with CAN/ULC-S112 and CAN/ULC-S112.1, meet requirements of authorities having jurisdiction, licensed to bear the AMCA seal, assemblies tested and rated in accordance with AMCA Standards 500-D and 511.
- .2 Damper: similar in all respects to smoke dampers specified above and incorporating required fire damper performance and rating.
- .3 Combined actuator: electric, similar in all respects to smoke dampers specified above, controlled from smoke sensor or smoke detection system and from fusible link.
- .4 Factory tested for proper operation.

2.4 Firestop Flaps

- .1 Firestop flaps: listed and bear label of ULC, assemblies fire tested and rated in accordance with CAN4-S112.2, meet requirements of authorities having jurisdiction.
- .2 Factory fabricated for fire resistance rating requirement to maintain integrity of fire separation.
- .3 Galvanized steel frame and blades, non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .4 Flaps to be held open with fusible link conforming to ULC-S505. Generally fusible links to be rated at 74 degrees C on exhaust and recirculation air ducts, and 100 degrees C on supply air ducts. Revise, with Engineer's approval, as required to meet the needs of special locations. Fusible links shall be readily removable by hand to facilitate testing.

- .5 Factory tested for proper operation.

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Installation

- .1 Refer to Architectural drawings for locations and ratings of fire and smoke separations. Provide dampers and firestop flaps of approved types in all duct penetrations of fire and smoke separations.
- .2 Review all damper and firestop flap locations and requirements with Engineer early in the project.
- .3 Install in accordance with ANSI/NFPA 90A, requirements of authorities having jurisdiction, and in strict accordance with conditions of ULC listing. Maintain integrity of fire and smoke separations.
- .4 Install and test in accordance with NFPA 80.
- .5 Install break-away joints of approved design on each side of fire separation unless otherwise directed by Engineer.
- .6 Coordinate with TAB contractor early in the project. Review locations and access requirements of all dampers and firestop flaps to facilitate testing.
- .7 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .8 Provide access door adjacent to each damper.
- .9 Coordinate with installer of firestopping. Any firestopping required by local codes or authorities having jurisdiction shall be done in strict accordance with conditions of ULC listing using approved materials. Fire stop in accordance with manufacturer's installation instructions.
- .10 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible for inspection, testing and replacement.
- .11 Identify all dampers and firestop flaps clearly and accurately on project record drawings.

3.3 Testing

- .1 Test for proper operation of all smoke and fire dampers, sensors, detectors, installed as component parts of air systems specified Division 23.

- .2 Test each fire damper by releasing it twice so as to check whether the damper is binding and is operating in accordance with requirements of the authority having jurisdiction. Reset dampers in accordance with manufacture's directions. Resolve all problems and then re-test, until satisfactory result is achieved. Permanently mark all dampers with an identification number which shall also appear on the "as-built" drawings. Submit a test report to the Engineer, listing the following data:
 - .1 Identification of each fire damper corresponding with the "as-built" drawings.
 - .2 Test results of each damper, including access problems.
 - .3 Repair procedures, if any, to each damper if not properly working.
 - .4 State the date of the check(s).
 - .5 Name of company and checker(s).
- .3 Affix tag to duct adjacent fire and smoke dampers indicating date of test, TAB company name and contact info, technician initials.
- .4 Include a complete copy of the written report in each Operating/Maintenance Manual.
- .5 Confirm closure of smoke and combination fire/smoke dampers on during fire alarm condition and power failure.
- .6 Confirm proper operation of smoke dampers and combination fire smoke dampers according to specified sequences of operation, including manual overrides and safeties.

3.4 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 References

- .1 Air Diffusion Council (ADC).
 - .1 Flexible Duct Performance & Installation Standards.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .4 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.
- .5 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.
- .6 Underwriters' Laboratories (UL)
 - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110, Standard Methods of Tests for Air Ducts.

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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Test and Evaluation Reports:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 General

- .1 Factory fabricated Class 1 flexible air ducts conforming to the requirements UL 181 and CAN/ULC-S110.
- .2 Joint mastics and tapes: listed and labelled in accordance with UL 181B and complying with CAN/ULC-S110.
- .3 Duct clamps: stainless steel construction with worm gear operators.
- .4 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .5 Flame spread rating not to exceed 25. Smoke developed classification not to exceed 50.
- .6 Thermal resistance properties determined in accordance with ADC Flexible Duct Performance & Installation Standards using ASTM C518. Products shall bear the ADC Seal of Certification.

2.2 Non-Metallic – Uninsulated

- .1 Type NM-UN: non-collapsible, heavy duty vinyl-impregnated woven fibreglass cloth permanently bonded to, and supported by, corrosion resistant spring steel wire helix.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Operating static pressure limits: 2.5 kPa positive, 0.25 kPa negative.
 - .3 Maximum relative pressure drop coefficient: 2.

2.3 Non-Metallic – Insulated (Lined)

- .1 Type NM-IL: non-collapsible, chlorinated polyethylene core (CPE) core permanently bonded to, and supported by, corrosion resistant spring steel wire helix with factory applied flexible mineral fibre acoustic insulation and encased in metallized polyester film (MPF) vapour barrier jacket reinforced with fibreglass scrim.

- .2 Performance:
- .1 Factory tested to 2.5 kPa without leakage.
 - .2 Operating static pressure limits: 2.5 kPa positive, 0.25 kPa negative.
 - .3 Maximum relative pressure drop coefficient: 2.
 - .4 Thermal resistance: 0.74 W/m²-degrees C mean.
 - .5 Acoustical performance: Minimum insertion loss (dB/m of straight duct @ no flow) to following table:

Duct Diam:	Frequency (Hz)				
(mm)	125	250	500	1000	2000
150	4.9	6.6	11.8	12.8	12.8
200	2.6	3.9	9.5	11.5	11.8
300	6.6	8.5	8.5	11.5	9.8

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Duct Installation

- .1 Install in accordance with SMACNA and ADC standards.
- .2 Joints shall be made up using mastic and duct clamps. Insulation and vapour barrier on type NM-IL flexible ducts shall be secured with a combination of tape and duct clamps.
- .3 Use to accommodate misalignment of branch ducts and diffusers. Provide type NM-IL flexible duct where connecting rigid duct is insulated internally or externally. Provide type NM-UN flexible duct where connecting rigid duct is not insulated.
- .4 Maximum length at each diffuser: 1,000 mm.
- .5 Maximum turn allowed: 30°. Otherwise use a rigid elbow.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 References

- .1 ASTM International
 - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 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.
- .3 North American Insulation Manufacturers Association (NAIMA)
 - .1 NAIMA AH116, Fibrous Glass Duct Construction Standards.
- .4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA IAQ Guideline for Occupied Buildings Under Construction.
- .5 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 Duct Liner

- .1 General:
 - .1 Mineral fibre duct liner: air surface coated with smooth matt acrylic polymer.
 - .2 Temperature limit: 121EC.
 - .3 Flame spread rating shall not exceed 25 and smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
 - .4 Water sorption: less than 3% by weight when tested in accordance with ASTM C1104.
 - .5 Fungi resistance: to ASTM C1338 and ASTM G21.
- .2 Rigid:
 - .1 Use on flat surfaces.
 - .2 25 mm thick, to ASTM C1071, Type II, fibrous glass rigid board duct liner.
 - .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m². EC)/W for 25 mm thickness when tested in accordance with ASTM C177 or C518, at 24EC mean temperature.
 - .5 Maximum velocity on faced air side: 30 m/sec.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type "A" mounting to ASTM C423.
- .3 Flexible:
 - .1 Use on round or oval surfaces and where otherwise directed by Engineer.
 - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.74 (m². EC)/W for 25 mm thickness when tested in accordance with ASTM C177 or C518, at 24EC mean temperature.

- .5 Maximum velocity on coated air side: 30 m/sec.
- .6 Minimum NRC of 0.65 at 25 mm thickness based on Type "A" mounting to ASTM C423.

2.2 Adhesive And Sealant

- .1 Adhesive and sealant: to ASTM C916.
- .2 Flame spread rating shall not exceed 25 and smoke developed classification shall not exceed 50. Temperature range minus 29EC to plus 93EC.
- .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.
- .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 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 General

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

3.3 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.

- .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 450 mm on centres to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with NAIMA AH124, Fibrous Glass Duct Liner Standard.
- .2 All joints to be tightly butted together with no interruptions or gaps.
- .3 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner.
- .4 Replace damaged areas of liner at discretion of Engineer.
- .5 Provide metal nosing over transverse oriented liner edges facing the airstream at the discharge of fans, at any section of lined duct preceded by unlined duct and where the continuity of liner is interrupted by duct mounted devices (e.g. fire dampers, coils).
- .6 Where duct air velocities exceed 20 m/sec provide sheet metal nosing on the leading edge of duct liner at every transverse joint.
- .7 Turning vane assemblies, dampers and other devices located inside lined ductwork shall be installed using insulated "build outs" secured to the duct wall.

3.4 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 2 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.

3.5 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 References

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 99, Standards Handbook.
 - .2 ANSI/AMCA Standard 210/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

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 HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide:
 - .1 Fan performance curves showing point of operation, bhp and efficiency.
 - .2 Sound rating data at point of operation.
 - .2 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers where applicable.

1.3 Maintenance Material Submittals

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

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

Part 2 Products

2.1 System Description

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

2.2 Direct Drive Premium Inline Cabinet Centrifugal Exhaust Fans

- .1 General Description:
 - .1 Inline mounted applications
 - .2 Maximum operating temperature is 130 Fahrenheit (54.4 Celsius)
 - .3 Fans are UL/cUL listed 507 - Electric Fans
 - .4 Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number
- .2 Wheel:
 - .1 Forward curved centrifugal wheel
 - .2 Constructed of galvanized steel or calcium carbonate filled polypropylene
 - .3 Statically and dynamically balanced in accordance to AMCA Standard 204-05
- .3 Motors:
 - .1 AC Induction Motor

- .1 Motor enclosures: Open drip proof (ODP) - opening in the frame body and or end brackets
 - .2 Motors shall be permanently lubricated sleeve bearing type to match with the fan load and furnished at the specific voltage and phase.
 - .3 Motor shall be mounted on vibration isolators and be accessible for maintenance
 - .4 Compatible for use with speed controls
 - .5 Thermal overload Protection
- .4 Housing:
 - .1 Constructed of heavy gauge galvanized steel
 - .2 Interior shall be lined with 0.5 inches of acoustical insulation
- .5 Spring Loaded Aluminum Backdraft Damper:
 - .1 Prevents air from entering back into the building when fan is off
 - .2 Eliminates rattling or unwanted backdrafts
- .6 Outlet:
 - .1 Type of outlet: Square
 - .2 Field rotatable from horizontal to vertical discharge
 - .3 Shall include an aluminum backdraft damper
- .7 External Electrical Accessories:
 - .1 Eliminates removing the motor pack which saves time on installation
- .8 Mounting Brackets:
 - .1 Fully adjustable for multiple installation conditions
- .9 Access Panel:
 - .1 Once installed shall have easy access to internal components

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Fan Installation

- .1 Install fans as indicated.
- .2 Provide sheaves and belts required for final air balance.

- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

3.3 Anchor Bolts And Templates

- .1 Size anchor bolts to withstand and velocity forces anticipated

3.4 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 Summary

- .1 Section Includes:
 - .1 Under floor fan powered boxes.

1.2 References

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .2 ANSI/NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 International Organization of Standardization (ISO)
 - .1 ISO 3741, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .4 Underwriter's Laboratories (UL)
 - .1 UL 181, Factory-Made Air Ducts and Air Connectors.

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 certified ADC (Air Diffusion Council) 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 (2) copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Test data: to ANSI/AMCA 210.
 - .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.

- .2 Sound power level with minimum inlet pressure of 0.5 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
 - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba, Canada.
 - .2 Indicate the following:
 - .1 Capacity.
 - .2 Pressure drop.
 - .3 Noise rating.
 - .4 Leakage.
- .3 Samples:
 - .1 Submit duplicate samples and mock-ups in accordance with Section 01 33 00 - Submittal Procedures.
- .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 Engineer will make available one (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 Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and 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 Furnish list of individual manufacturer's recommended spare parts for equipment include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

Part 2 Products

2.1 Manufactured Units

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

2.2 Fan Powered Terminal Unit Boxes

- .1 Maintains space condition by supply air from a conditioned plenum into the zone via a variable air volume ECM fan.
- .2 Sizes, capacities, pressure loss, and discharge sound pressure level: as indicated.
- .3 Discharge sound pressure level: as indicated.
- .4 Construction: The assembly casing shall be constructed of zinc coated steel. Casing sides shall be internally lined with ½" thick, 1.5lb density fiberglass insulation which complies with UL-181 and NFPA 90A. Any cut edges of fiberglass exposed to the air stream shall be coated with NFPA 90A approved sealant. Gauge of the assembly casing shall be 22 gauge. Casing shall be no higher 10" and must fit with the pedestals for the raised floor system. Unit casing shall have a top access door to allow removal of fan and servicing of the unit. Fan blower shall be constructed of steel with forward curved blades, dynamically balanced wheels and direct drive motor. Motors shall be permanent split capacitor type, with lubricated bearing and thermal overload protection. Motor shall be designed for use with electronic fan speed controller. Provide isolation between motor and blower assembly. Provide an electronic speed controller, which allows continuously adjustable fan speed from maximum to minimum. Speed control shall be equipped with a minimum voltage stop to ensure motor will not operate in the stall mode. Voltage stop shall be factory adjusted. Units shall include integral backdraft damper to prevent plenum air flow through nonoperating fan. Units shall incorporate a single point electrical and control connection for the entire unit. All electrical components shall be enclosed in a single control box with an access panel mounted on the side of the assembly. All controls shall be sealed from air flow. Units shall be ETL listed to meet UL1995 and CSA No. 236.

- .5 ECM Motor: Motors shall be ECM DC brushless motors complete with and operated by a single phase integrated controller / inverter that operates the wound stator and sensor motor position to electronically commutate the stator. All motors shall be permanently lubricated with ball bearings. Motor shall maintain a minimum of 70% efficiency over its entire operating range. Motor shall be direct coupled to the blower. Provide isolation between motor and blower assembly. Provide manual fan speed control for field adjustment of the fan air flow set point. Speed control shall accept as standard a (0-10 VDC, 0-20 mA) signal for remote fan adjustment from a BAS.
- .6 Controls: The terminal unit controller shall be dedicated, microprocessor-based, controller supplied by the terminal unit manufacturer (or by the Control Contractor). The controller shall be capable of stand-alone operation and have the ability to network with a building automation system, personal computer or portable operator interface device. All components shall be factory wired, calibrated and pretested to ensure a full functional unit. The zone sensor shall be furnished by the terminal unit manufacturer (or Controls Contractor) and shall include temperature set point adjustment and access for connection of a hand-held operator terminal. The thermostat shall also include integrated CO2 sensor. The DDC control package shall be calibrated and factory set for the maximum and minimum flow rates as scheduled on the drawings. The air terminal unit shall be designed, installed and field adjusted, if necessary, to maintain controlled air flow. To facilitate field adjustments, the terminal unit manufacturer shall furnish a portable hand-held operator interface. The operator interface shall have the capability of monitoring and changing all inputs, set points and operating parameters of the controller by connection to the zone sensor. All primary air control components shall be mounted inside a protective metal shroud.

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 underfloor terminal units level and plumb. Maintain sufficient clearance for normal services, maintenance, or in accordance with construction drawings.
- .2 Complete installation and startup checks according to manufacturer's instructions and perform the following.
 - .1 Verify that inlet duct connections are as recommended by manufacture to achieve proper performance.
 - .2 Verify that any identification tags are visible.
 - .3 Verify locations of thermostats, humidistats, and other exposed control sensors with drawings and room details before installation.
- .3 Locate controls, dampers and access panels for easy access.

3.3 Field Quality Control

- .1 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
 - .1 Materials and resources.
 - .2 Storage and collection of recyclables.
 - .3 Construction waste management.
 - .4 Resource reuse.
 - .5 Recycled content.
 - .6 Local/regional materials.
 - .7 Low-emitting materials.

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 References

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

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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.3 Maintenance Material Submittals

- .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.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan.
- .5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 System Description

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

2.2 General

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

2.3 Manufactured Units

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

2.4 Diffusers, Grilles And Registers

- .1 Refer to schedule.
- .2 General requirements:
 - .1 To meet the features, capacity, pressure drop, terminal velocity, throw, noise level, and neck velocity of the scheduled product.
 - .2 Frames:
 - .1 Appropriate to surrounding construction material.
 - .2 Plaster frames where set into plaster or gypsum board and where otherwise specified.
 - .3 Full perimeter gaskets.
 - .4 Concealed fasteners.
 - .3 Concealed manual volume control damper operators.
 - .4 Flow Equalizing Grids: provide in the neck of all ceiling diffusers.
 - .5 Colour: baked off-white epoxy enamel unless otherwise directed by the Engineer.
 - .6 Grilles, registers and diffusers of same generic type to be the product of one manufacturer.
 - .7 For in floor grilles, return and supply, provide dirt bucket to catch debris and facilitate cleaning.
- .3 Features and performance: as scheduled. Scheduled characteristics govern where they conflict with the general requirements herein.

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with 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 gymnasium and similar game rooms.

3.3 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 – Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION