
Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 11 – Cleaning
- .2 Section 21 05 01 – Common Work Results for Mechanical.
- .3 Section 23 33 00 – Air Duct Accessories.

1.2 REFERENCE DOCUMENTS

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE 52.2 – 2007 Method of testing general ventilation air-cleaning devices for removal efficiency by particle size.
- .2 Sheet Metal and Air Conditioning National Contractors Association (SMACNA):
 - .1 SMACNA – IAQ Guidelines for occupied building under construction.

1.3 SUBMITTALS

- .1 Submit an outline of the work scope for air duct systems with procedures equipment, materials and schedule prior to commencing work.
- .2 Submit a certification of completion stating that duct cleaning and disinfection has been completed as specified in this section.

1.4 DEFINITIONS

- .1 Air System: includes central equipment; heat pumps, return air boots, dampers, turning vanes, grilles, diffusers, low pressure ductwork that is associated with an air handling system.

1.5 PROTECTION

- .1 Protect furniture, equipment and flooring in close proximity to the work area with clean protective coverings.
- .2 Take precautions to ensure that dust and debris do not spread outside of duct system during the cleaning process.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 SCOPE OF WORK

- .1 Scope: This section defines the minimum requirements necessary to render HVAC components clean and to verify the cleanliness through inspection and/or testing in accordance with items specified herein.
- .2 The contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

3.2 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

- .1 Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.
- .2 Particulate Collection: Where the Particulate Collection Equipment is exhausting inside the building, HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or greater) particles shall be used. When the Particulate Collection Equipment is exhausting outside the building, Mechanical Cleaning operations shall be undertaken only with Particulate Collection Equipment in place, including adequate filtration to contain debris removed from the HVAC system. When the Particulate Collection Equipment is exhausting outside the building, precautions shall be taken to locate the equipment downwind and away from all air intakes and other points of entry into the building.
- .3 Controlling Odors: Measures shall be employed to control odors and/or mist vapors during the cleaning process.
- .4 Component Cleaning: Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards. Upon completion, all components must be returned to those settings recorded just prior to cleaning operations.
- .5 Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.
- .6 Service Openings: The contractor shall utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry, and inspection:
 - .1 Contractor shall utilize the existing service openings already installed in the HVAC system where possible.
 - .2 Other openings shall be created where needed and they must be created so they can be sealed in accordance with industry codes and standards.
 - .3 Closures must not significantly hinder, restrict, or alter the airflow within the system.
 - .4 Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.

- .5 Openings must not compromise the structural integrity of the system.
 - .6 Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, and applicable NFPA, SMACNA and NADCA Standards.
 - .7 Cutting service openings into flexible duct is not permitted. Flexible duct shall be disconnected at the ends as needed for proper cleaning and inspection.
 - .8 Rigid fiber glass duct systems shall be resealed in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiber glass duct system closures.
 - .9 All service openings capable of being re-opened for future inspection or remediation shall be clearly marked and shall have their location reported to the Owner in project report documents.
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- .7 Air distribution devices (registers, grilles & diffusers): The contractor shall clean all re-used air distribution devices.
 - .8 Duct Systems: The contractor shall:
 - .1 Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
 - .2 Mechanically clean all duct systems to remove all visible contaminants, such that the systems are capable of passing Cleaning Verification Tests.

3.3 MECHANICAL CLEANING METHODOLOGY

- .1 Source Removal Cleaning Methods: The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system:
 - .1 All methods used shall incorporate the use of vacuum collection devices that are operated continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned through a predetermined opening. The vacuum collection device must be of sufficient power to render all areas being cleaned under negative pressure, such that containment of debris and the protection of the indoor environment are assured.
 - .2 All vacuum devices exhausting air inside the building shall be equipped with HEPA filters (minimum efficiency), including hand-held vacuums and wet-vacuums.
 - .3 All vacuum devices exhausting air outside the facility shall be equipped with Particulate Collection including adequate filtration to contain debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any outdoor environmental standards, codes or regulations.

- .4 All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.
- .2 Methods of Cleaning Fibrous Glass Insulated Components:
 - .1 Fibrous glass thermal or acoustical insulation elements present in any equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure, and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.
 - .2 Cleaning methods used shall not cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests.
- .3 Damaged Fibrous Glass Material:
 - .1 Evidence of damage: If there is any evidence of damage, deterioration, delaminating, friable material, mold or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating, they shall be identified for replacement.
 - .2 Replacement: When requested or specified, Contractor must be capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement.
 - .3 Replacement material: In the event fiber glass materials must be replaced, all materials shall conform to applicable industry codes and standards, including those of ULC and SMACNA.
- .4 Antimicrobial Agents and Coatings:
 - .1 Antimicrobial agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.
 - .2 Application of any antimicrobial agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.
 - .3 When used, antimicrobial treatments and coatings shall be applied in strict accordance with the manufacturer's written recommendations.
 - .4 Antimicrobial coatings shall be applied according to the manufacturer's written instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than "fogged" downstream onto surfaces.

3.4 CLEANLINESS VERIFICATION

- .1 General: Verification of HVAC System cleanliness will be determined after mechanical cleaning and before the application of any treatment or introduction of any treatment related substance to the HVAC system including biocidal agents and coatings.
- .2 Visual Inspection: The HVAC system shall be inspected visually to ensure that no visible contaminants are present:

- .1 If no contaminants are evident through visual inspection, the HVAC system shall be considered clean; however, the Owner reserves the right to further verify system cleanliness through Surface Comparison Testing.
- .2 If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- .3 Verification of Coil Cleaning:
 - .1 Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed. If the original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a through visual inspection.

3.5 POST-PROJECT REPORT

- .1 At the conclusion of the project, the Contractor shall provide a report to the Project Manager indicating the following:
 - .1 Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
 - .2 Areas of the system found to be damaged and/or in need of repair.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Division 01 – General Requirements.
- .2 Shop drawings; submit drawings stamped and signed by a professional engineer registered or licensed in the Province of New Brunswick.
- .3 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .4 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
- .5 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and components.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.

- .3 Special performance data as specified.
- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 – Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed by Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 Site records:
 - .1 Consultant will provide 1 set of reproducible mechanical drawings. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information daily to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .9 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Consultant for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 QUALITY ASSURANCE

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

1.3 EQUIPMENT INSTALLATION

- .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.

1.4 CLEARANCES

- .1 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 or components.

1.5 MAINTENANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIRESTOPPING

- .1 All fire stopping work is to be performed by individual sub-trades as per Section 07 84 00 – Firestopping and Smoke Seals.
- .2 All Sub-Contractors shall coordinate all fire rated assembly penetrations with General Contractor.
- .3 Sub-Contractor shall provide required clearances between outside surface of pipe and inside surface of sleeve, core drilled hole or listed fire rated system.

