

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Common work results for HVAC.

I.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1, Energy Standard for Buildings except Low-Rise Residential Buildings
- .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

I.3 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.

I.4 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.

I.5 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.

I.6 AUTHORITIES HAVING JURISDICTION (AHJ)

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

I.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.

I.8 CONSTRUCTION SCHEDULE

- .1 The following requirements are in addition to those specified elsewhere. All reports refer to the final successful report. Include other tasks requested by the Departmental Representative.
- .2 Schedule individual HVAC tasks at no more than 4 weeks. Split larger tasks by floor or other approved means, to ensure individual tasks do not exceed the duration limit. Similarly, limit all tasks to maximum one-week duration during the last 6 weeks prior to Substantial Completion, and to Total Completion.

I.9 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.

I.10 SAFETY FEATURES

- .1 Provide safety features on all equipment to ensure safe operation and maintenance including belt, coupling, and other guards, screened fan intakes and discharges where inadequate ductwork for protection, safety interlocks and labels.

I.11 QUALITY OF MATERIALS

- .1 Furnish new materials, apparatus or products required for the work, of first class quality, delivered, erected, connected up and finished in every detail.
- .2 The use of any or all materials is subject to the approval of the Departmental Representative.
- .3 Unless otherwise specified, all products shall be CSA approved.
- .4 All fire protection materials and products shall be ULC approved.
- .5 If materials, apparatus or products are not CSA or ULC approved, obtain approval of the provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .6 Confirm colours with the Architect before ordering.

I.12 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data for all products and equipment specified within Division 22 must be submitted to the Departmental Representative for review.
- .3 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances (e.g. access door swing spaces).
- .4 Shop drawings and product data shall be 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 as to current model production.
 - .5 Certification of compliance to applicable codes.

I.13 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.

I.14 COORDINATION

- .1 Coordinate design with other disciplines, taking into account all project requirements.
- .2 Coordinate installation with other trades. To avoid conflicts, early in the project discuss proposed routing of ductwork, piping and locations of equipment with other trades.

I.15 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.

I.16 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.

I.17 PAINTING

- .1 Refer to Section 09 91 00 – Painting.
- .2 All paint shall be top quality enamel or as approved by the Departmental Representative, applied in strict accordance with the manufacturer's recommendations and the Departmental Representative instructions.
- .3 Prime and touch up marred finished paintwork to match original. Unmatched painting is not acceptable.
- .4 Finishes that have been damaged too extensively to be simply primed and touched up shall be restored to new condition and Departmental Representative satisfaction.

- .5 Be responsible for advising the painter as to the colors and identification of the piping, flow directions, etc.

I.18 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 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.

I.19 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.

I.20 TRIAL USAGE

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

I.21 CLEANING

- .1 Refer to Section 01 74 11 – Cleaning.

- .2 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

I.22 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.

I.23 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 Representatives 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.

I.24 SPARE PARTS

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals and as follows:
 - .1 One set of packing for each packed pump.
 - .2 One mechanical seal for each size and type of pump utilizing a mechanical seal.
 - .3 One casing joint gasket for each size and type of pump.

- .4 One head gasket for each tube-in-shell heat exchanger.
- .5 One plate gasket set for each plate-and-frame heat exchanger.
- .6 One glass for each gauge glass.
- .7 One set of filter media/cartridges, for each filter or filter bank in addition to final operating set.
- .8 One set of belts for each piece of belt-driven equipment.

I.25 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.

I.26 CLOSEOUT SUBMITTALS

- .1 In addition to the requirements of Section 01 78 00 – Closeout Submittals, provide the following in the Operating and Maintenance Manuals. Edit all general data to specifically apply to this project. Pay particular attention to safety requirements.
- .2 Operation data provided by manufacturer, and to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valve schedule and flow diagram.
 - .7 Colour coding chart.
- .3 Maintenance data provided by manufacturer, and shall 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 duration.
 - .3 Parts list including model numbers for replacement parts. Include contact name and phone number.

- .4 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Additional data:
 - .1 Prepare and insert additional material into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.
- .6 Submit for review by Departmental Representative, and make final additions and adjustments as directed.

I.27 RECORD DRAWINGS

- .1 Maintain neat record of changes on a set of prints during construction.
- .2 Submit to Departmental Representative a minimum of five (5) working days before Substantial Completion.
- .3 Contractor shall certify and check the accuracy of each drawing.
- .4 Record additional changes and submit final record drawings at Total Performance.

I.28 SUBSTANTIAL COMPLETION / CERTIFICATION BY DEPARTMENTAL REPRESENTATIVE / 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 Departmental Representative 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 Equipment start-up reports.
 - .4 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.).
 - .5 Test reports for backflow prevention devices with test taps.
 - .6 Written confirmation that propane system is approved by the utility and/or Authority Having Jurisdiction, and turned on.
 - .7 Record ('As-Built') drawings.
 - .8 Operation and Maintenance Manuals, complete with revisions as directed.
 - .9 Written confirmation that all life safety and health systems are fully functional, including but not limited to ventilation, both supply and exhaust.
 - .10 Written confirmation that all HVAC equipment is operational and under control, indicating exceptions and temporary controls/arrangements.
 - .11 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.

I.29 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, the requirements of ASHRAE 90.1, and National Energy Code of Canada
- .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.
- .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 Representatives 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 CLEANING

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 All dirt, rubbish, or grease on walls, floors or fixtures for which this Division is responsible must be removed and the premises left in first class condition in every respect.

- .3 Perform cleaning operations in accordance with manufacturer's recommendations.
- .4 Clean all HVAC piping and equipment and leave in a condition to receive paint.
- .5 Clean the interior of all ductwork. Ducts 750 x 300 mm and larger shall be vacuumed by hand. Power vacuum ducts smaller than 750 x 300 mm through duct openings, etc.

3.11 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.

3.12 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.

3.13 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 I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Material and installation of pipe work in general.

I.2 REFERENCES

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B24, Cast Copper Alloy Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B39, Malleable Iron Threaded Pipe Unions.
 - .3 ANSI/ASME B42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
- .2 American Society for Testing and Materials (ASTM)
- .3 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.9 – Building Services Piping.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

I.3 SHOP DRAWINGS AND PRODUCT DATA

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

I.4 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 GENERAL

- .1 Installations shall include all devices, attachments, equipment, components and piping necessary to form a complete working system to code requirements.

2.2 VALVES

- .1 Refer to the specific pipe specification sections for valve types.
- .2 All valves of one type (e.g. gate valves) must be of one manufacturer. Ensure that working pressure, size and manufacturer's name are cast or stamped into the body of each valve.
- .3 Use O. S. & Y. design on all valves 100 mm and larger unless specifically noted otherwise.
- .4 Provide valves with hand wheels accessible for operation.

2.3 STRAINERS

- .1 Provide Y-type strainers where, indicated on the drawings and where specified herein, in piping system, full size of the connected piping ahead of each pump, control valve, meter, etc. Install bucket or basket strainers only where indicated on the drawings.
- .2 All strainers shall have the same end connections and working pressure as the attached piping is specified.
- .3 Use monel screens with a reinforced edge. Perforations shall be 0.8 mm for steam, 1.6 mm for condensate, 3.2 mm for chilled and hot water, and 3.2 mm ahead of pumps.
- .4 Provide 20 mm blow-off lines with ball valves, piped directly to drain on all strainers over 50 mm.

2.4 DIELECTRIC PIPE FITTINGS /UNIONS

- .1 Dielectric fittings factory certified to withstand a minimum of 600 volts on a dry line with no flashover. Unions rated at 1.7 MPa conforming to ANSI B16.39. Flanged fittings rated at 1.2 MPa conforming to ANSI B16.24 (bronze) and B16.42 (iron).

2.5 PIPE SLEEVES AND SEALS

- .1 Where piping penetrates below grade walls or floors:

- .1 Seal: modular, mechanical type, consisting of inter-locking synthetic rubber links shaped to continuously fill the annular space between the pipe and the wall opening complete with 316 stainless steel fasteners. Seal elements shall be sized and selected per manufacturer's recommendations and be suitable for the required fire-resistance rating and anticipated environmental conditions. Standard of acceptance: 'Link-Seal'.
 - .2 Sleeve: custom-sized molded HDPE sleeves matched to the mechanical seal dimensions complete with reinforcing ribs, end caps, and integrally formed hollow water stop having a minimum outside diameter 100 mm larger than the diameter of the sleeve itself and allowing 13 mm movement between wall forms to resist pour forces. Standard of acceptance: 'Century-Line'
- .2 Elsewhere: Schedule 40 black steel pipe sleeve.

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 CLEARANCES

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

3.3 DRAINS

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

- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Provide air vents as required to assist in draining the piping.
- .5 Drain valves: Ball valves unless otherwise approved, NPS 3/4 minimum. Provide hose end male thread, cap and chain where not piped to drain

3.4 AIR VENTS

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

3.5 DIELECTRIC COUPLINGS

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

3.6 PIPEWORK INSTALLATION

- .1 Install exposed piping, equipment, rectangular cleanouts and similar items approximately as shown, parallel or perpendicular to building lines and as close to the structure as possible.
- .2 Conceal all piping except where otherwise approved. Install concealed piping to minimize furring space, maximize headroom, and conserve space.
- .3 Exposed piping must be carefully installed to be pleasing to the eye and meet the Architect's requirements.
- .4 Install all pipe mounted control devices, such as control valves and wells.
- .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 the size of main. Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Use only eccentric reducing fittings at pipe size changes, installed with the piping in line at the top to ensure positive drainage and venting.
- .8 Use only long radius welding or soldered fittings in expansion loops, not screwed fittings.
- .9 American National Taper pipe thread must be used for all thread connections. Remove burrs and chips and ream or file the pipe ends out to size of bore.
- .10 Leave not more than 2 threads exposed on threaded joints when made up.
- .11 Screwed fittings jointed with Teflon tape.
- .12 Do not use
 - .1 running nipples.
 - .2 threaded protectors as couplings.
 - .3 direct welded or screwed connections to valves, equipment or other apparatus.
- .13 Protect openings against entry of foreign material.
- .14 Ream pipes, remove scale and other foreign material before assembly.
- .15 Slope piping for positive drainage and venting.
- .16 Arrange piping to permit flushing.
- .17 Group piping, wherever possible.
- .18 Provide anchors and sway braces to Departmental Representative approval.
- .19 Provide for thermal expansion.
- .20 Provide for movement due to seismic events as required by the NBC and applicable NFPA standards.

3.7 EXPANSION OF PIPING

- .1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to the building and equipment. Where pipe runs past building expansion joints, provide expansion compensation.
- .2 Only major expansion configurations and fittings have been detailed on the drawings. Provide all required additional compensators, loops and swing connections as specified herein, and in accordance with good trade practice.
- .3 Use swing connections with a minimum of 3 elbows (i.e. four fittings including the tee) where required. These swing connections are not always shown on the piping drawings for reasons of clarity; they must however, be installed. Where close tolerances do not permit the installation of a complete swing connection, consult the Departmental Representative prior to the closing of tender.
- .4 Install expansion loops cold spring 50 percent of the calculated expansion. Use compensator type expansion joints with suitable pressure ratings for radiation piping where required. Install compensators with double guides on inlet and outlet with distances in accordance with manufacturer's instructions. Where not indicated, calculate compensator expansion equal to 38 mm per 30 m of run between the anchors.
- .5 Schedule for Expansion Loops:
 - .1 Maximum Distance between Anchors:
 - .1 Heating Hot Water; copper 30 m, steel 45 m.
 - .2 Loop Size Required:

Pipe Size NPS	Loop Size (m)
3/4	1.22
1	1.27
1-1/4	1.32
1-1/2	1.37
2	1.42
2-1/2	1.53
3	1.68
4	1.98
- .6 If the length between anchors is 50% of the maximum listed above, then the loop can be reduced to 67% of that listed.

- .7 Loops shall be located midway between guides.

3.8 PIPE GUIDES

- .1 Provide alignment guides where required for proper operation of the system.

3.9 PIPE ANCHORS

- .1 Provide substantial pipe anchors. Anchors shall be suitably attached to the structure and the pipe to prevent movement.

3.10 PIPE SLEEVES AND SEALS

- .1 General: Install where pipes pass through masonry structures, concrete structures, beams, fire rated assemblies, and elsewhere as indicated. Be responsible for maintaining the integrity of the building envelope when making penetrations. Enlist the services of qualified trade(s) to make openings in, and/or repairs to, building envelope.
- .2 Sleeve Sizes:
 - .1 Walls and beams: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
 - .2 Floors: 20 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .3 Sleeve Installation:
 - .1 Concrete walls, masonry walls, beams, and concrete floors on grade: Terminate flush with finished surface.
 - .2 Other floors:
 - .1 Terminate 50 mm above finished floor.
 - .2 Adjust as necessary to accommodate the requirements of through-penetration fire-stopping systems.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .4 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof, modular mechanical seal.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.

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

3.11 ESCUTCHEONS

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

3.12 PREPARATION FOR FIRESTOPPING

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

3.13 FLUSHING OUT OF PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant sections of Division 23.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.14 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representatives 48 hours minimum prior to performance of pressure tests.
- .2 Pework: Test as specified in relevant sections of Division 23 where specified, otherwise test to requirements of ASME B31.9.

- .3 Test all piping, with the exception of atmospheric vents and sanitary piping, hydraulically to 1½ times the operating pressure but not less than 860 kPag.
- .4 Prove piping with less than 14 kPa pressure drop and no visible leakages for a period of 24 hours with a hydraulic test.
- .5 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or test media.
- .6 Conduct tests in presence of Departmental Representative or designate approved by the Departmental Representative.
- .7 Pay costs for testing, repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .8 Insulate or conceal work only after approval and certification of tests by Departmental Representative. Test underground piping prior to backfilling.

END OF SECTION

Part I General

I.1 SUMMARY

.1 Section includes:

.1 This section includes a list of manufacturers whose products are approved for installation in the work, provided the product chosen meets with the required design characteristics as particularly noted in the specifications and equipment schedules, and matches the design features of the item where a particular trade name and model is given, and suits the installation. Conform to space limitations on products, which are approved as equal in design characteristics. If the model or size selection is doubtful, contact the Departmental Representative to ensure acceptability.

.2 Related Sections:

.1 Everything in this Project Manual is a requirement for this Division. The following references constitute assistance to the Contractors. Refer to the Table of Contents for additional guidance.

.1 Sections beginning with 23 05.

I.2 APPROVED MANUFACTURER APPROVAL

.1 The Drawings and Specifications are based upon manufacturers whose products are specified for installation in the work.

.2 Any other manufacturers requesting "approved equal" status must request approval from the Department Representative by letter stating specifically the items on which he wishes to quote and enclosing all necessary engineering data. Submit electronic copies of all requests. Include the appropriate specification and/or drawing references. Requests should be made at least 14 days prior to closing of tenders, and an addendum may then be issued by the Departmental Representative, prior to closing of tenders, listing any further Acceptable Manufacturers. Late requests may not be approved. Provide additional information requested by the Departmental Representative to facilitate evaluation.

.3 The Departmental Representative may also take other factors into account.

I.3 CHANGES DUE TO USE OF DIFFERENT MANUFACTURERS

- .1 Where the Contractor proposes to use an item of equipment other than that detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or of any other part of the mechanical, electrical or architectural layout, all such redesign and all new Drawings and details required shall, with the approval of the Departmental Representative, be prepared by the Contractor at his own expense.
- .2 Where deviations are approved requiring a different quantity or arrangement of ductwork, piping, wiring, conduit and equipment from that indicated on the Drawings, this Division is responsible to furnish and install all such ductwork piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system, without additional compensation.

Part 2 Products

2.1 HEATING, VENTILATION & AIR CONDITIONING ACCEPTABLE MANUFACTURERS LIST

Equipment	Acceptable Manufacturers
.1 Vibration Isolation	Amber/Booth, Mason, VAW Systems, Vibron
.2 Grilles, Registers, Diffusers	Nailor, Price, Titus
.3 Air Filters	AAF, Camfil Farr
.4 Ceiling Exhaust Fans	Cook, Greenheck, PennBarry
.5 In-Line Cabinet Fans	Cook, Greenheck, PennBarry
.6 Split Air Conditioning Systems	Mitsubishi, Daikin, LG
.7 Variable Air Volume Boxes	EH Price, Titus, Nailor
.8 Chemical Treatment	Match the Existing Manufacturer
.9 Duct Sealer	Duro-Dyne, McGill Airseal
.10 Flexible Ductwork	Flexmaster, Thermaflex
.11 Fire Dampers	Greenheck, Nailor, NCA, Price, Ruskin
.12 Volume Extractors	Nailor, Price, Titus
.13 Backdraft Dampers	Greenheck, Nailor, Ruskin
.14 Flexible Duct Connector	Carlisle Hardcast, Duro Dyne, Dyn/Air
.15 Welding Fittings	Anvil, Comco, Crane

.16	Malleable Iron Fittings, Flanges, Flange Gaskets	Anvil, Crane, Mueller
.17	Mechanical Pipe Joints	Gruvlok, Star, Victaulic
.18	Pipe Hangers and Saddles	Anvil, Crane, Myatt
.19	Alignment Guides	Adsko, Anvil, Flexon, Fulton, Yarway
.20	Ball Valves	Apollo, Crane, Kitz, Toyo
.21	Drain Valves	Crane, Toyo
.22	Gate and Globe Valves - Rising Stem	Crane, Toyo, Velan
.23	Horizontal Check Valves – up to Ø50mm	Crane, Toyo, Velan
.24	Horizontal Check Valves – Ø64mm and larger	Check-Rite, Crane, Tyco, Velan
.25	Vertical Check Valves – up to Ø50mm	Val-Matic I400S, Durabla WLC
.26	Vertical Check Valves – Ø64mm	Val-Matic I400, Durabla C-I
.27	Vertical Check Valves – Ø75mm and larger	Val-Matic I800, Durabla GLC
.28	Butterfly Valves	Bray, Keystone
.29	Balancing Valves - Manual	Armstrong, Danfoss, Griswold, Tour & Andersson
.30	Safety and Relief Valves	Cash-Acme, Conbraco, Consolidated, Kunkle
.31	Expansion Joints and Flexible Connections	Fulton, Hyspan, Senior Flexonics, Yarway, VAW
.32	Air Vents	Dole, Maid-O-Mist, Spirotherm
.33	Strainers	Armstrong, Spirax Sarco, Toyo, Watts
.34	Pressure Gauges and Thermometers	Ashcroft, H.O. Trerice, Winters
.35	Auxiliary Test Ports	Peterson Equipment “Pete’s Plug II”, Sisco, Watts
.36	Refrigerant Piping and Accessories	Mueller Brass, Sporlan
.37	Acoustic Duct Lining	CertainTeed, Knauf, Manson, Johns Manville, Owens Corning
.38	Mechanical Insulation – Fiberglas	Knauf, Manson, Johns Manville, Owens Corning

.39	Mechanical Insulation – Flexible Cellular Polyolefin	Armaflex, Imcoa, Merryweather
.40	Mechanical Insulation – Fire Retardant Canvas	Fattal, Radley, Robson
.41	Electric Motors	Baldor, G.E., Leeson, Toshiba, Westinghouse

Part 3 Execution

.1 Not used.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Mechanical identification of piping, ducts, accessories, and equipment.
- .2 Related sections:
 - .1 Refer to sections beginning with 21 05 for Common Work Results for Fire Protection.
 - .2 Refer to sections beginning with 22 05 for Common Work Results for Plumbing.
 - .3 Refer to sections beginning with 23 05 for Common Work Results for HVAC.
 - .4 Section 01 33 00 - Submittal Procedures.
 - .5 Section 09 91 23 - Interior Painting.

I.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
 - .1 NFPA 13, Installation of Sprinkler Systems.
 - .2 NFPA 14, Standpipe and Systems.

I.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data to include paint colour chips, other products specified in this section.

I.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.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

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

2.2 SYSTEM NAMEPLATES

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

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
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.
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: Size #9.
 - .2 Source and Destination identifiers: Size #6.
 - .3 Terminal cabinets, control panels: Size #5.
 - .3 Equipment elsewhere: Sizes as appropriate.

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, to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:

- .1 To full circumference of pipe or insulation.
- .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 All other pipes: Pressure sensitive [plastic-coated cloth] [vinyl] with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150oC and intermittent temperature of 200oC.
- .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	HOT GLYCOL HEATING
Hot glycol heating supply	Yellow	SUPPLY
Hot glycol heating return	Yellow	HOT GLYCOL RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Storm water	Green	STORM
Sanitary	Green	SAN

Contents	Background colour marking	Legend
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	
Gas regulator vents	to Codes	
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: Black, 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 to be in English.

Part 3 Execution

3.1 TIMING

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

3.2 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and or CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

3.3 NAMEPLATES

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

3.4 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 and where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.

- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 CONCEALED EQUIPMENT

- .1 Where equipment or valves are located above accessible ceilings or behind access panel, provide lemuroid label to indicate location of concealed equipment. Label shall indicate valve or equipment tag. In the case where the valve or equipment does not have a tag, identify with descriptive wording (example "Dom. Water Valve").

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.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Testing, adjusting and balancing HVAC systems and equipment.

I.2 REFERENCES

- .1 Associated Air Balance Council (AABC)
 - .1 AABC National Standards for Total System Balance
 - .2 AABC Test and Balance Procedures

I.3 GENERAL

- .1 TAB means to test, adjust and balance in accordance with requirements of Contract Documents and to do other work as specified.
- .2 TAB to be done by an independent AABC certified testing company. The TAB company must be a firm specializing in such work, equipped with a full range of calibrated instruments, and experienced in adjustment and operation of mechanical systems.

I.4 QUALIFICATIONS OF TAB PERSONNEL

- .1 Names of personnel proposed to perform TAB to be submitted and approved by Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.

I.5 PURPOSE OF TAB

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

I.6 EXCEPTIONS

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

I.7 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, final adjustments and re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with affected systems.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

I.8 INSTRUMENTS

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

I.9 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to the Departmental Representative, prior to commencement of TAB:
 - .1 A written description of approach to TAB for each system, written specifically for the project, outlining sequence and procedures for the work. Include relevant information including, but not limited to, location of main duct traverses, approach to optimizing system setpoints, concerns affecting other trades such as weatherstripping and penetration sealing, and possible limitations of specified equipment and design that may affect TAB. Identify deviations in methodology from referenced standards and commonly accepted industry practice.

I.10 PRELIMINARY TAB REPORT

- .1 Submit for review and approval by Departmental Representative, prior to submission of formal TAB report:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed, if different from procedures submitted earlier.
 - .3 Calculations procedures.
 - .4 Preliminary measurements.

I.11 TAB REPORT

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 System schematics.
 - .2 TAB data.
 - .3 Discussion of results, with focus on system where measurements deviated significantly from design values along with possible cause and/or recommendations for correcting problem.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English, spiral or Cerlox bound with covers, complete with index tabs.

I.12 VERIFICATION

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

I.13 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative, return systems and equipment to final operation condition. Replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

- .2 Permanently mark settings to allow restoration at any time during life of facility. Markings shall not be covered in anyway and shall be permanent and not easily eradicated.
 - .1 Mark position of balancing dampers using permanent pen, indicating position of damper handle on duct or quadrant.
 - .2 Set memory stop function on calibrated balancing valves. If ball or globe valves have been used for TAB, install locking quadrant or other means of permanently identified TAB setpoint.

I.14 COMPLETION OF TAB

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

I.15 INSTRUMENT TEST PORTS AND HOLES

- .1 Coordinate test openings with Division 23.
- .2 Utilize permanent test ports where installed by Division 23.
- .3 Where permanent test ports are not installed, make openings as required to facilitate the TAB. Seal test port openings in ductwork using rubber plugs or material with similar properties, which are not easily removed. Hard or semi-flexible plugs such as nylon or polyethylene will not be accepted. Submit samples for each side to the Departmental Representative for approval prior to installation. Alternately, patch ductwork using sheet metal patch screwed to duct and seal with aluminium tape or duct sealant.

I.16 DRIVE CHANGES FOR BELT DRIVEN EQUIPMENT

- .1 Allow for drive changes on all belt driven equipment.
 - .1 Include sheaves and bushings for driver and driven equipment, belts and other equipment and tools necessary to make drive change.
 - .2 Include all manpower necessary to make drive change, including removal and reinstallation of guards.
 - .3 For belt driven equipment forming part of life safety systems, such as pressurization or smoke exhaust fans, allow for minimum of two drive changes for each piece of equipment where less than 5 pieces are installed, or if more than 5 are installed, allow for total of 10 drive changes.

1.17 DESIGN INTENT APPLICABLE TO TAB WORK

- .1 Arrange a meeting with the Departmental Representative to review design intent for all systems prior to the start of TAB. Obtain all information relevant to TAB work prior, including, but not limited to minimum outside air volume flowrates, relative pressurization setpoints and locations, temperature, humidity setpoints.

1.18 CLOSEOUT SUBMITTALS

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

Part 2 Products

- .1 Not used.

Part 3 Execution

3.1 GENERAL

- .1 Investigate all problems and resolve with the contractor's help, to ensure all values are within range. Obtain direction from the Departmental Representative when necessary.
- .2 Perform coil testing, adjusting and balancing only when outside conditions are commensurate with design conditions for the given system.

3.2 PRE-TAB REVIEW

- .1 Review contract documents and submit documentation specified below in writing to the Departmental Representative prior to the installation of any systems that will require TAB.
- .2 Arrange and attend a meeting with the Departmental Representative and appropriate trades to review and discuss adequacy of provision for TAB and other aspects of design and installation pertinent to success of TAB. Meeting to occur at least 2 weeks before installation of any mechanical systems that will require TAB.
- .3 Review proposed location of sensors and test ports with other trades to confirm that locations are suitable for TAB equipment and will permit repeatable measurements to permit recalibration on HVAC controls sensors.

- .4 Review location of balancing dampers and control valves for adequacy with respect to successful TAB completion.
- .5 Confirm in writing to Departmental Representative adequacy of provisions for TAB, noting any inadequacies that may require attention.
- .6 Review specified standards and report to Departmental Representative in writing all proposed procedures that vary from standard.

3.3 START-UP

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

3.4 OPERATION OF SYSTEMS DURING TAB

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

3.5 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
Application of weatherstripping, sealing, caulking.
 - .2 All pressure, leakage, other tests specified.
 - .3 All provisions for TAB installed and operational.
 - .4 Areas served by air system are clean and dust producing activities have been suspended.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Clean filters in place.
 - .2 Duct systems and equipment, including inside of air handlers, 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 Grilles, register and diffusers 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.

3.6 APPLICATION TOLERANCES

- .1 All balancing to meet AABC requirements.
- .2 Do TAB to following tolerances of design values:
 - .1 Air systems: plus or minus 10% of the quantities shown on the drawings for each component, and to within 5% of design requirements for the overall system. Small systems below 250 l/s to be balanced within 20% or 20 l/s.
 - .2 Hydronic systems: plus or minus 10% of the quantities shown on the drawings for each component, and to within 5% of design requirements for the overall system.
- .3 Check all change orders and clarifications to ensure current information is utilized.

3.7 ACCURACY TOLERANCES

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

3.8 VERIFICATION OF CONTROLS SYSTEMS

- .1 TAB contractor shall assist in verification, demonstration and calibration of the HVAC controls systems, specified under Division 23.

- .2 Perform measurements at test ports to confirm calibration of controls sensors, including temperature, pressure, flow rate and humidity and report on measured versus sensed values.

3.9 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.
- .2 Do TAB of systems, equipment, components, controls specified in Division 23.
- .3 Qualifications: personnel performing TAB to be current member in good standing of AABC or NEBB.
- .4 Quality assurance: Perform TAB under direction of supervisor qualified by standards of AABC or NEBB.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, and 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, current draw, noise, vibration.
- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Fan coil discharge and return,
 - .2 Fresh supply to each fancoil,
 - .3 Discharge at each diffuser,
 - .4 Inlet flow at each exhaust inlet.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).
- .8 Measure and report quantity of outside air at minimum and maximum airflow for each system having an outside air connection.

3.10 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.

- .2 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
 - .2 Measure and report on building pressure during different operating mode and at various quantities of outside air. Report measurements at different percentages of outside based on total system air volumes, in increment of 10%. Perform measurements when all systems are in normal operating modes.

3.11 FIRE AND SMOKE DAMPERS

- .1 Refer to 23 33 16 Dampers – Fire and Smoke.

3.12 SCHEDULE

- .1 Schedule the balancing to suit the progress of the work. Make every attempt to complete the work, or at least the affected local work, prior to occupancy or partial occupancy.
- .2 In phased projects, complete the work in each phase, as it is completed. Make final checks and corrections as required to all phases at the completion of the entire project.

3.13 FINAL ADJUSTMENT

- .1 Allow for a final adjustment, as directed by the Departmental Representative. Revise the reports accordingly.

3.14 POST- OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, noise levels, in occupied zone as directed by Departmental Representative once building as occupied.
- .2 Participate in systems checks twice during Warranty Period – first visit approximately 3 months after acceptance and 2nd within 1 month of termination of Warranty Period.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Material and installation of insulation and fire rating material for ductwork.

I.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .3 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .5 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .6 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .7 ASTM C921, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

- .2 CAN/ULC-S701, Thermal Insulation Polystyrene, Boards and Pipe Covering.

I.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .4 "k" factor – refers to a measure to thermal conductivity/resistance and is measured in Watts per square meter per degree Celsius
- .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork.
 - .2 CRF: Code Rectangular Finish.

I.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit following additional information: Manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

I.5 SAMPLES

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

I.6 QUALIFICATIONS

- .1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

I.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather and construction traffic.

- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions recommended by manufacturer.

I.8 CLOSEOUT SUBMITTALS

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

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 Provide and apply insulation in accordance with TIAC National Insulation Standards Specification 1502, Commercial Duct and Plenum, and as herein specified:
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 oC mean temperature when tested in accordance with referenced standard.
- .3 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .4 Type D-1: Rigid mineral fibre board with FSK reinforced foil and paper jacket.
 - .1 Mineral fibre: to ASTM C612.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: 0.0337 W/m°C at 24°C.
 - .4 Density: 48 kg/m³.
- .5 Type D-2: Mineral fibre blanket with FSK reinforced foil and paper jacket.
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: 0.0337 W/m°C at 24°C.
 - .4 Density: 16 kg/m³.
- .6 Type D-3: Flexible Cellular Polyolefin.

- .1 Insulation: ASTM C1427.
- .2 Maximum "k" factor: 0.036 W/m°C at 24°C.

2.3 FIRE RATED MATERIAL

- .1 Applies to Area of Refuge (AOR) system ductwork that is not within fire rated shaft, or in an AOR, or is in AOR but serves more than one AOR.
- .2 Fire resistant duct insulation wrap with insulation totally encapsulated in foil to meet the durability requirements of NFPA-96.
- .3 Ceramic based core insulation material with high temperature stability, low thermal conductivity and corrosion resistance.
- .4 Product must be approved for 2hr fire rating and zero clearance with butt-joint (non-overlapping) installation.

2.4 JACKETS

- .1 Canvas:
 - .1 220 gm/m² fire resistant cotton, plain weave, to ASTM C921 and ULC listed.
 - .2 Lagging adhesive: inorganic, water-based fire-resistive lagging adhesive and coating, ULC listed.
- .2 Aluminium:
 - .1 Jacket: To ASTM B209, minimum H-14 temper with heat-laminated moisture barrier liner.
 - .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.

2.5 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.

- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .5 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.
- .6 Contact adhesive: quick-setting
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .10 Fasteners: 14 gauge diameter pins with 30mm diameter or 927 mm² square clips, pin length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

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

3.2 INSTALLATION - INSULATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 50mm. Where multiple layers are required, layer nearest duct need not require jacket.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.

- .2 Seal all penetrations and joints with tape or vapour retarder adhesive.
- .5 Supports, Hangers in accordance with 'Hangers and Supports for HVAC Piping and Equipment'.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm on centre in horizontal and vertical directions, minimum two rows each side.
- .7 Where ducts are internally insulated, thickness of internal lining may be deducted from external insulation.
- .8 Type D-2 insulation may be substituted for Type D-1 insulation on rectangular ductwork if the ductwork has no dimension greater than 500mm.
- .9 Round ducts greater than 600mm diameter requiring insulation, apply Type D-1 rigid board scored to accommodate curvature of duct.
- .10 Duct dimensions shown on drawings are clear inside internal duct insulation

3.3 INSTALLATION – FIRE RATING MATERIAL

- .1 Install as per manufacturer's written instructions.

3.4 JACKETS

- .1 Applied to insulation where located as follows:
 - .1 Indoor, concealed:
 - .1 No additional finish required.
 - .2 Indoor, exposed:
 - .1 Rectangular: To TIAC Code CRF/2: Apply continuous metal corner bead and apply vapour barrier tape. Cover with canvas with fabric adhesive, and apply one (1) coat of fabric coating.
 - .2 Round: To TIAC Code CRD/2: Cover with canvas with fabric adhesive, and apply one (1) coat of fabric coating.
 - .3 Outdoor:
 - .1 Aluminium jacket.

3.5 DUCTWORK INSULATION SCHEDULE

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

	Type	Vapour Retarder	Thickness (mm)
Rectangular and round >600mm dia. cold and dual temperature supply air ducts,	D-1	yes	25
Round cold and dual temperature supply air ducts <600mm dia.	D-2	yes	25
Return air ducts	None	n/a	n/a
Rectangular warm air ducts	D-1	no	25
Round warm air ducts >600mm dia.	D-1	no	25
Round warm air ducts <600mm dia.	D-2	no	25

END OF SECTION

Part I General

I.1 SUMMARY

.1 Section includes:

- .1 Material and installation of insulation of HVAC pipes and fittings, including well water piping.

I.2 REFERENCES

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

- .1 ASHRAE Standard 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

.2 American Society for Testing and Materials (ASTM)

- .1 ASTM B209, Specification for Aluminum and Aluminum Alloy Sheet and Plate
- .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .6 ASTM C921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .7 ASTM C547 Standard Specification for Mineral Fiber Pipe Insulation
- .8 ASTM C1136 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
- .9 ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
- .10 C1427 Specification for Extruded Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form

.3 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts

- .4 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings

I.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" – plumbing piping in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

I.4 QUALIFICATIONS

- .1 Installer to be specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

I.5 DELIVERY, STORAGE AND HANDLING

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

I.6 SHOP DRAWINGS AND PRODUCT DATA

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

- .2 Provide sample board with all types of insulation and proper labelling.

I.7 CLOSEOUT SUBMITTALS

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

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 Provide and apply insulation in accordance with TIAC National Insulation Standards Specification 1501, Piping, and as herein specified:
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 oC mean temperature when tested in accordance with ASTM C335.
- .3 Type P-1: Rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to ASTM C547.
 - .2 Maximum "k" factor: 0.033 W/m°C to ASTM C547.
 - .3 Acceptable material: Knauff, Manville Micro-lok
- .4 Type P-2: Flexible Cellular Polyolefin.
 - .1 Insulation: ASTM C1427.
 - .2 Maximum "k" factor: 0.036 W/m°C at 24°C to ASTM C1427.
 - .3 Acceptable material: Imcoa Imcolok
- .5 Type P-3: Calcium Silicate.
 - .1 High temperature abuse resistant.
 - .2 ASTM C 411 to 649 C (1200 F).
- .6 Type P-4: Cellular Glass.
 - .1 Insulation to ASTM C552

2.3 INSULATION SECUREMENT

- .1 Tape: Self-adhesive, fibreglass reinforced foil-white kraft paper lamination, 50 mm wide minimum.
- .2 Contact adhesive: low VOC, air-drying adhesive.
- .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 VAPOUR RETARDER LAP ADHESIVE

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

2.5 INDOOR VAPOUR RETARDER FINISH

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

2.6 OUTDOOR VAPOUR RETARDER FINISH

- .1 Water based, fire retardant type, compatible with insulation.
- .2 Reinforcing fabric: polyester fibre with PVA finish.

2.7 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet with pre-formed shapes.
 - .2 Colour and finish: white, gloss.
 - .3 Service temperature range: -18oC to 66oC.
 - .4 Moisture vapour transmission: 0.02 perm.
 - .5 Thickness: 0.50 mm.
 - .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.

- .2 Canvas:
 - .1 220 gm/m² fire resistant cotton, plain weave, to ASTM C921 and ULC listed.
 - .2 Lagging adhesive: inorganic, water-based fire-resistive lagging adhesive and coating, ULC listed.
- .3 Aluminium:
 - .1 Jacket: To ASTM B209, minimum H-14 temper with heat-laminated moisture barrier liner.
 - .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.
- .4 Stainless steel:
 - .1 Type: 304.
 - .2 Thickness: 0.25 mm.
 - .3 Finish: 4.7mm Corrugated, dull.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5mm 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 Laminate Foil Film:
 - .1 Five-ply laminate foil film consisting of 3 layers of aluminum foil, and 2 layers of polyester with factory-applied pressure sensitive acrylic adhesive.

2.8 **REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES**

- .1 Application: At valves, primary flow measuring elements and flanges and unions at equipment. Apply to expansion joints only where permitted by the expansion joint manufacturer's recommendations.
- .2 Design: To permit periodic removal and replacement without damage to adjacent insulation. For expansion joints, design to permit full range of motion for expansion joint.

- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as for piping.
 - .2 Jacket: as scheduled.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Silicones sealant:
 - .1 One part formulation, industrial grade, clear.

Part 3 Execution

3.1 PRE- INSTALLATION REQUIREMENT

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

3.2 INSTALLATION - GENERAL

- .1 Install in accordance with TIAC National Standards, following manufacturer's instructions and this specification. In case of conflict between TIAC National Standard's, manufacturer's instructions and this specification, this specification shall govern, unless otherwise directed by the Departmental Representative.
- .2 Use two layers with staggered joints when required nominal insulation thickness exceeds 75 mm.
- .3 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .4 Supports, Hangers:
 - .1 Apply high compressive strength insulation, as indicated below, at oversized saddles where insulation shoes have not been provided.
 - .1 Hot piping: Calcium silicate or Perlite.
 - .2 Cold piping: cellular glass or high density foam.
 - .3 Wood blocks or plastic inserts are acceptable only where approved by the Departmental Representative.

- .5 Insulate valves, valve bonnets, strainers, flanges and fittings unless otherwise specified to same requirements as associated piping.
- .6 Carry insulation through floors and walls on services above 121°C (250°F) or below room temperature.
- .7 Ensure adequate ventilation is provided upon initial heating of insulation, where manufacturer indicates that fumes and odors may be released.

3.3 INSTALLATION OF TYPE P-1 INSULATION (FIBREGLASS):

- .1 Without integral jacket: mechanically fasten at 300mm centres.
- .2 With integral jacket: staple flap on 75mm centres.
- .3 Insulation with self-sealing lap seal integral to jacket requires no additional fastening.
- .4 Seal butt joints with self-sealing butt strips, minimum 50mm wide.

3.4 INSTALLATION OF TYPE P-2 INSULATION (ELASTOMERIC)

- .1 Follow manufacturer's instructions.

3.5 JACKETS

- .1 Canvas:
 - .1 Make jacket ready to receive painted finish by applying lagging adhesive and coating to entire surface.
- .2 Aluminum and Stainless Steel:
 - .1 Outdoor installations:
 - .1 Water-proof installation.
 - .2 Apply silicone sealant under longitudinal and circumferential lap joints. Further apply silicone sealant along seam of longitudinal and circumferential joints.
 - .3 Locate longitudinal joints in jacket at bottom of pipe.

3.6 HEAT TRACED PIPES

- .1 Provide insulation oversized to accommodate the heat tracing without any gaps.

- .2 Confirm compatibility of insulation with the heat tracing before ordering.
- .3 Insulation and tracing to extend in through the outside wall.

3.7 SPECIFIC APPLICATIONS

- .1 Thickness:
 - .1 As listed in following table.
- .2 Runouts:
 - .1 Runouts up to 50mm to individual terminal units, not exceeding 3.7m in length, may have insulation thickness reduced to 13mm.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.
- .3 Jackets:
 - .1 Type P-1 insulations:
 - .1 Exposed indoors:
 - .2 Pipe: Canvas.
 - .3 Valves and Fittings: PVC.
 - .2 Exposed in mechanical rooms:
 - .1 Pipe: Stainless steel.
 - .2 Valves and Fittings: Stainless steel.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Outdoors:
 - .1 Inaccessible areas, such as roofs: Aluminum.
 - .2 Accessible areas: Stainless steel.
 - .5 On Type P-2 insulation:
 - .1 Indoors:
 - .1 No further finish required.
 - .2 Outdoors:
 - .1 PVC.

3.8 INSULATION SCHEDULE

Service	Sizes	Type	Thick	VB	Fittings
Refrig Suction Piping (indoors)	ALL	P-2	25mm	YES	YES

Refrig Hot Gas (indoors)	ALL	P-2	19mm	NO	NO
Refrig Suction Piping (outdoors)	ALL	P-2	25mm	YES	YES
Hydronic Chilled Water Piping	13- 50mm	P-1	25mm	YES	YES

END OF SECTION

Part I General

I.1 SUMMARY

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

I.2 REFERENCES

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

I.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.

I.4 WORK INCLUDED

- .1 Provide DDC controls for VAV boxes, to match existing on-site control system and connect directly to the existing network(s) and existing web-server operator interface software. Controls contractor shall supply actuator to terminal unit manufacturer for installation. If actuator is supplied by terminal unit manufacture, ensure compatibility with other controls equipment.
- .2 Interface BACnet adapters supplied by air conditioner manufacture with BMS. Controls contractor shall review air conditioner shop drawings and shall provide all necessary components to interface with existing BMS. BMS shall be capable of remote monitoring of all Air Conditioner functions, including status, set points, and alarms.
- .3 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.

I.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 VAV boxes, split air conditioning system, and ensure any existing equipment controls are maintained. Including but not limited to existing fan coils and perimeter heating controls.
- .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.
- .6 Provide connection point in mechanical rooms for portable computer to permit access to information and system communications network.

I.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 VAV boxes
 - .2 New split air conditioning system

- .3 All existing equipment that is currently being monitored shall continue being monitored.
- .2 Thermostats: wall mounted, equipped with lockable lexan guards. Use remote space temperature sensors in public areas.

Part 3 Execution

3.1 SEQUENCE OF OPERATIONS

- .1 VAV Bypass Boxes:
 - .1 Cooling only
 - .1 On a rise in room temperature, the thermostat will call for cooling and modulate the actuator open. The actuator slowly rotates the damper shaft to increase the cold air to the room.
 - .2 On fall in room temperature, the thermostat reverses the above action. The actuator slowly rotates the damper shaft clockwise to decrease the cold air to the room.
 - .2 Split air conditioning systems shall have packaged controls and sequences of operations. The system shall come with a BACnet interface and the building control system shall be able to monitor status, temperatures, set points and alarms.
 - .1 Cooling only
 - .1 On a rise in room temperature, the thermostat will call for cooling and initiate space air conditioner.
 - .2 On fall in room temperature, the thermostat reverses the above action.
- .3 Meeting Room Transfer Fans:
 - .1 Fans are manually activated with room speed controller.
- .4 Existing fan coils and perimeter heating sequences to remain the same. Confirm all sequences with existing controls systems.
 - .1 Fan Coils
 - .1 On a rise in room temperature, the thermostat will call for cooling and modulate the chilled water valve open.
 - .2 On a fall in room temperature, the thermostat will reverse the above action.
 - .2 Perimeter heating.

- .1 On a fall in room temperature, the thermostat will call for heating and modulate the hot water valve open.
- .2 On a rise in room temperature, the thermostat will reverse the above action.

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 I General

I.1 SUMMARY

.1 Section includes:

- .1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.

I.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).

- .1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASME B16.3, Malleable Iron Threaded Fittings.
- .3 ASME B16.5, Pipe Flanges and Flanged Fittings.
- .4 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
- .5 ASME B16.20, Metallic Gaskets for Pipe Flanges: Ring Joint Spiral Wound and Jacketed
- .6 ASME B16.21, Nonmetallic Flat Gaskets for Pipe Flanges
- .7 ASME B18.2.1, Square and Hex Bolts and Screws (Inch Series).
- .8 ASME B18.2.2, Square and Hex Nuts (Inch Series).

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

- .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- .3 ASTM A536, Standard Specification for Ductile Iron Castings.
- .4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
- .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .6 ASTM E202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 Canadian Standards Association (CSA International).

- .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
- .2 CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

- .4 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67, Butterfly Valves.
 - .2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.
- .5 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .6 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A276, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M, Specification for Copper-Base Alloy Continuous Castings.
- .7 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

I.3 MAINTENANCE

- .1 Extra Materials.
 - .1 Provide following spare parts:
 - .1 Valve seats: one for every ten valves, each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.
 - .4 Valve handles: two of each size.
 - .5 Gaskets for flanges: one for every ten flanges.

I.4 SHOP DRAWINGS AND PRODUCT DATA

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

I.5 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 Chilled water, hot water heating, glycol piping services:
 - .1 To NPS 10: Schedule 40.

2.2 PIPE JOINTS

- .1 Except as noted below:
 - .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
 - .2 NPS2-1/2 and over: grooved couplings and fittings or welded
- .2 Branch connections to radiation/wall fin up to 25mm may be formed on mains using manufactured threaded connection fittings, manufactured by ASTM A181, Grade 1.
- .3 Pipe thread: taper.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.
 - .2 Steel: to ASME B16.5, Class 150.
 - .3 Forged carbon steel flanges. Use 1034 kPa flanges on water system operating up to 682 kPa. Use 2068 kPa flanges on systems operating above 682 kPa.
 - .4 Plain face for connecting to materials of lesser strength, such as cast iron or bronze.

- .5 Raised face when connecting to materials of equal strength. Provide raised face on only one flange of each joint, unless otherwise recommend by manufacturer.
- .3 Flange gaskets: to ASME B16.21
- .4 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .5 Butt-welding fittings: steel, to ASME B16.9.
- .6 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.
- .7 Use long radius elbows.
- .8 Orifice flanges: slip-on raised face, 2100 kPa.
- .9 Dielectric Flanges and Unions:
 - .1 Provide where pipes of dissimilar metals are joined. Unions to be rated to 150C.
- .10 Provide unions or flanges for pipe 50mm and smaller and flanges on piping 64mm and larger.

2.4 VALVES

- .1 General:
 - .1 Application for each valve type indicated is for general information only. Refer to drawings and other specifications sections for additional valve applications.
 - .2 Except for specialty valves, to be single manufacturer.
 - .3 All products to have CRN registration numbers.
 - .4 Connections:
 - .1 NPS2 and smaller: screwed ends.
 - .2 NPS2.1/2 and larger: Flanged ends.
- .2 Ball valves: to MSS-SP-110:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125.
 - .3 Connections:
 - .1 Screwed ends to ANSI B1.20.1. and with hexagonal shoulders.
 - .4 Stem: tamperproof ball drive.

- .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable chrome-plated brass solid ball and teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle
- .3 Gate valves: to MSS-SP-70 and MSS-SP-82, as applicable
- .1 Application: Isolating equipment, control valves, pipelines .
 - .2 NPS 2 and under, rising stem, solid wedge disc, Class 125
 - .1 Body: bronze, screwed connections with hexagonal shoulder.
 - .2 Bonnet: screwed with stem retaining nut.
 - .3 Packing: PTFE
 - .4 Operator: non-ferrous handwheel.
 - .5 Use non-rising stem only where space is constrained, upon approval of the Departmental Representative.
 - .3 NPS 2 1/2 - 8, non rising stem, inside screw, bronze trim, solid wedge disc, Class 125:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B, bolted bonnet.
 - .2 Connections: flanged ends to ANSI B16.1.
 - .3 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .4 Packing and gaskets: non-asbestos.
 - .5 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: Handwheel, die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
- .4 Globe valves: to MSS-SP-80 and MSS-SP-85, as applicable.
- .1 Application: Throttling, flow control, emergency bypass:
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body: bronze, screwed connections with hexagonal shoulder.
 - .2 Bonnet: union bonnet.
 - .3 Packing: PTFE
 - .4 Disc and seat: renewable rotating, PTFE disc, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .5 Operator: non-ferrous handwheel.

- .6 Use non-rising stem only where space is constrained, upon approval of the Departmental Representative.
- .3 NPS 2 1/2 - 8, outside screw and yoke, rising stem, bronze trim, solid bronze disc, Class 125:
 - .1 Body: with multiple-bolted bonnet.
 - .2 Bonnet-yoke gasket: non-asbestos.
 - .3 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .4 Seat ring: renewable, regrindable, screwed into body.
 - .5 Stem: bronze to ASTM B62.
 - .6 Operator: Handwheel.
- .5 Balancing, for Testing, Adjusting and Balancing:
 - .1 Application: measurement and flow adjustment at equipment, branch and main pipelines.
 - .1 NPS 2 and under:
 - .1 Body: bronze with brass ball, carbon filled TFE seat rings, with differential pressure read-out ports across valve seat.
 - .2 Connections: screwed or sweat
 - .3 Read-out ports: fitted with check valve, internal insert.
 - .4 Calibrated nameplate, memory stop feature to permit closing of valve for service without affecting balance setting.
 - .2 NPS 2 1/2 to 3:
 - .1 Body: cast iron with brass ball, carbon filled TFE seat rings, with differential pressure read-out ports across valve seat.
 - .2 Connections: flanged
 - .3 Read-out ports: fitted with check valve, internal insert.
 - .4 Calibrated nameplate, memory stop feature to permit closing of valve for service without affecting balance setting.
 - .3 NPS 4 and larger:
 - .1 Body: cast iron with bronze seat, replaceable bronze disc, EPDM seal insert, with differential pressure read-out ports across valve seat.
 - .2 Connections: flanged
 - .3 Read-out ports: fitted with check valve, internal insert.

- .4 Calibrated nameplate, memory stop feature to permit closing of valve for service without affecting balance setting.
- .6 Drain valves:
 - .1 Application: to permit draining of equipment and pipelines.
 - .1 Pipe sizes up to NPS 10:
 - .1 NPS $\frac{3}{4}$ ball valve with $\frac{3}{4}$ " male threaded hose connection, cap and chain.
- .7 Swing check valves: to MSS-SP-71 and MSS-SP-80, as applicable.
 - .1 Application: at inlet to pumps, bypass lines.
 - .1 NPS 2 and under, Y-pattern swing type, bronze disc, Class 125:
 - .1 Body: bronze, screwed connections with hexagonal shoulder.
 - .2 Cap: screwed.
 - .3 Disc: brass to NPS $\frac{3}{4}$, bronze to NPS 2
 - .2 NPS 2 $\frac{1}{2}$ and over: Swing check valves, Class 125:
 - .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
 - .3 Disc: rotating for extended life..
 - .1 Up to NPS 6: bronze to ASTM B 62.
 - .2 NPS 8 and over: bronze-faced cast iron.
 - .4 Seat: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: replaceable brass.
- .8 Multi-purpose valves (combination check/balancing/isolation valve):
 - .1 Application: on discharge side of pumps
 - .2 NPS 2 and under, straight pattern:
 - .1 Body: bronze, screwed connections.

2.5 STAINLESS-STEEL BELLOW, FLEXIBLE CONNECTORS

- .1 Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- .2 End Connections: Threaded or flanged to match equipment connected.

- .3 Performance: Capable of 20-mm (3/4-inch) misalignment.
- .4 CWP Rating: 1035 kPa (150 psig).
- .5 Maximum Operating Temperature: 121 deg C (250 deg F).

Part 3 Execution

3.1 PIPING INSTALLATION

- .1 Install piping approximately as shown, with all lines being carried parallel to building walls and as close to the structure as possible.
- .2 Conceal all piping except where otherwise approved. Exposed piping must be carefully in a neat and tidy manner and must meet the Architect's requirements with respect to visual appearance.
- .3 Grade water and glycol lines up in direction of flow to aid in venting.
- .4 Cold spring piping where change in directions are shown for expansion compensation.
- .5 Where existing equipment is relocated, extend hydronic piping and relocate valves and accessories.

3.2 VALVES

- .1 Install valves of type suitable to the application at the following locations and as indicated on the drawings:
 - .1 Isolation valves:
 - .1 Inlet and outlet to each piece of equipment.
 - .2 Ahead of control valves.
 - .3 Provide isolation valve on discharge of balancing valves.
 - .4 Base of risers..
 - .5 On each branch line adjacent to main, where branch serves more than one piece of equipment.
 - .6 Use ball valves for service on water and glycol service.
 - .2 Drain valves:
 - .1 Low points of piping systems.
 - .2 At each piece of equipment.

- .3 Check valves:
 - .1 Discharge of pumps.
- .4 Balancing valves:
 - .1 Discharge of pumps.
 - .2 Outlet piping from coils, radiation, unit and force flow heaters.
- .2 Install rising stem valves in upright position with stem above horizontal.
- .3 Provide 3 valve by-passes at the following locations:
 - .1 Pressure reducing valves.
 - .2 Around coil control valves where design entering air temperature is less than 5C.
- .4 Provide union or flange downstream of isolation valves to permit removal of equipment.

3.3 WELDING

- .1 Make pipe to pipe welded joints with open, secure butt welds, reinforced by metal in excess of the net throat dimensions by at least 1.5 (1/16") built up to give a gradual increase in thickness from edge to centre. Clean all rust, paint, oil, grease or foreign matter from all welding faces and adjoining pipe surfaces for a depth of at least 12 (1/2") from the edge of welding groove. Maintain a surface clearance of 1.5 (1/16"). Carefully align piping using proper clearances and tacking before welding. Leave welded surfaces clean.
- .2 Welding must be performed by welders with proper certificates. All field welding must be in accordance with the procedures of CSA-W55.2-1957 and CSA-W117.2-1974 and the current edition of ASME Code for Power Piping. Do not caulk or pean welds. Perform all welding above 4.4°C (40°F) if necessary preheat to at least 21°C (70°F).

3.4 FLEX CONNECTIONS

- .1 Install flexible connections at connections to base-mounted pumps. Flexible connections not required on inline pumps unless recommended by pump manufacturer.
- .2 Install to absorb vibration and misalignment.
- .3 Insulate same as pipe.

3.5 CIRCUIT BALANCING VALVES

- .1 Install valve of size appropriate to design flow expected through valve. Coordinate with TAB contractor and confirm sizing with valve manufacturer.
- .2 Provide straight pipe lengths upstream and downstream of valve to manufacturer's recommendations. Relocate valve if necessary to accommodate these requirements, subject to approval of the Departmental Representative.

3.6 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section – 'Cleaning and Start-Up of Mechanical Piping Systems'.

3.7 TESTING

- .1 Test system in accordance with Section 23 05 02 Installation of Pipework.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section Includes:
 - .1 Refrigerant piping and accessories

I.2 REFERENCES

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

I.3 SHOP DRAWINGS AND PRODUCT DATA

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

I.4 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 TUBING

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

2.2 FITTINGS

- .1 Service: design pressure 2070 kPa and temperature 1210C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

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

2.4 VALVES

- .1 22 mm and under: Class 500, 3.5 MPa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

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

2.5 REFRIGERANT

- .1 Refrigerant type used shall be R410A

Part 3 Execution

3.1 GENERAL

- .1 Install in accordance with CSA B52, EPS1/RA/I and ASME B31.5.

3.2 BRAZING PROCEDURES

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

3.3 PIPING INSTALLATION

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction
 - .2 Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- .3 Install refrigerant piping according to ASHRAE 15.
- .4 Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- .5 Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- .6 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- .7 Install piping adjacent to machines to allow service and maintenance.
- .8 Install piping free of sags and bends.
- .9 Install fittings for changes in direction and branch connections.
- .10 Select system components with pressure rating equal to or greater than system operating pressure.
- .11 Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- .12 Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as required if valves or equipment requiring maintenance is concealed behind finished surfaces.
- .13 Install refrigerant piping in protective conduit where installed belowground.
- .14 Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- .15 Slope refrigerant piping as follows:
- .16 Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
- .17 Install horizontal suction lines with a uniform slope downward to compressor.
- .18 Install traps and double risers to entrain oil in vertical runs.
- .19 Liquid lines may be installed level.
- .20 When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- .21 Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
- .22 Shot blast the interior of piping.

- .23 Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
- .24 Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
- .25 Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
- .26 Finally, draw a clean, dry, lintless cloth through the tube or pipe.
- .27 Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.
- .28 Install pipe sleeves at penetrations in exterior walls and floor assemblies.
- .29 Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."
- .30 Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- .31 Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
- .32 Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.
- .33 Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 PRESSURE AND LEAK TESTING

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

3.5 DEHYDRATION AND CHARGING

- .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 130C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14Pa absolute and hold for 4 h.
 - .2 Break vacuum with refrigerant to 14kPa.
 - .3 Final to 5Pa absolute and hold for at least 12 h.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
- .7 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements to Departmental Representative.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of galvanized ductwork, joints and accessories.

I.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.

I.3 SHOP DRAWINGS AND PRODUCT DATA

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

I.4 CLOSEOUT SUBMITTALS

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

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: to match maximum design external static pressure of fans systems.

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 air	+500	B
exhaust air	-500	B
Misc. exhaust discharge	+250	B
Misc. exhaust suction	-500	C

- .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 Departmental Representative.
- .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 Departmental Representative.
- .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 Departmental Representative. Report all layout deviations to the Departmental Representative for approval prior to installation.
 - .1 Ductwork on drawings are based on existing drawings. Not all ductwork is visible. Therefore, contractor shall allow for deviations in ductwork layout and offsets as required for 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 Departmental Representative.
- .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 Exhaust and relief air outlets.
 - .2 Outside air intakes.
 - .3 Minimum 3000 mm from duct mounted humidifier in all directions.
 - .4 As directed by Departmental Representative.
- .2 Provide watertight drip pan below:
 - .1 Open-ended intakes for roof mounted equipment and hoods where condensation may occur.
 - .2 Cold equipment not insulated including pumps and water meters.
 - .3 As directed by Departmental Representative.
- .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 Departmental Representative.

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.

END OF SECTION

Part I General

I.1 SUMMARY

.1 Section Includes:

- .1 Materials and installation for duct accessories including flexible connections, access doors, turning vanes, balancing dampers, pressure gauges and thermometers.

I.2 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 Canadian Standards Association (CSA International)

- .1 CAN/ULC-S109M, Standard for Flame Tests of Flame-Resistant Fabrics and Films.

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

- .1 HVAC Duct Construction Standards - Metal and Flexible.

I.3 SHOP DRAWINGS AND PRODUCT DATA

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

I.4 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 GENERAL

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

- .2 General: construction and air tightness suitable for duct air velocities and pressure class. The following are minimum requirements. Provide additional features where required to suit the Work.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: 75 mm wide galvanized sheet metal frame, 0.7 mm thick, with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Indoor application: fire-resistant, self-extinguishing, neoprene-coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, 0.63 mm thick, and density of 1.02 kg/m². Meets the flame-resistance requirements of CAN/ULC-109M.
 - .2 Outdoor application: fire-resistant, self-extinguishing, DuPont 'Durolon'-coated glass fabric, temperature rated at minus 40 degrees C to plus 120 degrees C, 0.61 mm thick, and density of 0.81 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: closed cell neoprene, continuous, between door and frame.
- .4 Hinges: steel, zinc-plated, piano type, 90 mm wide x 90 mm minimum length unless otherwise specified.
- .5 Sash Locks: steel, zinc-plated, cam type.
- .6 Handles: corrosion-resistant zinc-aluminum alloy, steel and sponge shaft washers, inside and outside handles, plain finish.
- .7 Hardware:
 - .1 Up to 300 mm on hinge (long) side: continuous piano hinge and one sash lock.
 - .2 301 to 600 mm on hinge (long) side: continuous piano hinge and two sash locks.

- .3 601 to 900 mm on hinge (long) side: continuous piano hinge and minimum three sash locks.
- .4 901 to 1500 mm on hinge (long) side: three piano hinges and three handles.

2.4 **TURNING VANES**

- .1 Factory or shop fabricated of same material as duct.
- .2 Single Thickness Vanes:
 - .1 Use for duct heights up to 750 mm in plane of turn.
 - .2 To 400 mm duct width in plane of turn: 51 mm radius with 19 mm trailing edge, 41 mm vane spacing.
 - .3 Over 400 mm duct width in plane of turn: 114 mm radius with 41 mm trailing edge, 83 mm vane spacing.
- .3 Double Thickness Vanes:
 - .1 Use for duct heights over 750 mm in plane of turn.
 - .2 To 400 mm duct width in plane of turn: 51 mm radius, 41 mm vane spacing.
 - .3 Over 400 mm duct width in plane of turn: 114 mm radius, 83 mm vane spacing.
- .4 Vane Runners: embossed.

2.5 **INSTRUMENT TEST PORTS**

- .1 Cast aluminum or zinc-plated steel to suit duct material.
- .2 Heavy duty leak-proof screw cap.
- .3 Inside diameter to allow insertion of pitot tubes and other testing instruments. Length to suit insulation thickness.
- .4 Neoprene mounting gasket, flat or curved to suit duct profile.

2.6 **SPLITTER DAMPERS**

- .1 Of 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.
- .7 Vibration-free operation.

2.7 SINGLE BLADE DAMPERS

- .1 Of same material as duct, but at least one sheet metal thickness heavier.
- .2 Size and configuration to recommendations of SMACNA,
- .3 Rectangular: V-groove stiffened blade, maximum height 200 mm.
- .4 Round: frame with stiffening beads, continuous shaft for blades over 200 mm diameter.
- .5 Locking quadrant with shaft extension to accommodate insulation thickness.
- .6 Inside square end bearing and outside spring-loaded round end bearing.
- .7 Vibration-free operation.

2.8 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.

2.9 VOLUME EXTRACTORS

- .1 Factory manufactured of material compatible with duct.
- .2 Zinc-plated cold rolled steel blades and frame.
- .3 Gang-operated curved parallel blades, 25 mm blade spacing.
- .4 Controls both air flow rate and direction, pivots from full open to fully closed with blades overlapping for tight shut-off.
- .5 Key-operated mechanism for adjustment through grille face; otherwise adjusting rod with external set screw lock.
- .6 Vibration-free operation.

2.10 BACKDRAFT DAMPERS

- .1 Factory manufactured of material compatible with duct, licensed to bear the AMCA seal, rated in accordance with AMCA Standards 500-D and 511.
- .2 Parallel blade configuration, designed for installed orientation.
- .3 Frame: minimum 1.6 mm thick extruded aluminum with blade stop and flanges to suit application.
- .4 Blades: minimum 1.6 mm thick extruded aluminum with extruded PVC seals.
- .5 Axles: plated steel, full length.
- .6 Bearings: self-lubricating nylon.
- .7 Linkage: face type, aluminum tie bar.
- .8 Finish: mill.
- .9 Counter Balancing: external adjustment to permit setting for varying differential static pressure.
- .10 Smooth rattle-free operation.

2.11 BAFFLES FOR MIXED AIR PLENUMS

- .1 Hinged baffles with chains.

- .2 Corrosion resistant construction reinforced to prevent vibration and buckling.

2.12 DUCT PRESSURE GAUGES

- .1 Magnahelic, pressure or differential pressure, with 121 mm bezel, red-tipped pointer with stops, accuracy + 2 % of full scale.
- .2 Photohelic, pressure or differential pressure, with 140 mm dial, red-tipped pointer with stops, accuracy + 2 % of full scale, complete with electromechanical high limit relay with external adjustment knobs for remote monitoring by building automation system.
- .3 Select range to provide all normal readings in the mid 50 percent of full scale.

2.13 DUCT THERMOMETERS

- .1 Ducts less than 600 mm maximum dimension:
 - .1 Variable angle type with 175 mm case for locations up to 2,100 mm above the floor; 225 mm case for higher installations.
 - .2 Stem length to be 300 mm, except for ducts under 300 mm in width.
- .2 Larger ducts:
 - .1 Dial type with 2,400 mm long averaging element, element holder, and single hub duct flange.
- .3 Select range to provide all normal readings in the mid 50 percent of full scale.

Part 3 Execution

3.1 INSTALLATION

- .1 Install air duct accessories in accordance with recommendations of SMACNA HVAC Duct Construction Standards and manufacturer's instructions.
- .2 Provide adequate access for service, adjustment, replacement of all accessories.
- .3 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.
 - .2 Length of connection: 150 mm maximum.

- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .4 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
 - .3 Material does not protrude into the duct.
- .4 Access Doors:
 - .1 Size:
 - .1 One-hand or viewing access: 200 x 125 mm minimum.
 - .2 One-hand and viewing access: 300 x 150 mm minimum.
 - .3 Two-hands and viewing access: 450 x 250 mm minimum.
 - .4 Head and shoulders access: 525 x 350 mm minimum.
 - .5 Body entry: 625 x 350 mm minimum.
 - .6 Body entry plus ladder: 625 x 425 mm minimum.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Duct coils – both sides.
 - .6 Base of every duct riser.
 - .7 To allow access for inspection and cleaning; before and after each change in direction, 15 m maximum spacing.
- .5 Instrument Test Ports:
 - .1 Number and arrangement to be determined by the TAB contractor.
 - .2 Locate to permit easy manipulation of instruments and accurate readings.
 - .3 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhaust fans.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .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.
- .6 Turning Vanes:
- .1 Construct vane edges to project tangents parallel to duct sides. Where inlet and outlet duct widths are not equal, or angle of turn is not 90 degrees, modify vane shape to comply with this requirement; submit shop drawing prior to fabrication.
 - .2 Locations:
 - .1 Mitred elbows.
- .7 Balancing Dampers:
- .1 Install quadrant handles parallel to damper blade(s).
 - .2 Splitter dampers shall be used only where approved by the Departmental Representative.
 - .3 Where damper throttling produces excessive noise provide two dampers, duct baffle, volume extractor, or similar device to reduce noise to an acceptable level.
 - .4 Install as close as practical to main duct but at least two duct widths downstream of branch take-off. Where this is not possible use a volume extractor.
 - .5 Locations:
 - .1 Supply, return and exhaust systems: in each branch duct.
 - .2 Runouts to grilles, registers and diffusers: single blade damper regardless of whether dampers are specified as part of the air outlet assembly.
 - .6 All dampers to be vibration-free.
 - .7 Ensure damper operators are observable and accessible.
- .8 Volume Extractors:
- .1 Volume extractor size to match dimensions of branch duct served.
 - .2 Where main duct height exceeds branch duct height provide top and bottom baffles for proper performance in accordance with the manufacturer's instructions.
 - .3 Locations:
 - .1 Diffusers and registers with short (less than two duct widths) straight branch ducts connected to main supply ducts.

- .9 Back draft Dampers:
 - .1 Locations:
 - .1 Exhaust duct or exhaust fan discharge nearest to exterior wall or roof opening.
 - .2 Install square and provide sufficient length of unobstructed straight duct for entire range of blade motion.
 - .3 Adjust counter-balance and confirm proper operation.
 - .4 Ensure good seal when closed.
- .10 Baffles for Mixed Air Plenums:
 - .1 Install where poor mixing will occur.
- .11 Duct Pressure Gauges:
 - .1 Provide a Magnahelic gauge at the discharge of each fan rated at over 472 l/s air flow rate.
 - .2 Provide a Photohelic gauge at each filter location.
 - .3 Locate where there is a minimum of turbulence.
- .12 Duct Thermometers:
 - .1 Provide one at the following locations in each air handling system:
 - .1 Outside air intake.
 - .2 Mixed air section outlet.
 - .3 Coil inlet and outlet.
 - .2 Arrange averaging elements carefully to provide good duct coverage and compensate for temperature stratification.
 - .3 Locate downstream of mixing locations for accurate readings.
 - .4 Adjust case to facilitate reading from the floor.
 - .5 Use remote mounted type where required.

END OF SECTION

Part I General

I.1 SUMMARY

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

I.2 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 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112, Standard Methods of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.1, Standard for Leakage Rated Dampers for Use in Smoke Control Systems.
 - .3 CAN4-S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .4 ULC-S505, Fusible Links for Fire Protection Services.

I.3 SHOP DRAWINGS AND PRODUCT DATA

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

I.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.

I.5 EXTRA MATERIALS

- .1 Provide following:
 - .1 Six fusible links of each type.

I.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.

I.7 CLOSEOUT SUBMITTALS

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

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-SI 12, 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 Departmental Representative'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 Departmental Representative:
 - .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.

Part 3 Execution

3.1 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 Departmental Representative 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 Departmental Representative.
- .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.

3.2 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 manufacturer'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 Departmental Representative, 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.

END OF SECTION

Part I General

I.1 SUMMARY

.1 Section Includes:

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

I.2 REFERENCES

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

.2 Department of Justice Canada (Jus).

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.2 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.

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

.1 Material Safety Data Sheets (MSDS).

.4 National Fire Protection Association (NFPA).

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

.2 NFPA 90B, Standard for 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, (Addendum No.1, November 1997).

.2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition.

.6 Underwriters' Laboratories Inc. (UL).

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

.7 Underwriters' Laboratories of Canada (ULC).

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

I.3 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Submit Indoor Air Quality (IAR) Management Plan in accordance with Section 01 47 15 - Sustainable Requirements - Construction.
- .4 Product Data: submit WHMIS MSDS in accordance with Section 02 81 01 - Hazardous Materials for the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .5 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

I.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Sustainable Requirements:
 - .1 Construction requirements: in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
 - .2 Verification: contractor's verification in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

I.5 DELIVERY, STORAGE AND HANDLING

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

- .2 Store and manage hazardous materials in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Place materials defined as hazardous or toxic in designated containers.
 - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
 - .6 Ensure emptied containers are sealed and stored safely.
 - .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

I.6 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

- .1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance with Section 01 47 15 - Sustainable Requirements: Construction for construction and preoccupancy phases of building.
- .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

Part 2 Products

2.1 GENERAL

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

2.2 METALLIC - UNINSULATED

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

2.3 METALLIC - INSULATED

- .1 Type 2: spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl reinforced mylar/neoprene laminate aluminum jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.4 NON-METALLIC - UNINSULATED

- .1 Type 3: non-collapsible, coated mineral base fabric, aluminum foil, mylar type, mechanically bonded to, and helically supported by, external steel wire, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 0.5 W/m² degree C mean

2.5 NON-METALLIC - INSULATED

- .1 Type 4: non-collapsible, coated mineral base fabric, aluminum foil/mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37mm thick flexible mineral fibre thermal insulation with vapour barrier and vinyl reinforced mylar/neoprene laminate jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.6 METALLIC ACOUSTIC INSULATED - MEDIUM PRESSURE

- .1 Type 5: Spiral wound, flexible perforated aluminum with factory applied 37mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate Type M vapour barrier, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 0.5 W/m² degree C mean

2.7 METALLIC - ACOUSTIC INSULATED - HIGH PRESSURE

- .1 Type 6: Spiral wound, flexible perforated aluminum with factory applied 37mm thick flexible mineral fibre thermal insulation and encased in spiral wound flexible aluminum jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 0.5 W/m² degree C mean

2.8 NON-METALLIC - ACOUSTIC INSULATED

- .1 Type 7: non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible mineral fibre acoustic insulation and encased in aluminum foil/mylar laminate Type M vapour barrier, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

Part 3 Execution

3.1 DUCT INSTALLATION

- .1 Install in accordance with: CAN/ULC-S110, UL-181, NFPA 90A, NFPA 90B, SMACNA.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Materials and installation for acoustic duct lining.

I.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - .2 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .4 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.
 - .5 ASTM C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .6 ASTM C1104, Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - .7 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .8 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 North American Insulation Manufacturers Association (NAIMA).
 - .1 NAIMA AH124, Fibrous Glass Duct Liner Standard.
- .3 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - .1 HVAC Duct Construction Standards - Metal and Flexible.
- .4 Underwriter's Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

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 Departmental Representative.
 - .2 25 mm thick, to ASTM C1071 Type I, 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.

Part 3 Execution

3.1 GENERAL

- .1 Do work in accordance with NAIMA AH124, Fibrous Glass Duct Liner Standard and SMACNA HVAC Duct Construction Standards except where specified otherwise by Departmental Representative.
- .2 Line inside of ducts where indicated on drawings and all ductwork for motorized equipment within 3m of duct connection.
- .3 Duct dimensions listed on drawings are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
 - .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 Departmental Representative.
- .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.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.
 - .2 Sustainable requirements for construction and verification.

I.2 REFERENCES

- .1 Air Conditioning and Mechanical Contractors (AMCA)
 - .1 AMCA Publication 99, Standards Handbook.
 - .2 AMCA 300, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

I.3 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
 - .2 Capacity: flow rate, static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

- .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
- .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

I.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data 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.
- .3 Provide:
 - .1 Fan performance curves showing point of operation, BHP, kW, and efficiency.
 - .2 Sound rating data at point of operation.
- .4 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

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

I.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.

I.6 MAINTENANCE

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

I.7 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

2.1 FANS GENERAL

- .1 Motors:
 - .1 For use with variable speed controllers.
 - .2 Sizes as indicated specified.
 - .3 Two speed with two windings and speeds of approximately as indicated.
 - .4 Two speed with split winding, constant horsepower, constant or variable torque.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and or outlet safety screens as indicated. Inlet, outlet dampers and vanes and as indicated.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Finish on fume hood exhaust fans:
- .6 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .7 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .8 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 IN-LINE CABINET FANS

- .1 Duct mounted exhaust, supply or return air fans shall be of the centrifugal direct drive type. The fan housing shall be constructed of heavy-gauge galvanized steel. The housing interior shall be lined with 13 mm (0.5 in.) acoustical insulation. The outlet duct collar shall include an aluminum backdraft damper and shall be adaptable for horizontal or vertical discharge. The access for wiring shall be external. The motor disconnect shall be internal and of the plug-in type.
- .2 The motor shall be mounted on vibration isolators. The fan wheel shall be of the forward-curved centrifugal type and dynamically balanced. All fans shall bear the AMCA Certified Ratings program AMCA Air Performance seal and shall be UL/cUL Listed. Ceiling or wall mount fans shall be model CSP as manufactured by Greenheck Fan Corporation, Schofield, Wisconsin.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 FAN INSTALLATION

- .1 Install fans as indicated, provide flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

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

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 I General

I.1 SUMMARY

.1 Section Includes:

- .1 Variable volume boxes, constant volume bypass, and fan powered and electronic variable air volume boxes.
- .2 Sustainable requirements for construction and verification.

.2 Related Sections:

- .1 Sections 23.

I.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.

I.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.

I.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.
 - .2 Submit mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .3 Samples and mock-ups are required for following: VAV with by-pass equipment.
- .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.

I.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.

I.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.

I.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 CONSTANT VOLUME BYPASS BOXES

- .1 Maintains space condition by bypassing supply air to return air or plenum space.
- .2 Sizes, capacities, pressure loss, and discharge sound pressure level: as indicated.
- .3 Discharge sound pressure level: as indicated.
- .4 Unit casings shall be constructed of 22 gauge zinc-coated steel, acoustically and thermally lined with 13 mm insulation which meets the requirements of Standards NFPA 90A and ULI81. The liner shall not contain Pentabrominated diphenyl ether CAS#32534-81-9 and Octabrominated diphenyl ether. Units shall incorporate a gate valve with polyethylene bearings which slides in a metal track. Single blade pivoting dampers will not be accepted.
- .5 Units shall include integral inlet and bypass balancing dampers for field adjustment as standard components. Static pressure taps shall be provided to facilitate balancing. A minimum air volume stop shall also be provided for field adjustment.
- .6 Complete with:
 - .1 Minimum air volume stop.
 - .2 Manual balancing damper.
 - .3 Multiport outlets.
- .7 Controls:
 - .1 Damper and actuators to be provided by controls contractor. Coordinate requirements with controls contractor.
 - .2 Coordinate controls with controls contractor.
 - .3 Terminal units shall operate in cooling only where perimeter radiation valve is not present in space. Where the space does contain a radiation control valve, the VAV box shall work in conjunction with the existing heating system such simultaneous heating and cooling does not occur.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 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 I General

I.1 SUMMARY

- .1 Section Includes:
 - .1 Diffusers, grilles and registers.

I.2 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

I.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawing submissions for approved equal products shall include a schedule with the following additional data for each type of air inlet and outlet to confirm performance equal to the specified item:
 - .1 Type and model number.
 - .2 Neck size.
 - .3 Air flow rate.
 - .4 Pressure drop (total and static).
 - .5 Throw and terminal velocity.
 - .6 Noise criteria.

I.4 CERTIFICATIONS

- .1 Catalogued 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 ASHRAE Standard 70.

I.5 EXTRA MATERIALS

- .1 Include:
 - .1 Keys for volume control adjustment.

- .2 Keys for air flow pattern adjustment.

1.6 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 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 Departmental Representative.
 - .6 Grilles, registers and diffusers of same generic type to be the product of one manufacturer.
- .3 Features and performance: as scheduled. Scheduled characteristics govern where they conflict with the general requirements herein.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.

- .2 Adjust locations of air inlets and outlets to conform to architectural features, symmetry and lighting arrangement. Obtain approval of Departmental Representative prior to installation.
- .3 Install with flat or oval head screws in countersunk holes where fastenings are visible.
- .4 Install air inlets and outlets to ductwork with air-tight connections. Attach round neck diffusers to ductwork using drawbands.
- .5 Bolt grilles, registers and diffusers in place in gymnasias and similar game rooms.
- .6 Provide concealed safety chain on each grille, register and diffuser in gymnasias and similar game rooms and elsewhere as directed by the Departmental Representative.
- .7 Paint ductwork visible behind air inlets and outlets Matte Black, especially where eggcrate style grilles are connected to unlined ducts.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Material and installation of split type room air conditioning system, including indoor evaporator unit and outdoor condensing unit.
 - .1 Indoor Evaporators: AC-1 through 10
 - .2 Condensing Units: CU-1 and CU-2
 - .2 Related Sections:
 - .1 Everything in this Project Manual is a requirement for this Division. The following references constitute assistance to the Contractors. Refer to the Table of Contents for additional guidance.
 - .1 Sections beginning with 23 05.
 - .2 Section 23 23 00 Refrigerant Piping and Accessories.

I.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA B52, Mechanical Refrigeration Code.
 - .2 CAN/CSA-C656, Performance Standard for Single Package Central Air-Conditioners and Heat Pumps.
- .2 Environment Canada, (EC)/Environmental Protection Services (EPS)
 - .1 EPS 1/RA/2 Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.
 - .2 Environment Canada, Ozone-Depleting Substances Alternatives and Suppliers List.

I.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 In addition to the requirements specified elsewhere, include the following additional information:

- .1 Indicate major components and accessories including sound power levels of units.
- .2 Type of refrigerant used, R-410A.

I.4 WARRANTY

- .1 Provide 5 year warranty including material and labour on compressors.

I.5 CLOSEOUT SUBMITTALS

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

Part 2 Products

2.1 GENERAL

- .1 VRF (variable refrigerant flow), 2-pipe, multiple split air conditioning system. The system will utilise air cooled condensing unit supplying a maximum of twenty two indoor fan coil units. The system will be capable of cooling.

2.2 INDOOR AIR CONDITIONING UNITS

- .1 It will be possible for the total capacity of the indoor units to be between 50 and 130% of the capacity of the outdoor unit (applicable to AC-1 through 9).
- .2 AC-10 shall be capable of -40 C low ambient operation.
- .3 Each indoor unit will have a heat exchanger which shall be constructed from copper tubing with aluminum fins. The flow of refrigerant through the heat exchanger will be controlled by a linear expansion valve. This valve will be controlled by two pipe thermistors and a return air thermistor and shall be capable of controlling the variable capacity of the indoor unit between 25% and 100%.
- .4 Each indoor unit will require a 208-230 vac power supply. Control will be via the 30vdc data control signal from the outdoor unit.
- .5 4 Way Discharge Cassette
 - .1 The units will be manufactured from galvanized steel plate insulated with closed cell expanded polyurethane foam. The ceiling panel will be manufactured from ABS plastic.

- .2 Air will be discharged by an aerofoil bladed centrifugal turbo fan through four outlets on the perimeter of the ceiling panel. The four outlets shall each include electronically adjustable vanes to alter the angle of the airflow. The room air will be returned to the unit through one grille in the centre of the panel. The return air to the unit will be filtered through a synthetic fibre washable filter installed in the unit.
 - .3 The unit will have a drain lift up mechanism fitted as standard.
- .6 Wall Mounted Unit
- .1 The unit will be manufactured from ABS plastic.
 - .2 Air will discharged by a tangential line flow fan through an outlet in the bottom front edge of the unit. The outlet will have electronically adjustable vanes to enable variable air discharge through the horizontal to vertical downward planes. The outlet shall also include manually adjustable guide vanes to alter the airflow pattern in the horizontal directional plane.
 - .3 Air will be returned to the unit through grilles mounted in the front face of the unit above the outlet. The return air will filtered by synthetic fibre washable filters mounted behind the return air grilles.

2.3 **OUTDOOR CONDENSING UNITS**

- .1 Condensing Unit CU-I:
 - .1 The outdoor unit will be constructed from steel plate and painted with acrylic paint.
 - .2 The outdoor unit will have two air cooled heat exchange coils constructed from copper tubing with aluminum fins. The coils will be set in a 'V' formation with air being drawn in through two sides of the unit and discharged out of the top of the unit. The Y Series systems will have a single fan mounted on top of the two coils. The coils will be capable of being dividing into 20,30,50,70,80,100 % sections to enable the outdoor unit capacity to match the capacity required by the indoor units.
 - .3 The outdoor unit will have one inverter controlled hermetic scroll compressor capable of controlling the compressor frequency in 1Hz increments.
 - .4 Extra sub-cooling will be provided by a Heat Interchange Circuit (HIC), which allows better refrigerant distribution and control with electronic expansion valves.
 - .5 The refrigeration process of the outdoor unit will be maintained by pressure and temperature sensors controlling solenoid valves, check valves and bypass valves. The heating or cooling mode of the outdoor unit will be controlled by a 4 way

valve which will reverse the cycle of the refrigerant to change the mode of the outdoor unit. Condensate shall be removed from the condensing unit by means of a drain pipe connector located on the bottom of unit.

- .6 The outdoor unit will have one liquid discharge pipe which will supply high pressure liquid to the indoor units or to the condensing unit, depending on the mode of operation. Refrigerant return to the outdoor unit will be via one suction pipe. Both pipes shall be insulated.
- .7 The system will be capable of total pipe runs of up to 300m.
- .8 The outdoor unit will require a 208-230 vac 3 phase power supply and have a starting current of no more than 10 amps. Control will be via a 30vdc signal generated by the outdoor unit. This signal will be sent to the indoor units via a 16 AWG 2 core non polar screened cable.

.2 Condensing Unit CU-2:

- .1 Condensing unit shall be capable of low ambient (-40 C) operation
- .2 The indoor units must be of the same capacity as the outdoor unit.
- .3 The outdoor unit will be constructed from steel plate and painted with acrylic paint.
- .4 The fan grille shall be of polypropylene (PP) plastic.
- .5 The unit shall be furnished with DC fan motors for direct drive propeller fan.
- .6 The motor bearings shall be permanently lubricated
- .7 The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.
- .8 The L shaped condenser coil shall be of copper tubing with flat aluminum fins.
- .9 The coil shall be protected with an integral metal guard.
- .10 The compressor shall be hermetic rotary type with variable compressor speed inverter technology
- .11 The compressor crankcase shall be heated by intermittent low speed compressor motor rotation.
- .12 The outdoor unit shall have high pressure and over current protective device.
- .13 The unit electrical power shall be 208/230 Vac, 1 phase, 60 hertz.
- .14 The unit shall operate within voltage limits of 198Vac to 253Vac.
- .15 The unit shall have a power factor of 98%.

2.4 CONTROLS

- .1 It will be possible to use a range of different controllers to control the indoor fan coil units. These controllers will be capable of being connected on any part of the non polar 16 AWG two core screened control cable from the outdoor unit. The controls options will be as follows:-
 - .2 Reduced Function Zone Controller
 - .1 This controller shall be wall mounted and hard wired to the indoor fan coil units. It will be manufactured in ABS plastic with an LCD display and will be the manufacturer's standard colour.
 - .2 The controller will be capable of switching on/off and altering the set point and mode of up to sixteen indoor fan coil units. The controller will also display unit fault codes.
 - .3 Provide one per indoor unit.
 - .3 Centralized Controller (Up to 50 units)
 - .1 This controller shall be wall mounted and hard wired to the outdoor unit. It will be manufactured in ABS plastic with an LCD display and will be the manufacturers standard colour. The controller will require an additional power pack which will be housed in a galvanized steel box.
 - .2 The controller will be capable of individually controlling the following functions on fifty indoor fan coil units:-
 - .1 on/off.
 - .2 operating mode.
 - .3 set point.
 - .4 fan speed.
 - .5 louvre position.
 - .6 timer settings.
 - .7 test run.
 - .4 The controller shall also be capable of displaying the following information individually for fifty indoor fan coil units:-
 - .1 on/off.
 - .2 operating mode.
 - .3 set point.
 - .4 fan speed.

- .5 louvre position.
 - .6 timer settings.
 - .7 test run.
 - .8 fault diagnosis.
- .5 The centralized controller will be capable to be used as stand alone or each unit can be accessed either locally or remotely via a control PC utilizing standard Internet Explorer IE5 or IE6 software.
- .6 Centralized controllers can be networked together using the standard 10baseT Ethernet cabling structure.
- .7 Each centralized controller has the ability to automatically send e-mail error under Alarm Condition.
- .8 A modular software approach will allow additional features to all centralized controllers for future upgrades; example, Remote time scheduling, Energy consumption data, load shedding, Trend Logging and remote I/O capability, peak power shedding.

2.5 **BMS CONTROL**

- .1 The entire systems shall interface with the BMS via BACnet interface module through the centralized controller. Controlled variables will be ON/OFF, mode operation, set point adjustment, fan speed.
- .2 Monitoring will be ON/OFF mode operation, temperature set point, fan speed, return air temperature and fault code.

2.6 **OPTIONAL FEATURES**

- .1 Provide the following features:
 - .1 Web Browser Monitoring Control Personal Web
 - .2 Weekly/Annual Scheduling
 - .3 Proportion Charging System
 - .4 Email Error Notification
 - .5 Maintenance Tool
 - .6 Personal Web - Individual Control
 - .7 Demand Control - Energy Saving
 - .8 Demand Control - Peak Cut

- .9 Maintenance Tool
- .10 Power supply will be required for the centralized controller
- .11 Windscreens for condensing

Part 3 Execution

3.1 GENERAL

- .1 Manufacturer to certify installation.
- .2 Run drain line from cooling coil condensate drain pan to terminate over nearest floor drain with copper piping. Condensate piping shall not be exposed in finished areas. Where condensate cannot drain by gravity, provide condensate lift pump.
- .3 Install air conditioning system in accordance with manufacturer's installation instructions.
- .4 Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- .5 The fixing of all air conditioning equipment, installation of all refrigerant pipe work and full commissioning shall be performed by a specialist refrigerant installer who shall be authorized to install manufacturer's equipment. The installation of all internal and external units, refrigerant pipe work, inter-connecting wiring, commissioning and testing shall be carried out by an approved refrigerant systems installers.
- .6 Full access shall be afforded to site during the installations stage of the project to allow them to verify that installation methods are fully in accordance with manufacturers requirements and that the equipment warranties will not be invalidated.

3.2 ELECTRICAL WIRING

- .1 Install electrical devices furnished by manufacturer but not specified to be factory mounted, in accordance with requirements of Division 26.
- .2 Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

3.3 REFRIGERANT PIPING

- .1 Supply, install, test and commission all interconnecting refrigeration pipe work between the outdoor and indoor units.

- .2 All pipe work to be carried out in refrigerant quality ACR copper tubing and complete with the appropriate headers and joints. All pipe work must be suitable for R410A.
- .3 Longest possible lengths of copper pipe should be utilized to minimize joints on site.
- .4 Appropriate refrigeration installation tools must be utilized. Dry Nitrogen must be utilized at all times in the system during brazing.
- .5 All pipe work (suction and liquid lines) to be insulated with slip on close cell elastomeric pipe insulation having a wall thickness of not less than 1/2".
- .6 After installation of pipe work, and prior to sealing of insulation joints and starting of equipment, pipe work should be pressure tested. 303 kPa (44 PSI) test for 3 minutes minimum, then 1500 kPa (217 PSI) for 3 minutes minimum, then 3300 kPa (478 PSI) for 3 minutes minimum, then strength test to 4140 kPa (600 PSI) check the system for leaks and deformation, then lower the pressure back to 3300 kPa (478 PSI) and pressure test for 24 hours and checked for leaks. Vacuumed/dehydrated to 300 microns, and hold at that vacuum for 12 hours (minimum).
- .7 Refrigerant (R410A) charge weight must be calculated, to the actual installed length of pipe work in accordance to Mitsubishi recommendations.
- .8 The charging should be carried out with an appropriate charging station.
- .9 Pipe work to be properly fixed and supported at a minimum of 1.5 metres (5 feet) centres or as specified by local code and where required should be run on galvanized trays. All pipe work to be labeled with ID number (condensing units ref.) at 3 metre (9 feet) intervals.
- .10 Joints in copper pipe shall be brazed. Brazing shall be carried out to the requirements of the local code and as per the Canadian copper & brass development association recommendations.
- .11 Support all equipment on roof on manufactured non-penetrating support system with rubber bases and unistrut members.
- .12 Refer also to 23 23 00.

3.4 PIPING CONNECTIONS

- .1 Install and connect devices furnished by manufacturer but not specified to be factory mounted.

- .2 Connect condensate drain to the air conditioning unit and drain indirectly to nearest janitors room or washroom floor drain. Pitch and trap drain in accordance with manufacturer's instructions and prevailing codes/regulations. Provide condensate pump if flow by gravity is not possible. Piping to be soldered copper tube, hard drawn temper, type L.
- .3 Furnish copy of manufacturer's piping connection diagram submittal to piping contractor.

3.5 CONTROLS

- .1 Install control devices furnished by manufacturer but not specified to be factory mounted.
- .2 Furnish copy of manufacturer's controls connection diagram submittal to the electrical contractor.
- .3 All control wiring to be run in conduit.
- .4 Provide services of manufacturer's field Departmental Representative to set and adjust equipment for operation as specified.

END OF SECTION

Part I General

I.1 SUMMARY

- .1 Section includes:
 - .1 Requirements for Halocarbon Management.

I.2 REFERENCES

- .1 Status of Canada 1999 chapter 33: “Canadian Environmental Protection Act 1999:
 - .1 SOR/2003-289: “Federal Halocarbon Regulations 2003”.
- .2 Environmental Code of practice for Eliminations of Fluorocarbon Emissions from Refrigeration and Air conditioning Systems (the Environment Canada “ Refrigeration Code of Practice”, and the Report EPS I RA/2 dated March 1996.

I.3 GENERAL

- .1 Contractors and their personnel shall be familiar with the Section and its requirements.
- .2 The Contractor will comply with all Federal, Provincial, and Municipal regulatory requirements and guidelines for environmental protection and natural resources conservation, including the References noted above.
- .3 It is the Contractor’s responsibility to be aware of environmental requirements, the best management practices, and pollution control measures necessary to meet them.

I.4 HALOCARBONS

- .1 All work relating to halocarbons to comply with referenced standards outlined above in Paragraph I.2 – References.
- .2 All work related to halocarbon equipment installation, servicing, etc., to be carried out by, or under direct supervision of, a technician licensed by the Province of Manitoba as a refrigeration mechanic.
- .3 Technician to provide to Departmental Representative:
 - .1 Copy of Province of Manitoba license.
 - .2 Certificate issued by the Heating, Refrigeration, and Air Conditioning Institute of Canada; and,

- .3 Ozone Depletion Prevention Substance Awareness Card.
- .4 The following are the only halocarbons that are acceptable as refrigerants: (non-halocarbon refrigerants are also acceptable)
 - .1 R-410a
 - .2 R-407c
- .5 All work related to halocarbon equipment installation, servicing, decommissioning, leak-testing to be documented.
- .6 Immediately report all releases of halocarbons to Departmental Representative. Document release on Spill Report form.
- .7 Factory-charged halocarbon-containing shall be leak-tested by this Contractor in accordance with the "Refrigeration code of Practice" within one working day after delivery to the site.
 - .1 No payment for delivery of this equipment to the site will be made until it is documented to be leak-free.
- .8 Non-factory-sealed halocarbon-containing equipment shall be leak-tested using "triple evacuation": evacuate the system to 400 micron or less and break the vacuum with dry nitrogen three times.
 - .1 No payment for delivery of this equipment to the site will be made until it is documented to be leak-free.

END OF SECTION