1.8 TESTS

- .1 Give 48 hours written notice of date for all tests.
- .2 Insulate or conceal work only after testing and approval by Engineer and Commissioning Agent.
- .3 Conduct tests in presence of Engineer and Commissioning Agent and local authority having jurisdiction where applicable.
- .4 Bear costs including retesting and making good.
- .5 Equipment: test as specified in relevant sections and Commissioning Sections.
- .6 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

1.9 INTERPRETATION OF PLANS AND SPECIFICATIONS

- .1 These specifications are to be considered as an integral part of the plans which accompany them and neither the plans nor the specifications shall be used alone. Any item which is omitted in one but which is reasonably implied in the other shall be considered properly and sufficiently specified and must, therefore, be provided by this Contractor.
- .2 Misinterpretation of the plans or specifications shall not relieve this Contractor of responsibility; final interpretation of details and clauses remains with the Engineer.
- .3 Where uncertainty exists in the passing of pipes and location of equipment, the General Contractor and or project manager shall be consulted before work is started. Where such materials and equipment have been installed so as to cause interference with the inside treatment of the building, they shall be removed and relocated without additional cost to the Owner.
- .4 The plans do not necessarily show all valves, duct offsets, access panels, connections, balancing fittings, bases, isolators, flexible connections, drains, etc., and this Contractor shall not avail himself of these obvious omissions, but shall install the work complete in essential details so that it will function properly, can be easily balanced and so that repairs and removal of equipment can easily be made.
- .5 Building dimensions shall not be scaled from the Mechanical plans but shall be obtained from on-site dimensions of the building. Any discrepancy between the drawings and the building shall be questioned before proceeding with any installation.

1.10 CO-OPERATION OF CONTRACTORS

- .1 This Contractor shall become familiar with the work of other contractors and in laying out and installing the work shall co-operate with the other Contractors, so as to facilitate the progress of the work as a whole and avoid interference or delays. Where interference exists, this Contractor shall notify the General Contractor and/or project manager and the engineer before installing the work. Any changes in the work or alterations of the Mechanical Contractor's schedule of procedure required for such co-operation will not be considered as a claim for extra compensation.
- .2 Due to the complexities of many sub-trades, and the restrictive space available in this project, it is required that all trades co-operate closely so as to install all systems in their allotted locations as indicated on the drawings, or coordination on site.
- .3 The drawings are not intended to show all elbows, fittings and offsets required to perform the installation of the work where indicated on drawings. Contractor shall coordinate with all other trades and General Contractor on site. It is the responsibility of the Contractor to review site conditions prior to execution of work. Where services are shown to cross other building services, Contractor shall coordinate with other trades and determine best routing on-site prior to execution of work.
- .4 The Contractor shall review all Structural, Mechanical, Electrical and Architectural drawings to determine possible conflicts.

- .5 Contractor shall coordinate location of all hangers and seismic bracing systems as to avoid interference with other trades.
- .6 No extras will be allowed for lack of coordination or if additional fittings are required to perform the work as shown on the drawings.

1.11 ERRORS AND OMISSIONS

- .1 The drawings are not intended to show every item of accessory equipment, but the Contractor shall tender on and install all essential details to provide for efficiency of operation and ease of maintenance.
- .2 Should this Contractor discover errors or discrepancies in the plans or specification, he shall refer the matter to the Engineer for change or clarification and shall not proceed with that portion of the work until advised by the Engineer to do so.

Part 2 Products

2.1 MATERIALS

- .1 Choose products and materials with recycled content or resource efficient characteristics whenever possible. Use least toxic sealants, adhesives, sealers and finishes necessary to comply with the requirements of the project.

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

- .1 The Environmental Choice guideline CCD-047a, CCD-047b, CCD-047c, CCD-048 and the Master Painters Institute list of Green Approved Products provides acceptable standards for products that provide reduced environmental impacts.
- .2 Low VOC paints are preferable.
- .3 Prime and touch up marred finished paintwork to match original.
- .4 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

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

3.3 FIELD QUALITY CONTROL

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

- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

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

3.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Division 07 – Thermal and Moisture Protection.
- .3 Division 23 – Heating, Ventilation and Air Conditioning (HVAC).

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment or 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 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.4 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.

3.5 PIPEWORK INSTALLATION

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

- .5 Install globe valves in bypass around control valves.
- .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where otherwise specified.
- .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
- .8 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .15 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

3.6 SLEEVES

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

3.7 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.

- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.8 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 Un-insulated unheated pipes not subject to movement: No special preparation.
- .3 Un-insulated 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.

3.9 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 Division 01 – General Requirements.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.10 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Engineer 48 hours minimum prior to performance of pressure tests.
- .2 Piping: Test as specified in relevant sections of Divisions 22 & 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Division 22 & 23.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Engineer.
- .6 Pay costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Engineer.

3.11 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Engineer.
- .2 Request written approval 10 days minimum, prior to commencement of work.

- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.
 - .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - .1 ANSI/ASME B31.1-04, Power Piping.
- .2 American Society for Testing and Materials International (ASTM):
 - .1 ASTM A125-1996 (R2001), Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM).
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC).

1.3 SYSTEM DESCRIPTION

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

- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Division 01 – General Requirements.
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 GENERAL

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

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed in accordance with MSS SP69.
- .3 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
 - .3 Sway braces for seismic restraint systems.
 - .4 Pipe Racks
- .4 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22mm or 28 mm rod.
- .5 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .6 Adjustable clevis: material in accordance with MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis:
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .7 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .8 U-bolts: carbon steel in accordance with MSS SP69 with 2 nuts at each end to ASTM A563:
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated.
- .9 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 RISER CLAMPS

- .1 Steel or cast iron pipe: black carbon steel in accordance with MSS SP58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated in accordance with MSS SP58, type 42.
- .3 Bolts: in accordance with ASTM A307.
- .4 Nuts: in accordance with ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

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

2.5 EQUIPMENT SUPPORTS

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

2.6 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

- .2 Bolt-tightening torques to industry standards.
- .3 Steel pipes: install below coupling or shear lugs welded to pipe.
- .4 Cast iron pipes: install below joint.

- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.

- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .5 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 m	

- .6 Pipework greater than NPS 12: in accordance with MSS SP69.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

3.7 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports in accordance with Section 01 33 00 – Submittal Procedures.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Verification requirements shall 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 Certified wood.
 - .8 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Vibration isolation materials and components, seismic control measures and their installation.
 - .2 This section only applies to new work being done.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA):
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada (NBC) – 2005.

1.3 SUBMITTALS

- .1 Submittals: in accordance with Division 01 – General Requirements:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. 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 Division 01 – General Requirements.
 - .2 Indicate VOC's for all adhesives and solvents during application and curing.
- .2 Submit shop drawings in accordance with Division 01 – General Requirements:
 - .1 Shop drawings for seismic restraints: submit drawings stamped and signed by Professional Engineer registered or licensed in Province of New Brunswick, Canada.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Provide detailed drawings of seismic control measures for equipment and piping.
 - .4 Show isolation and restraints for each piece of equipment.
 - .5 Submit product data sheets for isolation components.
 - .6 Show fabrication details, location and size of anchor bolts and requirements for inertia / steel bases.
 - .7 Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
 - .8 Provide all details of suspension and support for ceiling hung equipment.

- .9 Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
- .10 Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
- .3 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.
- .4 Seismic Certification and Analysis:
 - .1 Seismic restraint calculations must be provided for all connections of equipment to the structure.
 - .2 All restraining devices shall have a pre-approval number from a recognized government agency showing maximum restraint ratings. Where pre-approved devices are not available, submittals shall be based on independent testing. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the Province of New Brunswick. Testing and calculations must include shear and tensile loads as well as one test or analysis at 45E to the weakest mode.
 - .3 Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.10 – Seismic Force Levels acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General 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 Division 01 – General Requirements.

1.6 INTENT

- .1 All mechanical equipment, piping and ductwork as indicated on the drawings or as noted in the specifications shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- .2 All vibration isolators and seismic restraints described in this section or supplied by a single trade shall be the product of a single manufacturer and shall be certified by the manufacturer.
- .3 It is the intent of the seismic portion of this specification to keep all mechanical building system components in place during a seismic event.
- .4 All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturer's or construction standards, the most stringent shall apply.
- .5 Isolators, seismic restraint devices, and minimum static deflections are shown in equipment schedules and equipment selection sheets.
- .6 Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
- .7 Seismic restraints shall be designed in accordance with seismic force levels as detailed in section.
- .8 The work in this section includes, but is not limited to the following:
 - .1 Vibration isolation for piping, ductwork and equipment.
 - .2 Equipment isolation bases.
 - .3 Flexible piping connections.
 - .4 Seismic restraints for isolated equipment.
 - .5 Seismic restraints for non-isolated equipment.
 - .6 Certification of seismic restraint designs and installation supervision.
 - .7 Certification of seismic attachment of housekeeping pads.
 - .8 All mechanical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical.

1.7 DEFINITIONS

- .1 Life Safety Systems:
 - .1 All systems involved with fire protection including sprinkler piping, service water supply piping and fire dampers.
- .2 Positive Attachment:
 - .1 A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, or any other equipment are not acceptable on this project as seismic anchor points.
- .3 Transverse Bracing:
 - .1 Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
- .4 Longitudinal Bracing:
 - .1 Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.8 MANUFACTURER'S RESPONSIBILITY

- .1 Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
 - .1 Determine vibration isolation and seismic restraint sizes and locations.
 - .2 Provide vibration isolation and seismic restraints as scheduled or specified.
 - .3 Provide calculations and materials if required for restraint of un-isolated equipment.
 - .4 Provide installation instructions, drawings and trained field supervision to ensure proper installation and performance.

1.9 RELATED WORK

- .1 Supplementary Support Steel:
 - .1 Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. as required.
- .2 Attachments:
 - .1 Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.10 SEISMIC FORCE LEVELS

- .1 Design of seismic restraints shall be In accordance with section 4.1.8 of the 2005 National Building Code of Canada.

- .2 All seismic restraint must meet the force levels outlined in the following equation: $V_p = 0.3 F_a S_a (0.2) I_e S_p W_p$.
- .3 Seismic restraint design must be reviewed and stamped by a licensed professional engineer with a minimum of 5 years' experience in the field of seismic restraint design.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01 – General Requirements.

2.2 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.
- .2 For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" (3mm) and/or horizontal permanent deformation greater than 1/4" (6mm).

2.3 ACCEPTABLE MANUFACTURERS

- .1 Acceptable Manufacturers: Mason Industry's, Vibron provided technical specifications are satisfied.

2.4 NEOPRENE PAD ISOLATORS

- .1 Two layers of 19mm thick neoprene pad consisting of 50mm square waffle modules separated horizontally by a 1.5mm gauge galvanized shim. Load distribution plates shall be used as required.

2.5 NEOPRENE MOUNT

- .1 Bridge-bearing neoprene mountings shall have a minimum static deflection of 5mm and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Pre-approval Number from a recognized government agency verifying the maximum certified horizontal and vertical load ratings.

2.6 SHEET METAL SUPPORT ATTACHMENT ISOLATORS

- .1 Neoprene bushing cushioned between 2 steel sleeves. Steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. All neoprene shall be bridge bearing quality.

2.7 OPEN SPRING ISOLATORS

- .1 Spring isolators shall be free standing and laterally stable without any housing and complete with a moulded neoprene cup or 6mm neoprene acoustical friction pad between the base plate and the support. All mountings shall have levelling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

2.8 RESTRAINED SPRING ISOLATORS

- .1 Restrained spring mountings shall have a mounting as described in Paragraph 2.7, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. A minimum clearance of 12mm shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Pre-approval Number from a recognized government agency certifying the maximum certified horizontal and vertical load ratings.

2.9 HOUSED SPRING ISOLATORS

- .1 Spring mountings as described in Paragraph 2.7 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 6mm travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Pre-approval number from a recognized government agency verifying the maximum certified horizontal and vertical load ratings.

2.10 SPRING AND NEOPRENE HANGERS

- .1 Hangers shall consist of rigid steel frames containing minimum 32mm thick neoprene elements at the top and a steel spring with general characteristics as described in Paragraph 2.7 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring.

2.11 SEISMIC CABLE RESTRAINTS

- .1 Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cable assemblies shall have an Anchorage Pre-approval Number from a recognized government agency verifying the maximum certified load ratings.

2.12 SEISMIC SOLID BRACES

- .1 Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval number from a recognized government agency verifying the maximum certified load ratings.

2.13 HANGER SEISMIC RESTRAIN CLAMPS

- .1 Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Pre-approval Number from a recognized government agency.

2.14 CLEVIS SEISMIC BRACES

- .1 Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Pre-approval from a recognized government agency.

2.15 SEISMIC SNUBBERS

- .1 All-directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber or neoprene material compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 6mm or 19mm thick. A minimum air gap of 3mm shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubbers shall have an Anchorage Pre-approval Number from a recognized government agency verifying the maximum certified horizontal and vertical load ratings.

2.16 STRUCTURAL STEEL BASE

- .1 Provide integral structural steel bases to maintain alignment of component parts (motors, drives, equipment, and isolators) and to support equipment, vibration isolation and seismic restraint devices. Pump bases for split case pump shall include supports for suction and discharge elbows.
- .2 All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 350mm provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 25mm.

2.17 METAL FLEXIBLE HOSES

- .1 Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 75mm and larger shall be flanged. Smaller sizes shall have male nipples. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.

2.18 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.19 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.20 SEISMIC CONTROL MEASURES

- .1 General:
 - .1 Following systems and/or equipment to remain operational during and after earthquakes:
 - .1 As per local authority having jurisdiction.
 - .2 NBC 2005 Edition.
 - .2 Seismic control systems to work in every direction.
 - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .4 Drilled or power driven anchors and fasteners not permitted.
 - .5 No equipment, equipment supports or mounts to fail before failure of structure.
 - .6 Supports of cast iron or threaded pipe not permitted.
 - .7 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Suspended equipment:
 - .1 Use one or more of following methods depending upon site conditions:
 - .1 Install tight to structure.
 - .2 Cross brace in every direction.
 - .3 Brace back to structure.
 - .4 Cable restraint system.
 - .3 Seismic restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
 - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
 - .3 As indicated.

- .4 Piping systems:
 - .1 Fire protection systems: to NFPA 13.
 - .2 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .3 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
 - .1 Approved by local authority having jurisdiction.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

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 All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
- .2 Seismic control measures to meet requirements of NBC 2005 Edition and Local Authority having jurisdiction.
- .3 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .4 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.
- .7 At locations where seismic restraints are located, the support rods must be braced when necessary to accept compressive loads with Hanger Seismic Restrain Clamps.
- .8 At all locations where seismic restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with Clevis Seismic Braces.
- .9 Vibration Isolation Manufacturer shall furnish integral structural steel bases or reinforced concrete inertia bases as required. Independent steel rails are not permitted on this project.

- .10 Use In-Line Pump Securement Brackets for in-line pump installation.
- .11 Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight by Horizontal thrust restraints.
- .12 Locate isolation hangers as near to the overhead support structure as possible.

3.3 VIBRATION ISOLATION OF PIPING

- .1 Horizontal pipe isolation:
 - .1 The first three pipe hangers in the main lines near the mechanical equipment shall be Pre-compressed Spring and Neoprene Hangers. This type of pre-compressed spring hangers must also be used in all transverse braced isolated locations. Brace hanger rods with seismic restraint clamps. Horizontal runs in all other locations throughout the building shall be isolated by Spring and Neoprene Hangers. Floor supported piping shall rest on Restrained Spring Isolators.
 - .2 The first pipe support isolators from the isolated equipment will have the static deflection twice the deflection as specified for the mountings under the connected equipment and 25mm deflection for pipe support isolators thereafter. Provide spring isolators for pipe support at first three supports for piping up to NPS 4; first four supports.
 - .3 Where piping connects to mechanical equipment install Metal Flexible Hoses. Isolate, with acoustic barrier material, at anchors and guides within pipe shafts, duct shafts, equipment and fan rooms, and up to first anchor outside these rooms or areas.
- .2 Riser isolation:
 - .1 Risers shall be suspended from Spring and Neoprene Hangers or supported by Open Spring Isolators, anchored with Acoustical Pipe Anchors, and guided with Acoustical Pipe Guides. Steel springs shall be a minimum of 19mm except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load.

3.4 SEISMIC RESTRAINT OF PIPING

- .1 Seismically restrain all piping listed below. Use Seismic Cables if isolated. Cables or Braces Restraints may be used on un-isolated piping.
 - .1 Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 25mm I.D. or larger.
 - .2 Piping located in mechanical equipment rooms that is 32mm I.D. and larger.
 - .3 All other piping 64mm diameter and larger.
- .2 Transverse piping restraints shall be at 12m maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
- .3 Longitudinal restraints shall be at 24m maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.

- .4 Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
- .5 For fuel oil and all gas piping transverse restraints must be at 6m maximum and longitudinal restraints at 12m maximum spacing.
- .6 Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 600mm of the elbow or TEE or combined stresses are within allowable limits at longer distances.
- .7 Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
- .8 Branch lines may not be used to restrain main lines.
- .9 Fuel oil and gas piping on roof area have to be solidly attached to roof structure.
- .10 Cast iron pipe of all types and any other pipes joined with a four band shield and clamp assembly shall be installed with shield reinforcement and at ½ distance of other piping.

3.5 VIBRATION ISOLATION OF DUCTWORK

- .1 All discharge runs for a distance of 15m from the connected equipment shall be isolated from the building structure by means of Spring and Neoprene Hangers or Open Spring Isolators. Spring deflection shall be a minimum of 19mm.
- .2 All duct runs having air velocity of 5 m/s or more shall be isolated from the building structure by specification Pre-compressed Spring and Neoprene Hangers or Open Spring Isolators. Spring deflection shall be a minimum of 19mm.

3.6 SEISMIC RESTRAINT OF DUCT WORK

- .1 Seismically restrain all duct work with Cable or Brace restraints as listed below:
 - .1 Restrain rectangular ducts with cross sectional area of 0.5 m² or larger.
 - .2 Restrain round ducts with diameters of 700mm or larger.
 - .3 Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
- .2 Transverse restraints shall occur at 9m intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
- .3 Longitudinal restraints shall occur at 18m intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 1.2m of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.

- .4 The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
- .5 A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
- .6 Walls, including gypsum board non-bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

3.7 LIFE SAFETY SYSTEMS

- .1 All fire protection piping shall be braced in accordance with NFPA 13 and 14.
- .2 All mechanical equipment shall be vibration isolated and seismically restrained.
- .3 All fire protection equipment is considered life safety equipment and shall be seismically restrained using the seismic force levels for life safety equipment in table if higher levels are shown.

3.8 SEISMIC RESTRAINT EXCLUSIONS

- .1 Piping:
 - .1 Gas piping less than 25mm inside diameter.
 - .2 Piping in boiler and mechanical rooms less than 32mm inside diameter.
 - .3 All other piping less than 64mm inside diameter.
 - .4 All piping suspended by individual hangers 300mm or less as measured from the top of the pipe to the bottom of the support where the hanger is attached. However, if the 300mm limit is exceeded by any hanger in the run, seismic bracing is required for the run. The 300mm exemption applies for trapeze supported systems if the top of each item supported by the trapeze qualifies.
- .2 Duct work:
 - .1 Rectangular and square and ducts that are less than 0.5m² in cross sectional area.
 - .2 Oval ducts that are less than 0.5m² in cross sectional area based on nominal size.
 - .3 Round duct less than 700mm in diameter.
 - .4 All duct suspended by hangers 300mm or less in length as measured from the top of the duct to the point of attachment to the structure. Hangers must be attached within 50mm of the top of the duct with a minimum of two #10 sheet metal screws. If the 300mm limit is exceeded by any hanger in the run, seismic bracing is required for the run.
- .3 Suspended equipment:
 - .1 VAV boxes and fan powered equipment weighing less than 23kg and rigidly connected to the supply side of the duct system and supported with a minimum of 4 hanger rods.

3.9 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After preparatory work is complete but before installation commences.
 - .2 Twice during the installation, at 25% and 60% completion stages.
 - .3 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental Representative and Engineer within 3 days of manufacturer representative's review.
 - .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing company to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Take vibration measurements for equipment as per Manufacturer's recommendations.
 - .3 Provide Departmental Representative and Engineer with notice 24 h in advance of commencement of tests.
 - .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
 - .5 Submit complete report of test results.
- .3 Verification requirements in accordance with Division 01 – General Requirements.

3.10 CLEANING

- .1 Proceed in accordance with Division 01 – General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections: Division 01 – General Requirements.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .2 National Fire Protection Association (NFPA):
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Division 01 – General Requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General 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.
 - .2 Do not dispose of unused paint or coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers 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 or existing installations).
- .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.

2.3 EXISTING IDENTIFICATION SYSTEMS

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

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Sprinklers: to NFPA 13.
 - .2 Natural Gas Piping: To CSA B.149.1-05.

2.5 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Legend: block capitals to following table:

Outside Dia. of Pipe or Insulation <u>mm</u>	Size of Letters <u>mm</u>
30	13
50	19
150	32
250	63
Over 250	88
- .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.
 - .4 Primary colour bands:
 - .1 At valves and fittings: 500 mm long.
 - .2 Elsewhere: 1000 mm long.
 - .5 Secondary colour bands: 50 mm wide, 75 mm in from one end of primary colour band.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.

- .6 Materials for background colour marking, legend, arrows:
- .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive plastic-coated cloth with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C. Apply to prepared surfaces, wrap tape around pipe or pipe covering with ends overlapping one (1) pipe diameter.
 - .3 Acceptable Material: W.H. Brady Inc.; Seton Nameplate Corp.

.7 Colours and Legends:

- .1 Where not covered by table below submit legend, primary and secondary classification colours to Engineer for approval.
- .2 Colours for legends, arrows: to following table:

.1 Pipe and valve identification.				
Type of Piping	Pipe Label	Background	Secondary	
<u>Legend</u>	<u>Legend</u>	<u>Colour</u>	<u>Colour</u>	
Domestic Cold Water Supply	DOM. CWS	Green		
Domestic Hot Water Supply	DOM HW SUPPLY	Green		
Sanitary	SAN	Green		
Plumbing Vent.	SAN VENT	Green		

2.6 LANGUAGE

- .1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 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.

3.3 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.

3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 Stencil over final finish only.
- .2 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.
- .3 Adjacent to each change in direction.
- .4 At least once in each small room through which piping or ductwork passes.
- .5 On both sides of visual obstruction or where run is difficult to follow.
- .6 On both sides of separations such as walls, floors, partitions.
- .7 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .8 At beginning and end points of each run and at each piece of equipment in run.
- .9 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .10 Identification easily and accurately readable from usual operating areas and from access points:
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 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 Number valves in each system consecutively.

3.6 CLEANING

- .1 Proceed in accordance with Division 01 – General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

- .1 Division 01 – General Requirements.

1.3 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to Engineer within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems - 1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing - 2002
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract:
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 PURPOSE OF TAB

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

1.5 EXCEPTIONS

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

1.6 CO-ORDINATION

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

1.7 PRE-TAB REVIEW

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

1.8 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.9 OPERATION OF SYSTEMS DURING TAB

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

1.10 START OF TAB

- .1 Notify Commissioning Agent and Engineer 7 days prior to start of TAB.
- .2 Start TAB when building is substantially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weather stripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23.
 - .4 Provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.11 APPLICATION TOLERANCES

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

1.12 ACCURACY TOLERANCES

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

1.13 INSTRUMENTS

- .1 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .2 Calibrate within 28 days of TAB. Provide certificate of calibration to Commissioning Agent and Engineer.

1.14 SUBMITTALS

- .1 Submit, prior to commencement of TAB:
 - .1 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.15 PRELIMINARY TAB REPORT

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

1.16 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit four (4) bound copies of TAB Report to Departmental Representative and Engineer for verification and approval, in English.

1.17 VERIFICATION

- .1 Reported results subject to verification by Engineer.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by Engineer.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative and Engineer.

1.18 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative and Engineer, 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. Do not eradicate or cover markings.

1.19 COMPLETION OF TAB

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

1.20 AIR SYSTEMS

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA and ASHRAE.
- .2 Do TAB of following systems, equipment, components and controls:
 - .1 New Heat Pump Units: HP-X1 and HP-X2.
 - .2 All new and existing diffusers, as noted.
 - .3 All outside air ducts, as noted.
 - .4 New VAV boxes.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.21 LIQUID SYSTEMS

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, and ASHRAE.
- .2 Do TAB of the following systems, equipment and controls:
 - .1 New Heat Pump Units: HP-X1 and HP-X2.

1.22 OTHER TAB REQUIREMENTS

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

1.23 POST-OCCUPANCY TAB

- .1 As per Commissioning Plan; refer to Division 01 – General Requirements.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .3 Section 23 31 13 - Metal Ducts - Low Pressure to 500 Pa.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ANSI/ASHRAE/IESNA 90.1-01, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM B209M-02, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
 - .5 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .6 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-M88 (R2000), Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-01, Thermal Insulation Polyotrene, Boards and Pipe Covering.

1.3 DEFINITIONS

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

- .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Division 01 – General Requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.5 MANUFACTURERS' INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with Division 01 – General Requirements.
- .2 Installation instructions to include procedures used, and installation standards achieved.

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE AND HANDLING

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

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

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

2.3 JACKETS

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: Compatible with insulation.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.
- .7 Contact adhesive: quick-setting.
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .11 Fasteners: 4 mm diameter pins with 35 mm diameter clips, length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

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

3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with Manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes:
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers in accordance with Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment:
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.3 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Cold air ducts exposed or concealed	C-1	yes	25
Heat pump supply ducts	C-1	yes	25

3.4 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01 – General Requirements.

3.5 CLEANING

- .1 Proceed in accordance with Division 01 – General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section includes:
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems.
 - .2 Sustainable requirements for construction and verification.
- .2 Related Sections:
 - .1 Division 01 – General Requirements.
 - .2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - .3 Section 23 05 05 - Installation of Pipework.
 - .4 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87 (R1999), Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84 (1999) e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA):
 - .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International):
 - .1 CSA B242-M1980 (R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS):
 - .1 MSS-SP-67-025, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submit shop drawings in accordance with Division 01 – General Requirements.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements and include following:
 - .2 Contractor to submit grooved product submittals. Grooved product to be of one manufacture, and must have current CRN #'s
 - .3 Grooved product Manufacture to supply on site tool and products installation training.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Construction occupational health and safety in accordance with Division 01 – General Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.
 - .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 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.6 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.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: in accordance with ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS8: Schedule 40, unless otherwise noted.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 Roll grooved: standard rigid coupling to CSA B242.
(Proprietary grooved joint systems acceptable provided specifications are met, Engineer Approved):
 - .1 Roll grooved: standard coupling to CSA B242. Victaulic # 107 Quick Vic couplings 2" to 6" / Victaulic # 07 Couplings 2" and above.
 - .2 Flexible Victaulic Couplings to CSA B242 to be used where noted on drawings prepared as part of Existing Design titled "Victaulic # 77 Flexible Couplings".
- .3 Flanges: raised face, weld neck in accordance with AWWA C111.
- .4 Orifice flanges: slip-on raised face, 2100 kPa.
- .5 Flange gaskets: in accordance with AWWA C111.
- .6 Pipe thread: taper.
- .7 Bolts and nuts: in accordance with ASME B18.2.1 and ASME B18.2.2.
- .8 Roll grooved coupling gaskets: type EPDM. (-30°C To + 110°C for continuous operation). Acceptable on hot water in all areas.

2.3 FITTINGS

- .1 Screwed fittings: malleable iron, in accordance with ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: in accordance with ASME B16.1, Class 125.
 - .2 Steel: in accordance with ASME B16.5.
- .3 Butt-welding fittings: steel, in accordance with ASME B16.9.
- .4 Unions: malleable iron, in accordance with ASTM A47/A47M and ASME B16.3.
- .5 Fittings for roll grooved piping: malleable iron in accordance with ASTM A47/A47M. Victaulic Grooved Fittings

2.4 VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
- .2 Balancing, for TAB:
 - .1 Sizes: Calibrated balancing valves, as specified this section.
 - .2 NPS2 and under:
 - .1 Valves are to be of the 'Y' pattern, equal percentage globe-style and provide: Precise flow measurement, Precision flow balancing, Positive drip-tight shut-off.
 - .2 Valve shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel.
 - .3 Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable.
 - .4 Valve handle shall have hidden memory feature, which will provide a means for locking the valve position after the system is balanced.
 - .5 Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve.
 - .6 Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar.
 - .7 The valve body, stem and plug shall be brass.
 - .8 The handwheel shall be high-strength resin.
 - .9 Acceptable Material: Armstrong CBV, Tour & Andersson, Bell & Gossett, or approved equal.
- .3 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze in accordance with ASTM B62.
 - .2 Pressure rating: Class125.
 - .3 Connections: Screwed ends in accordance with 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 stainless steel solid ball and teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.
 - .9 All valves to have CRN registration numbers.

Part 3 Execution

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.

3.2 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.3 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.4 TESTING

- .1 Test system in accordance with Section 20 00 01 - Common Work Results -Mechanical.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
- .2 Related Sections:
 - .1 Division 01- General Requirements.
 - .2 Section 07 84 00 - Firestopping.
 - .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .4 Section 23 05 94 - Pressure Testing of Ducted Air Systems.
 - .5 Section 23 07 13 – Duct Insulation.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM):
 - .1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA):
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

- .7 Transport Canada (TC):
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Division 01 – General Requirements.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Division 01 – General Requirements for the following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.
- .3 Co-ordinate submittal requirements and provide submittals required in accordance with Division 01 – General Requirements.
- .4 Submit Indoor Air Quality (IAQ) Management Plan in accordance with Division 01 – General Requirements.
- .5 Indicate VOC's for adhesives and solvents during application and curing.

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01 – General Requirements.
- .3 Indoor Air Quality (IAQ) Management Plan:
 - .1 Develop and implement an Indoor Air Quality (IAQ) Management Plan in accordance with Division 01 – General Requirements for construction and preoccupancy phases of building.
 - .2 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .4 Sustainable Requirements:
 - .1 Construction requirements: in accordance with Division 01 – General Requirements.
 - .2 Verification: contractor's verification in accordance with Division 01 – General Requirements.

1.5 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 Division 20 – Common Work Results for Mechanical and Manufacturer’s Written Instructions.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and resources in accordance with Division 01 – General Requirements

2.2 SEAL CLASSIFICATION

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
- .2 Seal classification:
 - .1 Class C: transverse joints and connections made air tight with gaskets, sealant or combination thereof. Longitudinal seams unsealed.

2.3 SEALANT

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30°C to plus 93°C.
- .2 Indicate VOC’s during application and curing.

2.4 TAPE

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

2.5 DUCT LEAKAGE

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

2.6 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: standard radius.
 - .2 Round: five piece.

- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with double thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radiused elbows or as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area:
 - .1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 – Firestopping, Fire Damper Manufacturer’s written instructions and local authority having jurisdiction.
- .2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.
- .3 Joints: to ASHRAE and SMACNA.

2.9 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment and Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment.
 - .1 Hanger configuration: to ASHRAE and SMACNA.
 - .2 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .3 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp.
 - .3 For steel beams: manufactured beam clamps.

Part 3 Execution

3.1 GENERAL

- .1 Do not break continuity of insulation vapour barrier with hangers or rods:
 - .1 Insulate strap hangers 100 mm beyond insulated duct and Ensure diffuser is fully seated.
- .2 Support risers in accordance with ASHRAE and SMACNA.
- .3 Install breakaway joints in ductwork on sides of fire separation.
- .4 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .5 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining (clear inside dimensions shown on drawings).

3.2 HANGERS

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

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

3.3 SEALING AND TAPING

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

3.4 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests as instructed to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degree elbows.
- .7 Complete test before performance insulation or concealment Work.

3.5 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01 – General Requirements.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes, collars, balance dampers, motorized dampers, silencers and flexible ductwork.
- .2 Related Sections:
 - .1 Division 01 - General Requirements.
 - .2 Division 20 - Common Work Results for Mechanical.
 - .3 Division 25 - EMCS Controls.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .4 National Fire Protection Association (NFPA):
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .5 Underwriters' Laboratories Inc. (UL):
 - .1 UL 181-96, Standard for Factory-Made Air Ducts and Air Connectors.
- .6 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.

1.3 SUBMITTALS

- .1 Submittals in accordance with Division 01-General Requirements.
- .2 Product Data:
 - .1 Submit manufacturer's printed shop drawings, product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

- .5 Balance Dampers.
- .6 Motorized Dampers.
- .7 Flexible Ductwork.
- .8 Acoustically insulated plenums.
- .2 Indicate following; where applicable:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
 - .6 Sound Attenuation Data.
 - .7 Dimensional and Weight Data.
- .3 Submit WHMIS MSDS in accordance with Division 01-General Requirements. Indicate VOC's for adhesive and solvents during application and curing.
- .4 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .5 Closeout submittals: submit maintenance and engineering data for incorporation into manual in accordance with Division 01- General Requirements.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Division 01- General Requirements.
- .2 Construction requirements: in accordance Division 01- General Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 20- Common Work Results Mechanical.
 - .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 Division 01- General Requirements.

Part 2

Products

2.1 MATERIALS

- .1 Materials and resources in accordance with Division 01 - General Requirements.

2.2 GENERAL

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

2.3 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame match duct thickness with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C, density of 1.3 kg/m².
- .3 Acceptable Manufacturer: Duro-Dyne or approved equal provided technical specifications are satisfied.

2.4 ACCESS DOORS IN DUCTS

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

2.5 TURNING VANES

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

2.6 INSTRUMENT TEST PORTS

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

2.7 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to co-responding round duct standards.

2.8 BALANCE DAMPERS

.1 Single Blade Dampers:

.1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 250mm.

.3 Locking quadrant.

.4 Inside and outside end bearings.

.5 Acceptable Material: Duro-Dyne or approved equal provided technical specifications are satisfied.

.2 Multi-Bladed Dampers:

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration to recommendations of SMACNA.

.3 Maximum blade height: 100mm.

.4 Bearings: pin in bronze bushings.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

2.9 FLEXIBLE DUCT

.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 Metallic Acoustic Insulated – Medium Pressure:

.1 Spiral wound, flexible perforated aluminum with factory applied 37 mm 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 Acoustical performance: Minimum attenuation (dB/m) to following table:

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

2.10 ACOUSTICALLY INSULATED PLENUM

- .1 Acoustic lining in ductwork plenums for new heat pumps shall be 25 mm thick flexible, (3.0 lb/cu. ft.) fibreglass duct liner with 5.0 mil Tedlar vapour barrier.
- .2 Adjust outer duct dimensions to compensate for thickness as dimensions indicated on the drawings prepared as part of the Existing Design are inside dimensions.
- .3 Build all plenums indicated in accordance with this Section.
- .4 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50.
- .5 Adhesive:
 - .1 To NFPA 90A and NFPA 90B.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29°C to plus 93°C.
 - .3 Water-based fire retardant type.
- .6 Fasteners:
 - .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.
- .7 Joint Tape:
 - .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.

- .3 Minimum distance between metal parts when system in operation: 75 mm.
- .4 Install in accordance with recommendations of SMACNA.
- .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 As required.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Engineer.
 - .3 Downstream of junctions of two converging air streams of different temperatures.
 - .4 And as indicated.
- .4 Turning vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.
- .5 Balance Dampers:
 - .1 Install where indicated.
 - .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .6 Flexible Ductwork:
 - .1 Install in accordance with: CAN/ULC-S110, UL-181, NFPA 90A, NFPA 90B, SMACNA.
 - .2 Maximum allowable length 1,500mm.

3.3 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01- General Requirements.

3.4 CLEANING

- .1 Perform cleaning operations in accordance with manufacturer's recommendations.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA):
 - .1 ANSI/NFPA 90A-2002, 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 Underwriters Laboratories of Canada (ULC):
 - .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
 - .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed Shop Drawings, Product Literature, Specifications and Datasheet in accordance with Division 01 - General Requirements. Include product characteristics, performance criteria, and limitations.
 - .1 Submit required copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01- General Requirements. Indicate VOC's for adhesives and solvents during application and curing.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Division 01- General Requirements:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual in accordance with Division 01- General Requirements.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Division 01- General Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Division 01- General Requirements.
 - .2 Provide following:
 - .1 6 fusible links of each type.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01- General 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 Division 01- General Requirements.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Division 01- General Requirements and Division 20 - Common Work Results for Mechanical.

2.2 FIRE DAMPERS

- .1 Fire dampers: listed and bear label of ULC meet requirements of provincial fire authority Fire Commissioner of Canada (FCC) ANSI/NFPA 90A and authorities having jurisdiction. Fire damper assemblies' fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation:
 - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.

- .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: offset single damper, round or square; sized to maintain full duct cross section as indicated.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.
- .11 Acceptable manufacturer: Controlled Air, Nailor, E.H. Price, Air Management Inc.

2.3 SMOKE DAMPERS

- .1 Smoke dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of NFPA 92, 101 and further shall be tested, rated and labelled in accordance with the latest edition of UL Standard 555S. Smoke dampers shall be of low leakage design qualified to UL555S Leakage Class I.
- .2 Each damper/actuator combination shall have a UL555S elevated temperature rating of 121°C minimum and shall be rated to operate at maximum design air flow at its installed location. Each damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 24 volt operation. Actuator must be modulating.

- .3 Damper blades shall be of the double skin air foil type and shall have an equivalent metal thickness of 1.99mm. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Blade edge seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seal shall be stainless steel compression type. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper.
- .4 Damper must be rated for mounting horizontally with blades running horizontal and be UL555S rated for leakage and airflow in either direction through the damper.
- .5 Blade Indication: Provide OCI option, fully wired, for open and closed indication of blade position. Provide terminals for BAS monitoring.
- .6 Smoke Detector: Acceptable Material – Innovair D4120: 4-wire; velocity 0.5 – 20.3 m/s; 120V.
- .7 Damper with actuator and detector must be a listed assembly.
- .8 Acceptable Materials: Damper: Greenheck SMD-301M.
- .9 Refer to schedule on drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Division 01- General Requirements:

3.4 CLEANING

- .1 Proceed in accordance with Division 01- General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Electronic variable air volume boxes.
 - .2 Heat pump terminal units.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI):
 - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .2 ANSI/NFPA 90A-2002, 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 3741-2001, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .4 Underwriter's Laboratories (UL):
 - .1 UL 181-2003, Factory-Made Air Ducts and Air Connectors.

1.3 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

1.4 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Division 01 – General Requirements. Include product characteristics, performance criteria, and limitations.
 - .2 Test data: in accordance with 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 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Division 01 – General Requirements.
 - .2 Indicate the following:
 - .1 Capacity.
 - .2 Pressure drop.
 - .3 Noise rating.
 - .4 Leakage.
 - .5 Reheat Coils.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Division 01 – General Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Division 01 – General Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Division 01 – General Requirements.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Division 01 – General Requirements.
 - .2 Provide one set of replacement filters for each type/size of new heat pumps being installed under this contract.

Part 2 Products

2.1 MANUFACTURED UNITS

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

2.2 VARIABLE VOLUME BOXES

- .1 Pressure independent factory reset to air flow between minimum and maximum air volume.
- .2 Sizes, capacities: as indicated on the drawings prepared as part of Existing Design.
- .3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.

- .4 Complete with:
 - .1 Electronic controller to operate damper operator between maximum or minimum air volume settings.
- .5 Minimum 35 kPa reset span.
- .6 Adjustable reset start point.
- .7 Casing: constructed of thick galvanized steel, internally lined with 25mm, to UL181 and ANSI/NFPA 90A.
- .8 Damper: double thickness galvanized steel with peripheral gasket and self lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .9 Acceptable Material: E.H. Price RDS-5000 or approved equal.

2.3 HEAT PUMP TERMINAL UNITS

- .1 Units shall be supplied completely factory assembled, piped, internally wired, fully charged with (sizes 007-012), HFC 410A (sizes 019-060) and capable of operation with an entering water temperature range from 55 ° to 110 ° on models CCH/FCV. All equipment must be rated and certified in accordance with ARI /ISO 13256-1,UL, ULC and have correct ARI /ISO and ULC labels mounted on side of the cabinets. Each unit shall be fully run tested at the factory. All equipment shall be Trane Model GEH and McQuay Model CCH.
- .2 Casing and Cabinet:
 - .1 The cabinet shall be fabricated from heavy gauge G-60 galvanized sheet metal with interior surfaces lined with 1/2 inch thick, 1-1/2 lb. coated glass fibre insulation. The insulation shall have a flame spread of less than 25 and a smoke developed classification of less than 50 per ASTM E-84 and UL 723.
 - .2 All fiberglass shall be coated and have exposed edges tucked under flanges to prevent the introduction of glass fibers into the air stream. All insulation must meet NFPA 90A.
 - .3 **Horizontal Units** shall be configured in one of the following airflow arrangements:
 - .1 Left Return/End Discharge.
 - .2 Left Return/Straight Discharge.
 - .3 Right Return/End Discharge.
 - .4 Right Return/Straight Discharge.
 - .4 Contractor shall verify proper configuration for all units on shop drawings.
 - .5 Horizontal units must be capable of being field converted from side to end discharge (or the reverse) without unit modifications or additional parts. All units shall have a factory-installed 1" duct flange on the discharge of the blower and must have a minimum of two access panels to provide access to the compressor compartment and /one access to the blower compartment.

- .6 Unit shall have an insulated panel separating the blower compartment from the compressor compartment. Units are to ship with heavy metal brackets, rubber isolators, fasteners and washers to suspend and isolate the unit from the building. Hanging brackets shall be fastened in the field. Cabinets shall have separate openings and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be brass FPT fittings and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Unit shall have a plastic “dual-sloped” drain pan with a drain connection being flush mounted to the unit casing. There shall be sufficient clearance so that units can be easily removed for servicing.
- .3 Filters:
 - .1 Unit shall have a (25 mm thick MERV 13 filter and a factory-installed combination filter rack/return air duct collar. The filters shall be removable from the side or from the bottom.
- .4 Refrigerant Circuit:
 - .1 Units shall have a sealed refrigerant circuit which includes a rotary (sizes 007 to 012) reciprocating (sizes 019 to 024, scroll (sizes 030 to 060) compressor, a thermostatic expansion valve, an aluminum fin and rifled copper tube refrigerant-to-air heat exchanger, a reversing valve and a water-to-refrigerant coaxial heat exchanger. The coaxial coils shall be made of copper and shall be deeply fluted to enhance heat transfer and minimize fouling and scaling. The coil shall have a working pressure of 400 psig on the waterside of the unit, 500 psig on the refrigerant side for R-410A.
- .5 Drain Pan:
 - .1 The condensate pan shall be constructed of high impact plastic to prevent corrosion and sweating. The bottom of the drain pan shall be sloped on two planes to provide complete drainage of water from the pan. The unit shall be supplied with a standard solid-state electronic condensate overflow protection.
 - .2 All units shall be installed level and Contractor shall verify operation of overflow protection prior to start-up.
- .6 Fan and Motor Assembly:
 - .1 Units 5 tons and smaller shall have a direct drive centrifugal fan. The fan housing shall have a removable orifice ring to facilitate fan motor and fan wheel removal. The fan housing shall protrude through the cabinet to facilitate field duct connection. The fan motor shall be a PSC type isolated from the fan housing and thermal overload protection.
 - .2 Units above one ton shall have a terminal strip mounted on the fan motor to facilitate motor speed change. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule.

- .7 Electrical:
- .1 A control box shall be located within the unit and shall contain controls for compressor, reversing valve and fan motor operation and shall have a 50 VA transformer, circuit breaker in the low voltage circuit, and a terminal block for low voltage field wiring connections. Unit shall be name plated to accept time delay fuses or HACR circuit breaker for branch over current protection of the power source. Unit control system shall provide heating or cooling as required by the set points of the wall thermostat. The unit control scheme shall provide for fan operation simultaneous with compressor operation (fan interlock) regardless of the thermostat type. The unit shall be capable of providing an output signal to an LED on the thermostat or to a central monitoring panel to indicate a “fault” condition from the activation of any one of the safety switches.
- .8 Solid-State Control System:
- .1 Unit shall have a microprocessor-based control system. The unit control logic shall provide heating and cooling operation as required by the setpoints on the wall thermostat. The control system shall provide the following:
- .1 Fan operation simultaneous with the compressor (fan interlock) regardless of thermostat logic.
- .2 Time delay compressor operation.
- .3 Delayed de-energization of the reversing valve for quiet reversing valve operation.
- .4 Compressor short cycle protection of a minimum of three minutes before restart is possible.
- .5 Random unit start-up after coming off on unoccupied mode.
- .6 Single grounded wire connection for activation of the unoccupied, load shed or unit shutdown modes.
- .7 Night setback temperature setpoint input signal from the wall thermostat.
- .8 Override signal from wall thermostat to override unoccupied mode for 2 hours.
- .9 Brownout protection to suspend unit operation if the supply voltage drops below 80%of normal.
- .10 Condensate overflow protection to suspend cooling operation in an event of a full drain pan.
- .11 Suspended compressor operation upon activation of the refrigerant pressure switch(s).
- .12 Cooling operation activated for 60 seconds upon activation of the low suction temperature (freezestat) switch –defrost cycle.
- .13 Method of defeating compressor, reversing valve and fan time delays for fast service diagnostics.
- .9 Flexible Hoses:
- .1 Two fire rated flexible hoses 3” long with ASTM ratings of Flame Spread 25, Fuel Contribution 25 and Smoke Density 50 for connection to unit and field piping. Hose shall be covered with stainless steel.

- .10 Automatic Flow Devices:
- .1 The automatic flow device kit shall be a Hays Mesurflo® automatic flow control valve, two ball valves, two flexible hoses, a high flow Y-strainer, and may include a strainer blow-down and various other accessories. The automatic flow control valve shall be factory set to a rated flow, and shall automatically control the flow to within 10% of the rated value over a 40 to 1 differential pressure, operating range (2 to 80 PSID). Operational temperature shall be rated from fluid freezing, to 225°F. The valve body shall be constructed from hot forged brass UNS C37700 per ASTM B-283 latest revision.
 - .2 Add to specification for careful installation of these to match the flow to the actual heat pump.
 - .3 Contractor shall not install hose kits with strainers and flow control devices until all system flushing is complete. Flushing shall be performed by installing one hose at each unit to run supply water directly back to return line. On completion of flushing, both hoses shall be connected to allow flow through the heat pump unit and flow control device.
- .11 Field Installed Controls:
- .1 *Motorized valve relay and control valve.* The assembly shall include a relay, valve and wire harness. The valve shall open when the compressor is on and close when the compressor is off. Harness shall be installed by Mechanical Subcontractor.

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 shall 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 Division 01 – General Requirements.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION