

**AGENCE SPATIALE CANADIENNE
CANADIAN SPACE AGENCY**



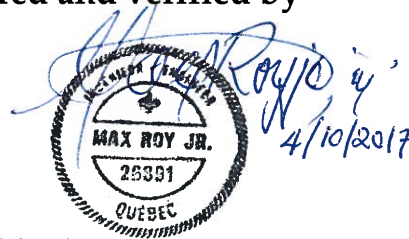
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**MODERNIZATION OF ROOM CONTROLS
SECTOR AREA 1A-200, 2A-300 AND 4A-300
PROJECT # A16-3.4**

**TECHNICAL SPECIFICATIONS
MECHANICAL**

For tender

Prepared and verified by



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ROCHON
EXPERTS-CONSEILS INC.

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Division 23: Heating, ventilation and air conditioning

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Division 23

Heating, Ventilation and Air Conditioning (HVAC)

1. PART 1 – GENERAL

1.1 General

- .1 This section applies to mechanical works indicated on plans and in attached Division 23 that form the Mechanical Specification.
- .2 This section complements all contract clauses, all general clauses of Architectural Specifications and Departmental Representative clauses. Most restrictive clauses take precedence.
- .3 These Mechanical Specifications concern the Contractor responsible for the whole works and the Mechanical Contractors. The Contractor responsible for the whole works has overall responsibility and ensures good coordination for work performed by its Mechanical Contractors regarding the work. The Contractor responsible for the whole works must resolve any conflict that arises between Contractors. The word "Contractor" in this specifications document means the Contractor responsible for the whole works.
- .4 Responsibilities – Scope of work
 - .1 Work described in sections of divisions below is an integral part of the responsibilities of the Contractor:
 - .1 Division 23: HVAC, including piping related to HVAC equipment, thermal insulation for Plumbing and piping related to HVAC, and HVAC ductwork and accessories.
 - .2 The work described on the following plans are an integral part of the Contractor responsibilities:

CSA project file no.	Project title	Mechanical drawings No.
A16-3.4	Modernization of room controls Sector area 1A-200, 2A-300 and 4A-300	H-01 to H-07

- .3 The drawings and specifications complete each other and shall be read together in order to well understand the scope of work and associated specifications.
- .4 Particular notes regarding works:
 - .1 Heating hot water pipes will be performed by the plumbing subcontractor (div. 23 of mechanical).
 - .2 All ventilation works are by the HVAC subcontractor (div. 23 of mechanical).
 - .3 All thermal insulation works are under the responsibility of each discipline plumbing / piping and ventilation, but by a well licensed specialist.
 - .4 Controls systems work will be done by a specialist as subcontractor (see section 230933E of these specifications).

1.2 Work schedule

- .1 Within fifteen (15) business days following the award of the contract, submit milestones for work of this nature, a scheduling diagram and a work schedule indicating the dates of the various completion stages of work, which should be completed by the deadline specified in the contract.
- .2 Revision of work progress, according to submitted schedule, will be held at the discretion of the Departmental Representative. The schedule will be updated by the Contractor, with collaboration of and approval by the Departmental Representative.

1.3 Permits and certificates

- .1 Obtain all required permits, inspection certificates and certificates of acceptance before starting and completing successfully all work, and pay for the cost of such permits and certificates.
- .2 Refer to the description of each section for individual permits and certificates required. These permits and certificates shall be returned to the Departmental Representative and will be a condition for acceptance of work.

1.4 Plans and specifications

- .1 Plans and specifications are an integral part of the contract and complement each other and work appearing on one and not the other, and vice-versa, shall be executed as if they were mentioned in both. All work or material not listed or specified but implicitly required for the installation of a complete system, as proposed in plans and specifications, shall be included in the bid and installed.
- .2 The Contractor shall inform the Contracting Authority for any errors or omissions that he could detect on plans at the time of bidding, in order to obtain any necessary clarification to present a full bid.
- .3 In case of conflict, the Contractor shall inform the Contracting Authority who will give an exact interpretation of the disputed point.
- .4 All notes on plans are deemed to be part of this contract.
- .5 Any change in plans and specifications during the bidding process will be given in writing.

1.5 Codes and standards

- .1 Unless otherwise stated, work shall be done in accordance with National Building Code of Canada (NBC), and any other applicable provincial or municipal code. In case of omissions and contradictions between these standards, the most stringent requirements shall apply.
- .2 Work must comply with or exceed requirements of standards, codes and other documents referred to.

1.6 Site examination

- .1 In his bid, the Contractor implicitly confirms that he knows all local conditions that may affect the performance of his work and that he has taken them into account in his bid. No supplement will be granted for works and materials needed but not planned by the Contractor.
- .2 Prior to work, the Contractor shall check all elevations and dimensions on site.

1.7 Modification of work

- .1 No change to original plans and specifications shall be made without a written request by the Departmental Representative writing and before an assessment, in accordance with the following, if first approved by the Departmental Representative. If the Departmental Representative asks for modification that entails no price adjustment, the Contractor shall perform it immediately without further notice.
- .2 In all cases, the Departmental Representative will have to be consulted and he/she alone can give permission for change to be made regarding plans and specifications. All work that does not comply with plans and specifications will be modified by Contractor, without any additional costs.

- .3 The Departmental Representative will have the right to request changes to plans and specifications as required during construction. These changes will not affect neither nullify this contract's terms and conditions. If these changes entail an increase or a decrease in the cost of work, this contract will be amended following an assessment, in accordance with the following section.
- .4 All additional work will be governed by the terms and conditions of this contract.

1.8 Specified and equivalent equipment or materials

- .1 When equipment or material is specified by reference to a standard, choose equipment or material that meets or exceeds the requirements of this standard.
- .2 The Contractor shall base his bidding price on equipment or materials identified by catalogue numbers or on equipment manufactured by one of the manufacturers or on trademark identified in plans and specifications for such equipment. If a single product is specified, the bid shall be based on this product.
- .3 Mention of names of manufacturers on plans and specifications in addition to the product specified by a catalogue number does not mean that the Departmental Representative agrees to accept a product brand. It is the responsibility of the Contractor to ensure the equivalency of the products he uses in his bid and to prove it during presentation of shop drawings. The Departmental Representative will be the sole judge for equivalency of a product, and in case of refusal of a submitted product by the Departmental Representative, the Contractor shall provide the equipment specified by a catalogue number.
- .4 The Contractor may propose in his bid products differing from those listed in plans and specifications, but the conditions of the "Substitutions" section below will apply.
- .5 Changes in the work, design and drawings caused by an equivalent product will be the responsibility of the Contractor.
- .6 It is understood that the choice of material does in no way modify Contractor responsibilities.
- .7 Unless otherwise stated, use the products of a single manufacturer for materials and equipment that are of the same type or same class.
- .8 Required quality or acceptable product:
 - .1 Means that the equipment or material indicated and identified by a catalogue number is an integral part of the specifications and serves as performance and quality indicator for material and work.

1.9 Substitutions

- .1 When equipment or material is specified by a catalogue number or by a trademark or a manufacturer, the Contractor may request for alternative equipment or material if brand or manufacturer's name is not mentioned.
- .2 Request for substitution must be made in writing within thirty (30) days of award of contract.
- .3 Enclose with the request for substitution a comparative table of the main specifications of specified equipment or material and of proposed equipment or material; this table will include all data on overall dimensions and electrical and mechanical data specific for this kind of equipment or material.
- .4 Join to the request for substitution the following information:
 - .1 Copy of the bid for specified equipment or material;
 - .2 Copy of the bid for proposed equipment or material; if it is possible go save money, price difference will be submitted to the Departmental Representative;
 - .3 Reasons for the request for substitution.

- .5 Request for substitution will be taken into consideration only if:
 - .1 Specified equipment or materials is not available; or
 - .2 Delivery schedule for specified equipment or materials unduly delays work; or
 - .3 Proposed equipment or materials is deemed equivalent to specified equipment, taking into consideration maintainability and availability of spare parts.
- .6 The Contractor is responsible to demonstrate equivalence, at his own expense.
- .7 The Departmental Representative reserves the right to require the Contractor to pay for the examination of the substitutions.
- .8 The decision regarding approval or refusal of substitution will be taken by the Departmental Representative and this decision will be final.
- .9 If the specifications of the approved substitution equipment or material require changes to plans and work to be performed, pay for the costs of all these changes. In case of refusal of the proposed equipment or material, supply and install the equipment or material specified by a number, all without additional charges.

1.10 Shop drawings and product data

- .1 Submit shop drawings and product data as specified. Submit shop drawings and product data in an electronic Acrobat form.
- .2 Shop drawings shall bear the seal of the Contractor and the signature of an authorized representative stating that submitted documents have been approved, that measures taken on site have been verified and that they comply with contract documents.
- .3 Shop drawings must also include the following information:
 - .1 Dates of preparation and revision;
 - .2 Project name and number;
 - .3 Section number where a shop drawing is required;
 - .4 Name and address of:
 - .1 Subcontractor;
 - .2 Supplier;
 - .3 Manufacturer.
- .4 Shop drawings and product data must be accompanied by typed information sheet.
- .5 Shop drawings and product data must show the following information:
 - .1 Details of installation;
 - .2 Working space necessary to operate and maintain equipment, e.g. working space necessary for the operation of access doors;
 - .3 Power supplies required and their specifications;
 - .4 Technical details for evaluating the performance of submitted equipment.
- .6 Submit the following documents with shop drawings and product data:
 - .1 Drawing details of bases, materials and anchor bolts;
 - .2 Data on acoustic power of systems and equipment, as appropriate;
 - .3 Performance curves showing operating points;
 - .4 Document submitted by the manufacturer certifying that the products in question are current models;
 - .5 Certificate of compliance to the relevant codes;
- .7 Shop drawings will be commented by the Departmental Representative and the Contractor must comply with the following comments:
 - .1 Supply equipment as submitted on shop drawings;
 - .2 Supply equipment taking into account corrections and annotations;
 - .3 Review equipment drawings and resubmit;
 - .4 Equipment refused. Resubmit drawings using specified equipment.

- .8 Comments indicated on shop drawings are broad in nature and are not intended to serve as final document. Therefore, they do not relieve the Contractor of his responsibility to verify plans himself or to supply materials and work required by plans and specifications.
- .9 The Departmental Representative retains the right to remove, at Contractor's expenses, all materials or products that have not been officially presented on shop drawings and installation plans.
- .10 Retain a copy of shop drawings and product data on work site and ensure that they are always available for reference.
- .11 All shop drawings and product data must be written in French.

1.11 Equipment and materials

.1 Quality

- .1 Equipment and materials used in performing the work must be new (unless otherwise indicated), in perfect condition, manufactured, assembled and tested at the factory, of the highest quality in accordance with terms and conditions of contract documents and ready to be installed for intended purpose; if necessary, provide evidence showing nature, origin and quality of supplied products.
- .2 Equipment and materials shall be affixed with appropriate CSA, ULC or other certification labels, and be installed in accordance with applicable codes and standards.
- .3 All markings on equipment and materials (operating instructions or other) must be in French.
- .4 Equipment and materials found defective before completion of work will be rejected, whatever the findings of previous inspections. Inspections are not intended to relieve Contractor of his responsibilities, but simply to reduce the risk of omission or error. The Contractor shall ensure removal and replacement of defective products at his own expense, and will be held responsible for delays and costs.
- .5 In the event of conflict regarding quality or suitability of products, only the Departmental Representative shall settle the matter, based on the requirements of contract documents.
- .6 Unless otherwise indicated, ensure some degree of uniformity by ensuring that equipment or material of a similar nature come from the same manufacturer, that they are the same standard product from a manufacturer and that parts required for maintenance are available at all times.
- .7 Labels, trademarks and permanent nameplates affixed in a conspicuous way on to be installed equipment or materials are not acceptable unless they contain operating instructions or they are affixed on equipment or material installed in mechanical or electrical rooms.
- .8 Equipment or material shall have specifications and dimensions suitable for sites where they will be installed. Notify the Departmental Representative before installing equipment or material which does not respect these conditions.

.2 Availability

- .1 Immediately after award of contract, review requirements for delivery of equipment or material and anticipate any delay. Order required quantities in a timely manner, taking into account work schedule and storage capacity on site. If some delays in delivery is to be anticipated, notify the Departmental Representative so that measures can be taken to substitute equipment or material for alternative ones or make necessary corrections sufficiently in advance to avoid any delay in project.
- .2 In the event that the Departmental Representative had not been notified of delays in delivery that could have been anticipated prior to work, and that it seems likely that execution of work will be delayed, the Departmental Representative reserves the right to change planned equipment or materials for comparable equipment or materials that can be delivered more quickly, without any increase in contract prices.

- .3 Transportation
 - .1 Pay for the cost of transportation for equipment or materials required for executing the work.
 - .2 Departmental Representative will pay the cost of transportation for equipment or materials supplied by the Departmental Representative. Assume responsibility for unloading, handling and storing equipment and materials. The Contractor will supply lifting equipment required from delivery point to installation point of equipment and materials.
 - .3 Coordinate deliveries and pay demurrage charges.
- .4 Storage, handling and protection of equipment or materials
 - .1 Contractor is responsible for the inspection of equipment and materials arriving on site, their storage, installation and connection.
 - .2 Move and store in locked premises equipment and materials, avoiding damage, alteration or dirt and following manufacturer's instructions wherever applicable.
 - .3 Store equipment and materials in their original packaging, and leave intact manufacturer's labels and seals. Do not unpack or untie equipment or materials prior to their inclusion to the work.
 - .4 Equipment or materials that could be damaged by adverse conditions must be kept in suitable premises.
 - .5 Replace at no additional cost damaged equipment or materials, to Departmental Representative satisfaction.

1.12 Manufacturers recommendations

- .1 Unless otherwise indicated, install or set up equipment or materials following manufacturer's instructions.
- .2 Do not rely on information contained on labels and containers provided with equipment or materials; obtain directly from the manufacturer diagrams, drawings, and all written instructions required for proper installation of equipment and all other information that could facilitate the work.
- .3 Copy of these instructions will be given to the Departmental Representative prior to installation.
- .4 The Departmental Representative may require removal and reinstallation, without increase of contract price, of all products that were put or installed incorrectly.

1.13 Coordination of plans and specifications

- .1 Plans and specifications show in a schematic and approximate way the location of equipment, ducts, piping, pull and junction boxes, etc.
- .2 Check sizes and exact location of equipment on site and not to scale on plans.
- .3 There will be no supplement for changes of openings for conduits, piping, shafts, etc., that may be deemed necessary by conditions on site.

1.14 Usage of premises

- .1 If necessary, determine with the Departmental Representative access routes to site, storage areas, materials stacking areas, location of facilities, etc.
- .2 Do not unduly accumulate equipment or materials that could clutter work site.
- .3 Displace stored equipment or materials that cause obstruction to work by Departmental Representative or another Contractor.
- .4 After obtaining necessary authorizations, pay usage fees for additional storage or work areas required for performance of work.
- .5 Provide evidence that materials and waste coming from work site have been removed to an authorized site.

1.15 Implementation

.1 General

- .1 Implementation shall be of the highest quality possible and be done to good engineering practices, codes and standards in force, by teams of experienced workers, composed of professional workers skilled in their respective trade. Notify the Departmental Representative immediately if the nature of work to be performed is such that it would be almost impossible to obtain anticipated results.
- .2 Do not hire unskilled persons not having adequate qualifications to perform work they have been assigned. The Departmental Representative reserves the right to demand the lay-off of any person deemed incompetent, negligent, insubordinate or whose presence should not be tolerated on site.

.2 Cooperation

- .1 Ensure that workers work together to the performance of the work. Monitor closely and constantly work done by workers.
- .2 Ensure coordination and implementation of openings, sleeves and fittings.
- .3 Ensure that openings planned in the building are large enough to allow entry of equipment.

.3 Concealment of pipes

- .1 In finished areas, conceal pipes, ducts and electrical wiring in ceilings, walls and floors, unless otherwise indicated.
- .2 Before concealing pipes, notify Departmental Representative of any abnormal situation. Proceed to install in accordance with the instructions of the Departmental Representative.
- .3 No work, such as pipes, conduits, etc., will be concealed until it has been inspected and approved.

.4 Cutting and patching

- .1 Cutting and patching work to be done such that all parts of the work form a coherent whole. Coordinate work accordingly.
- .2 Cutting and patching work must be performed by specialists familiar with materials they are going to use. Work to be done so as not to damage or risk to damage any part of structure.

.5 Location of equipment and materials

- .1 The exact location of equipment or materials for which location is defined only schematically on plans will be made jointly with the Departmental Representative on site; location can be changed at no additional charge or credit, provided that displacements do not exceed 5 m.
- .2 Install equipment, materials and pipes in order to limit overall dimensions and to conserve as much floor space as possible in accordance with manufacturer's recommendations as to safety, access and maintenance.
- .3 Inform the Departmental Representative of any problem that may be caused by the location of equipment or material, and install according to his instructions.
- .4 If access traps need to be installed for maintenance or access to equipment or materials, obtain approval of Departmental Representative before installation. Supply and installation of access traps will be made at no additional cost for the Departmental Representative.

.6 Concrete pouring, excavation and backfilling

- .1 Concrete pouring, excavation and backfilling required for work in accordance with this division will be borne by other divisions unless otherwise indicated on plans or specifications of each individual division.
- .2 When trenches or concrete bases are required for equipment, each division will identify required dimensions, determine the exact location and monitor it to ensure proper execution of work in accordance with plans and specifications.

- .7 Protection of work during construction
 - .1 Ensure completed works or in construction have sufficient protection. Works damaged or modified because of lack of compliance with the specified protective measures are to be replaced or repaired without charge, as specified by the Departmental Representative.
 - .2 Do not overload any part of work. Unless otherwise indicated, obtain Departmental Representative's written authorization before cutting, drilling or installing sleeves in any part of the building structure.
- .8 Existing installations
 - .1 When connection works to existing systems are required, connect at times established by responsible authorities, with minimum disruption of normal usage of premises, tenants and pedestrian and vehicle traffic.
 - .2 Repair any damage to facilities and systems during connection works.
 - .3 Protect, move or maintain in service existing pipes. If abandoned pipes are discovered during work, they should be closed and identified by signs, or their location should be recorded. Seal conduits, pipes, etc., in accordance with applicable codes and standards.
 - .4 Submit to the Departmental Representative the work schedule and obtain his approval for temporary shutdown of existing systems or services. Cut services according to approved schedule and notify in advance those affected.
 - .5 Any interruption of service must be coordinated in writing with the Departmental Representative, at least forty-eight (48) hours in advance, unless otherwise specified in writing by the Departmental Representative.
 - .6 Unless otherwise specified by the Departmental Representative, connection to existing systems must be carried without service disruption.
 - .7 Reusable existing equipment will be dismantled carefully, stored in a climate controlled room, cleaned and reinstalled in accordance with manufacturer's recommendations.
- .9 Temporary services
 - .1 No permanent equipment shall be used for temporary services without written authorization of the Departmental Representative.
 - .2 If the Contractor fails to respect this warning, the Departmental Representative reserves the right to reject material so used and to replace it with new material, all at the expenses of the Contractor.
- .10 Start-up
 - .1 Contractor shall include in his bid services required to ensure, upon completion of work, start-up, coordination and integration of mechanical systems and their adjustment for optimum operation.
 - .2 Start-up must be performed for a full season, such as heating in winter and air conditioning in summer in the case of an air-conditioned building. When start-up is carried out through a heating period, the Contractor will have to come back and perform start-up during an air conditioning period, or vice-versa.

1.16 Work coordination

- .1 Each division will review all submission plans before installation of its equipments and ensure, according to equipment and/or shop drawings, that it can install them at location indicated on plans without impeding installation of equipments by other divisions.
- .2 It should be noted that plans are schematic and that final coordination between each division will be done on site under the supervision of the Contractor. In the event of contradiction between installation and plans and/or specifications, and if works cannot be coordinated at site level without affecting the design, the Contractor shall notify the Departmental Representative and obtain written authorization for modifications prior resuming work.

- .3 Particular attention will be paid to installation of equipments in ceilings (surface-mounted and/or suspended ceiling) and in risers in shafts and on/in walls. Equipment that must remain accessible will be installed so that their access is not impeded by other equipment, ventilation ducts or in inaccessible ceilings. Verify depth of equipments recessed in walls and ceilings as not to hamper their installation.
- .4 Installation in mechanical and electrical rooms, and in particular location of equipments, ducts and concrete bases, must be coordinated between the different sections and divisions and approved by the Departmental Representative prior to installation. In these rooms, installation of equipment in ceilings must comply with above sections and take into account locations of lighting equipment and the fact that lighting equipment will be determined after installation of other equipments.
- .5 When a section or a division will perform work that could damage existing building or work done by another section or division, it must notify this section or division in the presence of the Contractor and agrees on how to protect equipment in the most effective way.
- .6 Considering above remarks, if any section or division hampers or prevents the installation of equipment by another section or division, begins or continues work without coordination, it will be required to prove that it was unable to install its equipment without hampering this section or division, or, failing that, to undo or modify the installation of its equipment in order to remedy the situation, as directed by the Departmental Representative.

1.17 Tests and certification

- .1 Upon completion of work, demonstrate that all equipment is working as designed. If required, a second series of tests will be done within a period of two (2) weeks after the first one. Submit test report to the Departmental Representative.
- .2 Execute testing and supply all equipment required. Notify the Departmental Representative twenty-four (24) hours in advance so that his operating and maintenance staff can be on site to attend tests and help if required.
- .3 Manufacturer of equipment shall be present on site for start-up and give necessary instructions to maintenance staff.
- .4 Refer to the description of each section for specific tests requested.
- .5 Submittal of test reports will be a condition for acceptance of work by the Departmental Representative.
- .6 Submit all certificates required by regulations, laws and contract.

1.18 Repairs

- .1 If necessary, repair any damage caused to existing or new installations and systems, in the course of carrying the work.
- .2 No additional charge will be granted when work has to be redone due to error, omission or lack of coordination on part of the Contractor.

1.19 Departmental Representative's privilege

- .1 The Departmental Representative reserves the right to use other Parties, to his own expenses, to perform work related to the project but not included in plans and specifications. Contractor will therefore not be held liable for works that are part of his contract.

1.20 Site inspection

- .1 Unless otherwise indicated, Departmental Representative requires that the Contractor notify him forty-eight (48) hours prior to concealing installed materials, for inspection. Omission to this procedure will require the Contractor, if so ordered by Departmental Representative, to uncover these materials for the required tests.
- .2 Periodically, the Departmental Representative will visit the construction site and review work progress. If a deficiency is brought to the attention of the Contractor, he or she will make every effort to correct this anomaly. Refusal by the Contractor to comply with this order may result in the interruption of work until an agreement is reached between those responsible.

1.21 Architecture and structure details

- .1 Since all architecture and structure details are not repeated on mechanical plans, the Contractor for each trade should, before beginning work, check all architecture and structure plans to ensure they know all the details that might affect their work.

1.22 Equipment location

- .1 Location of equipment and materials indicated or specified must be regarded as approximate.
- .2 Install equipment and piping in order to limit overall dimensions and conserve as much floor space as possible, in accordance with manufacturer's recommendations as to safety, access and maintenance.
- .3 At the request of the Departmental Representative, submit a layout plan indicating the relative position of various services and equipment parts.
- .4 The Contractor shall respect perfect symmetry between the various parts of systems in each trade. Moreover, it should be noted that plans are provided as a guide and are sometimes at a small scale and do not always present elevations and dimensions. Therefore, judgment is required to ensure that fittings for those systems are well integrated to the structure and the architecture of the building.
- .5 Location of major equipment, even if it is indicated accurately on drawings, may be modified at any time by the Departmental Representative if required in his judgment by existing conditions, at no additional cost to the Departmental Representative when it is specified prior to installation.
- .6 Pull and junction boxes must be located in protected and easily accessible locations.
- .7 If equipment is installed without regard to these Specifications and constitutes an obstacle or is damaged, the Contractor must displace it or replace at no additional cost to the Departmental Representative.
- .8 Respect applicable laws and codes regarding working space around equipments.

1.23 Levels and grades

- .1 Before proceeding with installation of pipes, cabletroughs and other equipment, check all levels and grades indicated on drawings to ensure that required slopes can be obtained and that there is no interference between trades.
- .2 Failure to notify the Departmental Representative about errors found on drawings will make the Contractor responsible for any necessary change, without additional compensation.

1.24 Site cleaning

- .1 The Contractor shall, regularly or at the request of the Departmental Representative, clean the site and remove debris caused by his work.

- .2 Before the Departmental Representative inspects work for temporary acceptance, the Contractor must remove remaining tools and materials and entirely clean the site of all work debris and waste. The Contractor shall clean the buildings and other structures in order to perfect order to Departmental Representative satisfaction.
- .3 In addition, he shall replace in good condition, at his own expense, anything that could have been affected by his work.
- .4 He shall also clean and restore, at his own expense, any area used as "service area". However, the Contractor shall not claim any cost supplement for this work.
- .5 Clean reflectors, diffusers, globes and any lighting fixtures at the end of work.

1.25 Foreman

- .1 Every building trade should be represented on site by a foreman.
- .2 The foreman shall have sufficient experience and knowledge of his trade to allow good collaboration with other contractors and ensure proper execution of orders transmitted by his superiors.
- .3 The foreman shall be the same person from start to completion of work, unless otherwise authorized by the Departmental Representative.
- .4 The Departmental Representative reserve the right to demand the dismissal of the foreman if, in their opinion, this person is not competent for the work assigned to him.
- .5 Moreover, the foreman is required to attend all regular meetings on site, unless otherwise authorized by the Departmental Representative.
- .6 The foreman shall be able to speak French.

1.26 Excavation and backfilling

- .1 The Contractor is responsible for any excavation and filling of trenches, holes, sumps, deep wells, reservoirs, holes for poles and concrete foundations, etc., but this work is not part of divisions 21, 22 and 23, unless otherwise specified on plans.
- .2 The Contractor shall not proceed to backfill until the inspection is done and he is authorized to do so by the Departmental Representative. The Contractor agrees not to conceal any work such as conduits, etc., without having first obtained permission from the Departmental Representative.

1.27 Protection of work during performance

- .1 All open pipes laid by the Contractor shall be hermetically closed with screw caps to prevent dust and waste from entering these pipes during performance of work. All machinery shall be protected by polythene tarps against dust and weather.

1.28 Concrete base and structural supports

- .1 Unless otherwise specified in plans, all major items of equipment, such as boilers, pumps, compressors, collectors, fans, motors, etc., shall be mounted on a concrete base. Concrete foundations placed above floor will be bolted to floor, except when they are isolated by anti-vibration materials such as cork or Tyco. These bases will protrude by 4" more on the entire perimeter of foundation plates for equipment. Base finish shall be smooth, level, with bevelled edges to 45 degrees.
 - .1 Construction of concrete bases is part of structural work (General).
- .2 Unless otherwise indicated, horizontal and vertical tanks and some heavy parts of ventilation units will be supported by a steel frame made of I-beams, H-beams or angles with reinforcements and crosspieces.
 - .1 Horizontal tanks will be laid on steel easel, with steel or cast iron cradles.

- .3 Supports made of pipes are acceptable. All steel supports, legs, etc., must be laid on steel plates bolted to floor.
- .4 For ceiling or wall mounting, use suspended platforms or suspension rods, supports or shelves. Suspend and/or attach to the building structure with Departmental Representative approval.
- .5 The Contractor shall supply all steel structures required for the installation of equipment. Non-galvanized steel must be cleaned properly and be coated with one (1) primer layer and two (2) layers of grey paint finish.

1.29 Protection against corrosion

- .1 All galvanized steel parts, supports for piping, anchors, machinery or other must be coated on site with one (1) layer of anti-corrosion paint after metallic surfaces are cleaned.
- .2 All caps, screws, etc., outside will be either in bronze or cadmium-plated.

1.30 Anchoring

- .1 No anchor gun shall be used, unless otherwise authorized by the Departmental Representative. Expansion bolts shall be used to secure pipes to walls or ceilings. The Departmental Representative reserve the right to ask for any type of anchoring they consider particularly suited to conditions of construction work, at no extra cost.
- .2 Anchoring used to support equipment other than pipes on concrete walls and ceilings will be of HILTI type, HVA series and on hollow block walls, HILTI, series HY20.

1.31 Operation and Maintenance Manual

- .1 Provide operating, maintenance and performance sheets, and incorporate them in the "Operation and Maintenance Manual" ("Manuel d'exploitation et d'entretien").
- .2 Operating, maintenance and performance sheets shall be verified prior to final inspection by the Departmental Representative who will retain final copies.
- .3 Operation sheets must include the following:
 - .1 Regulation/control circuit diagrams for each system, including environmental regulation/control system.
 - .2 Description of each system/installation and related regulation/control devices.
 - .3 Description of each system/installation operation under various loads, with set points modification programs and indication of seasonal variations.
 - .4 Instruction on each system/installation and each component operation.
 - .5 Description of actions to be performed in case of equipment failure.
 - .6 Table of valves and flow diagram.
 - .7 Color code.
- .4 Maintenance sheets must include the following:
 - .1 Instructions for maintenance, repair, operation and identification of defects for each piece of equipment.
 - .2 Instructions about maintenance task frequency, including tools, parts and time required for these tasks.
- .5 Performance sheets must contain the following:
 - .1 Performance data provided by equipment manufacturer, including use points of equipment after start-up.
 - .2 Results of equipment performance tests.
 - .3 Any other specific performance data specified elsewhere in the contract documents.
 - .4 System tests, adjusting and balancing reports.

- .6 "Operation and Maintenance Manuals" must also include the following information:
 - .1 Shop drawings already discussed and corrected if required.
 - .2 Show all equipment as installed in the project.
 - .3 Describe the exact functioning, step by step, for each installed system.
 - .4 Describe step-by-step procedure for start-up and stopping for reliable and safe operation.
 - .5 Provide a list of the different parts of the equipment that would likely need to be replaced on a regular basis, with replacement interval.
 - .6 List of spare parts including names, addresses and phone numbers of suppliers for all equipment, engines, fittings, etc., that were provided and installed, with reference to specification sections that describe these parts.
- .7 Approval
 - .1 For the purpose of approval, submit to Departmental Representative one (1) copy of draft version of "Operation and Maintenance Manual". Unless otherwise directed by the Departmental Representative, it will be forbidden to submit the various forms individually.
 - .2 Amend as required the "Operation and Maintenance Manual" and submit it again as directed by the Departmental Representative.
 - .3 Submit three (3) final copies of the "Operation and Maintenance Manual".
- .8 Additional information
 - .1 Prepare additional information sheets and append them to the "Operation and Maintenance Manual" when demonstrations or execution of instructions previously described show that such sheets are necessary.
- .9 The "Operation and Maintenance Manual" shall be written entirely in French and be titled "Operation and Maintenance Manual".

1.32 Training of operation and maintenance staff

- .1 Provide tools, equipment and services of qualified instructors to train operation and maintenance staff regarding functioning, control, setting, problem diagnostic and maintenance of systems and materials, during normal working hours and prior to acceptance and delivery of systems and materials.
- .2 When indicated elsewhere, manufacturers must conduct demonstration and provide training to staff.
- .3 Training courses must be based on the content of the "Operation and Maintenance Manual", as-built drawings, audiovisual material and others.

1.33 As-built drawings

- .1 Documents to keep on site:
 - .1 The Departmental Representative will provide two (2) sets of drawings. On one set, indicate all changes made while performing work as they occur.
 - .2 Upon completion of work, report on the second set of drawings all information recorded on the first set to show as-installed systems and equipment.
 - .3 Use indelible ink pen of different colour for each service.
 - .4 Keep these drawings on site and make them available to required persons for reference and verification.
- .2 As-built drawings
 - .1 Prior to test, balancing and adjusting systems, complete as-built drawings.
 - .2 Identify each drawing in the lower corner at right in letters at least 12 mm high, as follows: "DESSIN D'APRÈS EXÉCUTION : LE PRÉSENT DESSIN A ÉTÉ RÉVISÉ ET MONTRE LES SYSTÈMES ET APPAREILS TELS QU'ILS ONT ÉTÉ INSTALLÉS". (Contractor's signature) (Date).

- .3 Submit drawings to Departmental Representative for approval, and then make corrections as directed.
- .4 Perform test, balancing and adjusting of systems, equipment and networks taking into account indications of as-built drawings.
- .5 Submit copies of completed as-built drawings with the "Operation and Maintenance Manual".
- .3 Submit one copy of each as-built drawing and incorporate in the final report on test, balancing and adjusting of systems and installations.
- .4 As-built drawings must be provided prior to approval of works. Otherwise, approval of work will be delayed until as-built drawings are submitted.

1.34 Warranty

- .1 Ensure good working condition of all structures and equipment under this contract.
- .2 Replace immediately any part of the installation that is found defective during the twelve (12) months following written final approval by the Departmental Representative, of the entire undertaking, without cost to the Departmental Representative.
- .3 If the Contractor does not correct defects within three (3) days of the notice given by the Departmental Representative or if works do not progress at a sufficient pace, the Departmental Representative could make repairs or corrections himself or by any other person he designates, and cost of these works will be to the Contractor.

1.35 Requirements for interim inspection

- .1 Before requesting interim inspection, the Contractor shall:
 - .1 Complete as much work as possible; otherwise the Departmental Representative could refuse to establish a too long list of deficiencies. Furthermore, the Contractor could be charged for unnecessary travel by Departmental Representative caused by lack of coordination or neglect.
 - .2 Clean all equipment supplied to the project and retouch paint on equipment, as appropriate.
 - .3 Submit "As-built drawings".
 - .4 Post all certificates.
 - .5 Submit instruction booklets.
 - .6 Submit balancing reports.
 - .7 Give all necessary instructions to the Departmental Representative.
 - .8 Provide spare parts.
 - .9 Provide all other documents deemed appropriate by the Departmental Representative.
- .2 During inspection, the Contractor shall:
 - .1 Systematically demonstrate that the systems and the equipment operate according to plans and specifications requirements.
 - .2 Make available to the personal hired by the Departmental Representative means for verification, such as a person available to place ladders and step ladders where required, move ceiling tiles, open access doors, etc.

1.36 Acceptance of work

- .1 Upon reception of written notice sent by the Contractor to the effect that his work is complete and a certificate of acceptance is required, the Departmental Representative will conduct an initial inspection of the work.
- .2 He will prepare a list indicating deficiencies that should be corrected. This list will be titled "LISTE DE DÉFICIENCES #1".

- .3 Following written confirmation from the Contractor that his work is complete according to the contract documents and the “LISTE DE DÉFICIENCES #1” issued by the Departmental Representative, the Departmental Representative will conduct a second verification and, if necessary, produce a “LISTE DE DÉFICIENCES #2”, or if installation is deemed in accordance with the contract and acceptable, an official document approving mechanical and electrical works will be issued.
- .4 Following written confirmation from the Contractor that his work is complete according to the contract documents and the “LISTE DE DÉFICIENCES #2” issued by the Departmental Representative, the Departmental Representative will conduct a second verification and, if necessary, produce a “LISTE DE DÉFICIENCES #3”, or if installation is deemed in accordance with the contract and acceptable, an official document approving mechanical and electrical works will be issued.
- .5 The Contractor will be required to pay all costs of inspection subsequent to the third general inspection if it proves insufficient.
- .6 Consequently, a list of deficiencies “number 4, number 5”, etc., required for the emission of acceptance documents of work will be computed on an hourly basis and the amount will be deducted one indicated in the contract with the Contractor.
- .7 Above sections are not intended to unduly penalise the Contractor, but rather to obtain his full collaboration to complete his work and to ensure that his negligence does not cause unwarranted charges to the Departmental Representative.

1. PART 1 - GENERAL

1.1 References

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-1998, Power Piping.
 - .2 ANSI/ASME B31.3-1999, Process Piping.
 - .3 ANSI/ASME, Boiler and Pressure Vessel Code -1998:
 - .1 Section I: Power Boilers.
 - .2 Section V: Non Destructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-88, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1-66, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-1980, Welding Inspection.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA)
 - .1 CSA W47.2-M1987 (R1998), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSAW48 Series-M1980(R1998), Electrodes.
 - .3 CSA B51-M1991 (R1997), Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CAN/CSA-W117.2-94, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-1996, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-1996, Certification of Welding Inspectors.

1.2 Welders qualifications

- .1 Welding qualifications to be in accordance with CSA B51.
- .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from authority having jurisdiction.
- .3 Furnish welder's qualifications to Departmental Representative.
- .4 Each welder to possess identification symbol issued by authority having jurisdiction.
- .5 Certification of companies for fusion welding of aluminum to be in accordance with CSA W47.

1.3 Inspectors qualifications

- .1 Inspectors to be qualified to CSA W178.2.

1.4 Welding procedures

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures to be available on site for inspection at all times.
- .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA W117-W117.2.

1.5 Waste management and disposal

- .1 Separate and recycle waste materials in accordance with provincial and municipal requirements and standards.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

2. **PART 2 - PRODUCTS**

2.1 Electrodes

- .1 Electrodes: in accordance with CSA W48 Series.

3. **PART 3 - EXECUTION**

3.1 Workmanship

- .1 Welding to be in accordance with ANSI/ASME B31.1 B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and applicable requirements of provincial authority having jurisdiction and special procedures specified elsewhere in Divisions 21, 22 and 23.

3.2 Installation requirements

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
 - .1 Where used, fit to minimize gaps between ring and pipe bore.
 - .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.3 Inspections and tests – General requirements

- .1 Review all weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before any work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect all welds during early stages of welding procedures in accordance with AWS W1. Repair or replace all defects as required by codes and as specified herein.

3.4 Specialist examinations and tests

.1 General

- .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by the Departmental Representative.
- .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .2 Hydrostatically test all welds to requirements of ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations
 - .1 Upon failure of any weld by visual examination, perform additional testing as directed by Departmental Representative of a total of up to 10% of all welds, selected at random by Departmental Representative by radiographic and particle tests.

3.5 Defects causing rejection

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

3.6 Repair of welds which failed tests

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.7 Claims against Crown for delays

- .1 Claims against Crown for delays in completion of project will not be entertained for reasons of failures of welds to pass examinations.

1. PART 1 – GENERAL

1.1 Related Sections

- .1 Section 230548E - Vibration and seismic controls for HVAC piping and equipment.

1.2 References

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-1989, Power Piping (SI Edition).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 125-81 (1998), Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A 307-94, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A 563-94, Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP 58-1993, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 ANSI/MSS SP69-1991, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP 89-1991, Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 Design Requirements

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support piping, air ducts and mechanical equipment under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments of supports and hangers after erection and during commissioning. Amount of adjustment in accordance with MSS SP 58.

1.4 Submittals

- .1 Submittals: in accordance with Section 230500E – Common Work Results for Mechanical.
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.

1.5 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 230500E – Common Work Results for Mechanical.

2. **PART 2 – PRODUCTS**

2.1 General

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP 58.
- .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 or hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and galvanized steel retaining clip.
 - .1 Rod: 9 mm UL listed.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP 58 and MSS-SP 69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP 69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut, UL listed.
- .4 Upper attachment to concrete:
 - .1 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP 69.
- .5 Hanger rods: threaded rod material to MSS SP 58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .6 Pipe attachments: material to MSS SP 58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP 69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.
- .9 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A 563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized with formed portion plastic coated or epoxy coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.

2.3 Riser clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP 58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP 58, type 42.
- .3 Bolts: to ASTM A 307.
- .4 Nuts: to ASTM A 563.

2.4 Insulation protection shields

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 69.

2.5 Constant support spring hangers

- .1 Springs: alloy steel to ASTM A 125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10 % minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 Variable support spring hangers

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A 125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.7 Equipment supports

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of details and specifications of drawings.

2.8 Equipment anchor bolts and templates

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

3. PART 3 – EXECUTION

3.1 Installation

- .1 Install in accordance with:
 - .1 manufacturer's instructions and recommendations.
- .2 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.
- .3 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .4 Support from structural members. Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .5 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.
- .6 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.

3.2 Hangers spacing

- .1 Plumbing piping: to most stringent of Canadian Plumbing Code, Provincial Code or authority having jurisdiction.
- .2 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .5 Within 12" of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel – in feet	Maximum Spacing Copper – in feet
Up to 1-1/4	7	6
Up to 1-1/2	9	8
Up to 2	10	9
Up to 2-1/2	12	10
Up to 3	12	10
Up to 3-1/2	13	11
Up to 4	14	12
Up to 5	16	
Up to 6	17	
Up to 8	19	
Up to 10	22	
Up to 12	23	

- .6 PVC plastic pipework: as per table above, with one support on each side of elbow and/or fitting.
- .7 Pipework greater than NPS 12: to MSS SP 69.

3.3 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.

3.4 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.

3.5 Final adjustment

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

1. PART 1 – GENERAL

1.1 Related section

- .1 Section 230529E – Hangers and supports for HVAC piping and equipment.

1.2 References

- .1 National Fire Protection Association (NFPA):
 - .1 NFPA-13, Standard for installation sprinklers.
- .2 National Building Code of Canada (NBC)-2005.
- .3 SMACNA 1338 "Seismic restraint manual guidelines for mechanical systems", including addendum no. 1.
- .4 ASTM E – 488.
- .5 ASHRAE – Applications handbook.

2. PART 2 – PRODUCTS

2.1 General

- .1 Size and shape of bases type and performance of vibration isolation as indicated.
- .2 Each mechanical and electrical contractor is responsible for the seismic controls related to this discipline.

2.2 Seismic control measures

.1 General:

- .1 Following systems and/or equipment to remain operational during and after earthquakes or similar events:
 - .1 Water, oil, air and gas piping.
 - .2 HVAC fans, duct works and equipment.
- .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.
- .4 Piping systems:
 - .1 Fire protection systems: to NFPA 13.
 - .2 All other piping systems: hangers longer than 300 mm braced at each hanger.
 - .3 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
 - .1 Approved by Engineer hired by the contractor at his own expenses.
 - .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.

3. PART 3 – EXECUTION

3.1 Manufacturer's instructions

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

3.2 Installation

- .1 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .3 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.
- .4 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.

3.3 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:
 - .3 Submit manufacturer's reports to Departmental Representative within five (5) 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 professional engineer to certify the protection devices for HVAC systems after start up and TAB of systems.

1. PART 1 – GENERAL

1.1 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-M89, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .2 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1-10.

1.2 Submittals

- .1 Submittals: in accordance with Section 230500E – Common Work Results for Mechanical.
- .2 Product data to include paint colour chips, other products specified in this section.

1.3 Samples

- .1 Submit samples in accordance with Section 230500E – Common Work Results for Mechanical.
- .2 Samples to include nameplates, labels, tags, lists of proposed legends.

2. PART 2 – PRODUCTS

2.1 Manufacturer's equipment nameplates

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

2.2 System nameplates

- .1 Colours:
 - .1 Hazardous: RED letters, WHITE background.
 - .2 Elsewhere: BLACK letters, WHITE background (except where required otherwise by applicable codes).
- .2 Material and construction:
 - .1 1/8" thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

- .3 Sizes:
.1 Conform to following table:

Size #	Sizes (inch)	No. of Lines	Height of Letters (inch)
1	1/2 x 2	1	1/8
2	1/2 x 3	1	1/4
3	1/2 x 3	2	1/8
4	3/4 x 4	1	3/8
5	3/4 x 4	2	1/4
6	3/4 x 8	1	3/8
7	1 x 5	1	1/2
8	1 x 5	2	3/8
9	1 1/2 x 8	1	3/4

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

2.3 Existing identification systems

- .1 Apply existing identification system to new work.
.2 Before starting work, obtain written approval of identification system from the Departmental Representative.

2.4 Piping systems governed by codes

- .1 Natural gas: to CSA/CGA B149.1.

2.5 Identification of piping systems

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
.2 Pictograms:
.1 Where required: to Workplace Hazardous Materials Information System (WHMIS) regulations.
.3 Legend:
.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
.4 Arrows showing direction of flow:
.1 Outside diameter of pipe or insulation less than 3": 4" long x 2" high.
.2 Outside diameter of pipe or insulation 3" and greater: 6" long x 2" high.
.3 Use double-headed arrows where flow is reversible.
.5 Extent of background colour marking:
.1 To full circumference of pipe or insulation.
.2 Length to accommodate pictogram, full length of legend and arrows.
.6 Materials for background colour marking, legend, arrows:
.1 Pipes and tubing 3/4" and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
.2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 300°F and intermittent temperature of 400°F.

.7 Colors and Legends:

- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:

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

.3 Background colour marking and legends for piping systems:

<u>Contents</u>	<u>Background colour marking</u>	<u>Legend</u>
Treated water	Green	TREATED WATER
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	GLYC. HEATING RETURN
Condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Domestic hot water supply	Green	DOM. HW SUPPLY
Domestic cold water supply	Green	DOM. CWS
Plumbing vent	Green	SAN. VENT

2.6 Valves, controllers identification

- .1 Brass tags with ½” stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 Controller and system component identification

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

2.8 Language

- .1 Identification of systems and components: bilingual in French and in English.

3. PART 3 – EXECUTION

3.1 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.

3.2 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.

3.3 Location of identification on piping and ductwork systems

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 50 feet intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.4 Valves, controllers

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

1. PART 1 – GENERAL

1.1 General

- .1 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.
- .2 Air systems are under responsibility of ventilation subcontractor, hydronic systems are under responsibility of plumbing subcontractor.

1.2 Qualifications of TAB personnel

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

1.3 Purpose of TAB

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

1.4 Exceptions

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

1.5 Co-ordination

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

1.6 Pre-TAB Review

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

1.7 Start-Up

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

1.8 Operation of systems during TAB

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

1.9 Start of TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, caulking.
- .5 All pressure, leakage, other tests specified elsewhere Divisions 22 and 23.
- .6 All provisions for TAB installed and operational;
- .7 Start up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 Application tolerances

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

1.11 Accuracy tolerances

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

1.12 Instruments

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

1.13 Submittals

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

1.14 Preliminary report

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

1.15 TAB report

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in both official languages, French and English, in D ring binders, complete with index tabs.

1.16 Verification

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

1.17 Settings

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

1.18 Completion of TAB

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

1.19 Air systems

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC, NEBB, SMACNA, ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified Divisions 21 and 23 following systems, equipment, components, controls:
- .3 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross sectional area, RPM, electrical power, voltage, noise, vibration.
- .4 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filters, heating/cooling coils, humidifiers, fans, other equipment causing changes in conditions.
 - .2 At controllers, controlled devices.
- .5 Locations of systems measurements to include, but not be limited to, following as appropriate: main ducts, main branch, sub branch, run out (or grille, register or diffuser).).

1.20 Hydronic systems

- .1 Definitions: for purposes of this section, to include low pressure hot water heating, chilled water, condenser water, glycol systems.
- .2 Standard: TAB to be to most stringent of this section or TAB standards of A AABC, NEBB, SMACNA, ASHRAE.
- .3 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:
- .4 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of heat exchangers (primary and secondary sides), boilers, chillers, heating/cooling coils, humidifiers, cooling towers, condensers, pumps, PRV, control valves, other equipment causing changes in conditions.
 - .2 At controllers, controlled devices.
- .6 Locations of systems measurements to include, but not be limited to, following as appropriate: supply and return of primary and secondary loops (main, main branch, branch, sub branch of all hydronic systems, inlet connection of make up water).

1.21 Other systems

- .1 Automatic wet pipe sprinkler systems:
 - .1 Standards: applicable NFPA standards.

1.22 Other requirements during TAB

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

2. **PART 2- PRODUCTS**

2.1 Not applicable

- .1 Not applicable

3. **PART 3 – EXECUTION**

3.1 Air systems to balance

- .1 Increase the air flow of the supply fan of No. 25-013 system, as per instructions on plans.
- .2 New air distribution with control box, grilles and diffusers as per indicated flows on plans.

3.2 Hydronic systems to measure

- .1 Provide reading of the water flow through the new valve when fully opened with heating demand at the temperature probe of the zone.

1. PART 1 - GENERAL

1.1 Related sections

- .1 Section 230529E - Hangers and Supports for HVAC Piping and Equipment.

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 B 209M-02, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C 335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C 411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C 449/C 449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C 547-00, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C 553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C 612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C 795-92, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C 921-92(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .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" - 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 as required in section 230500E – Common work results for mechanical.

2. 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 materials

- .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 C 335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C 612, with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C 553 faced with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C 553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C 553.

2.3 Jackets

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
 - .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 C 449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921 untreated.
- .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, plain reinforced, 50 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 galvanized.
- .11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter square clips, length to suit thickness of insulation.

3. 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 manufacturers 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 230529E - 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 – type, thickness and scope of work

- .1 Insulate hot and cold ducts of double duct and single duct systems.
 - .1 Type: TIAC code C-1, rigid fiberglass insulation for duct.
 - .1 Hot duct: Fiberglass without vapour retarder.
 - .2 Cold duct: Fiberglass with vapour retarder.
 - .2 Thickness: 40 mm.
- .2 Acceptable products: Microlite of Manville or approved equivalent of KNAUF or Fiberglass.
- .3 Finish: canvas jackets as per part 2.

1. PART 1 – GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-1989.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B209M-95, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-82 (1992), Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C 449M-88, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C795-92, Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .6 ASTM C921-89, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.2-95, Calcium silicate thermal insulation for piping, machinery and boilers.
 - .2 CAN/CGSB-51.9-92, Mineral Fibre Thermal Insulation for Piping and Round Ducting.
 - .3 CAN/CGSB-51.11-92, Mineral Fibre Thermal Insulation Blanket.
 - .4 CAN/CGSB-51.12-95, Thermal Insulating and Finishing Cement.
 - .5 CAN/CGSB-51.40-95, Flexible elastomeric, unicellular thermal insulation, sheet and pipe covering.
 - .6 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .7 CGSB 51-GP-53M-95, Jacketing, Polyvinyl Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .4 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-M88, Surface Burning Characteristics of Building Materials and Assemblies.

1.2 Definitions

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

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 230500E – Common Work Results for Mechanical.
- .2 Submit for approval all manufacturers' documentation regarding installation, forming and jointing of pipes, fittings, and valves.

1.4 Qualifications

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

1.5 Delivery, storage and handling

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

1.6 Waste Management and Disposal

- .1 Sort and recycle waste according to provincial and municipal requirements and standards.
- .2 Place all packaging in designated containers.
- .3 Place excess or unused insulation and insulation accessory materials in designated containers.

2. **PART 2 – PRODUCTS**

2.1 Fire and smoke rating

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

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 75°F mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.9.
 - .2 Maximum "k" factor: to CAN/CGSB-51.9.
 - .3 Acceptable product: Fiberglas SSL-II or equivalent.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.9.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.9.
 - .4 Acceptable product: Fiberglas SSL-II or equivalent
- .5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in Part 3 of this section).
 - .1 Mineral fibre: to CAN/CGSB-51.11.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.11.

- .6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: to CAN/CGSB-51.40.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.40.
 - .4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.
 - .5 Acceptable product: Armaflex AP or equivalent.
- .7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: to CAN/CGSB-51.2.
 - .2 Maximum "k" factor: to CAN/CGSB-51.2.
 - .3 Design to permit periodic removal and re-installation.

2.3 Insulation securement

- .1 Tape: self-adhesive, aluminum, reinforced, 2" wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 0.06" diameter stainless steel.
- .5 Bands: stainless steel, 0.02" wide, 3/4" thick.

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 To CAN/CGSB-51.12.
 - .2 Air drying on mineral wool, to ASTM C449/C449M.

2.5 Vapour retarder lap adhesive

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

2.6 Indoor vapour retarder finish

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

2.7 Jackets

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: white.
 - .3 Minimum service temperatures: -5°F.
 - .4 Maximum service temperature: 150°F.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.04".
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .8 Special requirements:
 - .1 Install on all exposed piping, as indicated on drawings.
 - .2 Outdoor: UV rated material at least 0.5 mm thick.

- .2 Canvas:
 - .1 0.05 lb/ft cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm (0.05") sheet.
 - .3 Finish: smooth.
 - .4 Joining: longitudinal and circumferential slip joints with 2" laps.
 - .5 Fittings: 0.02" thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 3/4" wide, 0.02" thick at 12" spacing.
- .4 Stainless steel:
 - .1 Type: 304.
 - .2 Thickness: 0.01".
 - .3 Finish: smooth.
 - .4 Joining: longitudinal and circumferential slip joints with 2" laps.
 - .5 Fittings: 0.02" thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 3/4" wide, 0.02" thick at 12" spacing.

3. PART 3 – EXECUTION

3.1 Pre-installation requirement

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

3.2 Installation

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

3.3 Removable, pre-fabricated, insulation and enclosures

- .1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as adjacent insulation system.
 - .2 Jacket: aluminum in mechanical rooms, canvas or PVC, above hanging ceilings.

3.4 Installation of elastomeric insulation

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

3.5 Piping insulation schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: wire at 12" on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: aluminum bands.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Seals: lap seal adhesive for elastomer.
 - .2 Installation: to applicable TIAC Code.
- .5 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Insulation securements: aluminum bands.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .6 TIAC Code: A-2.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 Installation: TIAC Code: 1501-H.
- .7 Piping insulation
 - .1 Scope of work
 - .1 Hot Water Heating piping full length: insulation to TIAC-A1, 25 mm thick for NPS-1" and less; 38 mm for NPS-1¼" diameter and more.
 - .2 Finishes
 - .1 Finish all exposed insulation with certified finishing coating and according to section 3.3 for this usage. Joints on cold piping must be completely sealed.
 - .2 Acceptable product: Proto PVC by Proto Corp. or equivalent with canvas lining coated with two (2) fire retardant coatings, gauge 26 aluminium.

1. PART 1 – GENERAL

1.1 Product Data

- .1 Submit shop drawings and product data in accordance the requirements of section 230500E.
- .2 Design detailed control systems for specific operations. Refer to operation sequences in accordance with drawings and this section.
- .3 Shop drawings, product data for all control equipment and complete control diagrams must indicate rest position of equipment, model numbers, connection lines, operation sequences, set points, and adjusting ranges.

1.2 Automatic control works

- .1 Scope of work
 - .1 Automatic control contractor shall be a subcontractor of the HVAC contractor.
 - .2 Provide materials and manpower as well as training and programming required for control works.
- .2 Dismantling
 - .1 Remove existing useless control accessories.
- .3 New setup
 - .1 Provide, install and connect all new electronic and electro-pneumatic accessories to operate equipment according the sequence described on drawings (see diagram and details on drawings). Include all local controllers, I/O cards, relay, thermostats, probes, 120/24 VAC transformers, conduits and wiring cables required for complete work including interlocks and remote commands of motors at 120 volts.
- .4 Materials
 - .1 All products from Delta Controls to be compatible with existing management network at CSA or equivalent by Trane Quebec.
 - .2 See details for some control diagram items not be interpreted as connection diagram.
 - .3 All wiring to Quebec Electrical Code and NCB-2005. All wiring in visible locations to be installed in EMT conduits, and in Greenfield conduct in partitions and for the last 600 mm connection to a motor or a mobile equipment.
 - .4 Pneumatic signal will be 0 to 15 psig for direct action, and of 10 to 15 psig for reverse action of a DD box, when it applies.

2. PART 2 – PRODUCTS

2.1 General

- .1 Include all equipment and accessories required for operations and respect operation sequences.
- .2 Control to be of electric-electronic type, or/and electro-pneumatic type.
- .3 In general, concealed tubing in walls to be in PVC, but in copper in ceiling spaces, control wiring to be installed in conduit in accordance with Division 26.
- .4 Control equipment from same manufacturer-installer, unless otherwise indicated in drawings or in specifications.

2.2 Control valves

- .1 See control valve schedule hereafter:

Tableau des vannes de contrôles / Control valve schedule								
No/Nb	Type	Débit	Corps/Body	Fonction/Service	Operation	CV	Diametre	Notes
VC-001	2W	1.8 gpm (0.11 l/s)	Brass	Heating hot water	On-Off	3.5	DN-1/2	1, 2, 3, 4, 5, 6
Notes: 1- Bille en acier inoxydable / Stainless steel ball 2- Actuateur thermoélectrique silencieux (0 dB) / Thermoelectric silent actuator (0 dB) 3- Signal de contrôle 2-10 vdc / 2-10 vdc control signal 4- Alimentation à 24 Vac / 24 Vac supply 5- Normalement ouvert / Normally open 6- Temps d'ouverture très long / Very long opening time								

- .2 Quality required: Spartan model VE243-12-EP3.5-1607 or equivalent from Honeywell, of on-off operation and complete with its factory mounted actuator.

2.3 Double duct box and single VAV box

- .1 See box schedule on plans.
.2 Quality required: EH Price or equivalent approved, model DDS-5000 and SDV-5000.

3. PART 3 – EXECUTION

3.1 Installation

- .1 Install all required control components in accordance with manufacturer's recommendations.
.2 After installation, use, adjust and set all control elements and equipment installed in accordance with this section, to operate systems in accordance with operation sequences.

3.2 Control sequences and building management

- .1 See mechanical drawings for control diagrams and HVAC system sequences.
.2 The monitoring of the following actions and functions have to be displayed on the screen of the building management central controller located in the 6B-104-A:
.1 Room temperature and set point of probes in all controlled zones.
.2 Operation mode of double duct and single duct VAV boxes.

1. PART 1 – GENERAL

1.1 Summary

- .1 Section Includes.
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems
- .2 Related Sections.
 - .1 Section 230500E - Common Work Results for Mechanical.
 - .2 Section 230517E - Pipe Welding.
 - .3 Section 230802E - Cleaning and Start-up of Mechanical Piping Systems.
 - .4 Section 230593E - 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 Butt welding 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 A 47/A47M-[99], Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A 53/A53M-[02], Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A 536-[84(1999)e1], Standard Specification for Ductile Iron Castings.
 - .4 ASTM B 61-[02], Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B 62-[02], Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E 202-[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 Association canadienne de normalisation (CSA)/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], Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

2. PART 2 - PRODUCTS

2.1 Heating or chilled water piping (with or without glycol)

- .1 General
 - .1 Use steel piping for NPS-2 ½ and larger and copper tubing for NPS-2 and smaller (steel pipes optional). A dielectric device shall be inserted between two different metals.
- .2 Steel pipes and accessories
 - .1 Schedule 40, Victaulic of flanged types for fittings with welded joints on NPS-2 ½ and larger, screwed fittings and joints on NPS-2 and smaller, black steel ASTM-A53 grade B.
 - .2 Forged steel fittings class 200 per ANSI B-16.9.
- .3 Copper piping and accessories
 - .1 Rigid type "L" tubing per ASTM-B-88M.
 - .2 Brazed joints with 95% tins and 5% antimony.
 - .3 Forged brass fitting per ANSI B-16.15 and B-16.22.
 - .4 Class 125 cast steel flanged c/a rubber gasket.
- .4 Valves
 - .1 Ball valves up to NPS-2 : Crane F-902, Watts B-6000, Victaulic or M.A. Stuart.
 - .2 Butterfly valves from NPS-2 : Appollo no. 148, Mueller Steam specialty, Victaulic, Keystone or Bray-Valve.
 - .3 Supply with and extension stem to clear the insulation material according to thickness.
 - .4 Dielectric joint as per ASTM F492.
 - .5 Manual balancing valves of Venturi type 2A Griswold, Preso, Flow Design or Hays on low flows, and as Armstrong CBV, Tour & Anderson or Preso for NPS-2 ½ on larger, sized for the flow by the manufacturer.
- .5 Supports
 - .1 Support and anchor piping with screwed rods chosen for the definite charge and in consideration of expansion and contractor of pipes and as per MSS-SP-58 recommendations.
 - .2 Refer to section 230529E – Hangers and supports for HVAC piping and equipment, and also to section 230548E – Vibration and seismic controls for HVAC piping and equipment, for material and installation.
- .6 Fire protection
 - .1 Fill the annular space around the pipe going through partitions and floors having a fire resistance with CSA approved caulking products as Hilti or equivalent.

3. PART 3 - EXECUTION

3.1 Piping installation

- .1 Install pipework in respect of the building lines and leaving the maximum room in the premises.

3.2 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.

3.3 Cleaning, flushing and start-up

- .1 In accordance with Section 230802E - Cleaning and Start-Up of Mechanical Piping Systems (if applicable).

3.4 Testing

- .1 Test the network to 1.5 times the service pressure, but never less than 860 kPa.
- .2 Segregate all equipment of accessory of nominal pressure low than the testing pressure.
- .3 The testing pressure shall be maintained during at least 4 hours without dropping.
- .4 Correct all leaks and remake the test.
- .5 For gas networks, make tests as per standard CAN/CGA-B-149.10, Natural and Propane gas installation Code.

3.5 Balancing

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 Refer to Section 230593E - Testing, Adjusting and Balancing for HVAC or applicable procedures.

1. PART 1 – GENERAL

1.1 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A 635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A 653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 National Fire Protection Agency 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.
- .4 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.

2. PART 2 - PRODUCTS

2.1 Seal Classification

- .1 The seal class of ducts has to be determined according the following table :

<u>Maximum Pressure Pa</u>	<u>SMACNA Seal Class</u>
500	B
250	B
125	B

- .2 Seal classification :
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape or combination thereof.
 - .3 Class C: transverse joints and connections made air tight with sealant, tape or combination thereof. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.2 Sealant

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.
 - .1 Acceptable products : Duro-Dyne S-2; Foster 30-02; 3M; EC-800.

2.3 Tape

- .1 Tape: polyvinyl treated, open weave fiberglass tape, 50mm wide.
 - .1 Acceptable product : Duro-Dyne FT-2.

2.4 Duct Leakage

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual for a Class B.

2.5 Fittings

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: standard radius.
 - .2 Round: centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400mm: with single thickness turning vanes.
 - .2 Over 400mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 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 Radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.

2.6 Fire Stopping

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Fire stopping material and installation must not distort duct.

2.7 Galvanized Steel Ducts

- .1 Lock forming quality: to ASTM A 653/A 653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.
- .3 Joints: to ASHRAE, SMACNA, proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

2.8 Stainless Steel

- .1 To ASTM A 480/A 480M, Type 316.
- .2 Finish: No. 4.
- .3 Thickness, fabrication and reinforcement: to ASHRAE, SMACNA, as indicated.
- .4 Joints: to ASHRAE and SMACNA be continuous inert gas welded.

2.9 Hangers and Supports

- .1 Hangers and Supports: in accordance with Section 230529E - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500.
 - .2 Hanger configuration: to ASHRAE and SMACNA.
 - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA and the following table :

<u>Duct Size (mm)</u>	<u>Angle Size (mm)</u>	<u>Rod Size (mm)</u>
Up to 750	25 x 25 x 3	6
751 to 1 050	40 x 40 x 3	6
1 051 to 1 500	40 x 40 x 3	10
1 501 to 2 100	50 x 50 x 3	10
2 101 and 2 400	50 x 50 x 3	10
2 401 and over	50 x 50 x 3	10

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

3. PART 3 - EXECUTION

3.1 General

- .1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct. Ensure diffuser is fully seated.
- .3 Support risers in accordance with ASHRAE, SMACNA, as indicated.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.2 Hangers

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

<u>Duct Size (mm)</u>	<u>Spacing</u>
To 1 500	3 000
1 501 and over	2 500

3.3 Watertight Duct

- .1 Provide watertight duct for:
 - .1 Dishwasher exhaust.
 - .2 Fresh air intake.
 - .3 Minimum 1000 mm from duct mounted humidifier in all directions.
 - .4 All indicated ducts.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume or gas hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150mm deep drain sump and 32mm drain connected, with deep seal trap and valve, trap primer and discharging to open funnel drain as indicated.

3.4 Sealing and Taping

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

3.5 Leakage Tests

- .1 Refer to Section 230593E – Testing, Adjusting and Balancing (TAB) of Mechanical 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 30m long with not less than three branch takeoffs and two 90 degrees elbows.
- .7 Complete test before performance insulation or concealment Work.

1. PART 1 – GENERAL

1.1 References

- .1 Design, manufacture, supply and install the ducts in accordance to the following standards:
 - .1 SMACNA, HVAC Duct Construction Standards Metal and Flexible, second edition, 1995 – Add. November 1997.

2. PART 2 - PRODUCTS

2.1 Metal duct – High pressure to 2 500 Pa

- .1 Manufactured to support a pressure 1.5 times the static pressure of the system. Designed to support a minimum pressure of 300 mm of water.
- .2 Gauge of ducts, supports, rods and spacing of supports as per ASHRAE, SMACNA and applicable codes.
- .3 Material: galvanized steel G-90 ASTM A-633, sealing and tightness classes according to SMACNA, industrial spiral reinforced joint type duct.
- .4 Closed T-joints as described by SMACNA and flanged fittings.
- .5 Sealant: Duro-Dyne S-2 and FT-2, over all non-welded joints.
- .6 Round-type elbows with a radius of (1 1/2) time the width of the conduit.
- .7 Application of high pressure ducts:
 - .1 The hot and cold ducts of the double duct network of all the areas concerned.

3. PART 3 – EXECUTION

- 3.1 The new ducts of the double duct systems shall be air tight and supported according to section 230529E “*Hangers and supports for HVAC piping and equipment*”.

1. PART 1 – GENERAL

1.1 No object

2. PART 2 - PRODUCTS

2.1 Flexible connections

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material: neoprene
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated between 40°C to 90°C, with a density of 1.3 kg/m².
 - .2 Acceptable products: Duro-Dyne or Dyn-Air.

2.2 Access doors in ducts

- .1 General
 - .1 Non-insulated ducts
 - .1 Sandwich construction of same material as duct, non-insulated, one sheet metal thickness heavier, minimum 1.0mm thick complete with sheet metal angle frame.
 - .2 Insulated ducts
 - .1 Sandwich construction of same material as duct, insulated, although with 25mm thick rigid glass fiber insulation. The fiber shouldn't be exposed.
- .2 Gaskets: neoprene or rubber mousse.
- .3 Hardware:
 - .1 For door measuring up to 300 x 300mm: 2 sash locks
 - .2 For door measuring from 301 to 450 mm: 4 sash locks
 - .3 For door measuring from 451 to 1 000mm: piano hinge and minimum 2 sash locks
- .4 Acceptable products: Nailor, Cendrex, Trolec or approved equivalent

2.3 Turning vanes

- .1 Factory or shop fabricated single or double thickness, to recommendations of SMACNA.

2.4 Air distribution dampers

- .1 Dampers made of same material as the ventilation duct although with a standardized thickness sheet immediately greater than that of the air duct.
- .2 Dampers made from only one sheet thickness.
- .3 Dampers dimensions and configuration in accordance with the SMACNA.
- .4 Dampers provided with a control rod with locking mechanism.
- .5 Curve at the tip of the rod preventing this tip from entering into the ventilation duct.
- .6 Pivot: piano hinge.

2.5

Balancing dampers with only one shutter

- .1 Dampers made of same material as the ventilation duct and grooved to ensure a better rigidity.
- .2 Dimension and configuration of the dampers in accordance with the SMACNA, except the maximum height which will be 250mm.
- .3 Dampers equipped with locking devices.
- .4 Dampers provided with interior and external angles bearings.
- .5 Hardware for balancing shutters :
 - .1 Round or rectangular shutters less than 10 in. – Duro-Dyne KS-7.
 - .2 Round shutters of 11 in. with 20 in² - Duro-Dyne KSR-19.
 - .3 Rectangular shutters of over 11 in. – Duro-Dyne KS-19.

2.6 Balancing dampers with multiple shutters

- .1 Dampers made in factory with a compatible material of that of the ventilation duct.
- .2 Opposite shutters: configuration in accordance to the SMACNA.
- .3 Maximum height of the shutters: 100mm.
- .4 Bearings: needle bearings within a bronze padding.
- .5 Clutch control: shaft extension with locking device.
- .6 Frame in angles, provided with butted angle.
- .7 Hardware for balancing shutter:
 - .1 Round or rectangular shutters less than 10 in. – Duro-Dyne KS-7.
 - .2 Rectangular shutters of over 11 in. – Duro-Dyne KS-19.

2.7 Operation dampers with multiple shutters (or motorized dampers)

- .1 Of the type with blades opposed on modulating shutters, or parallel blades on on/off shutters.
- .2 Interrelated blade out of cast steel or extruded aluminum containing gaskets made out of extruded vinyl, stainless steel trimmings with spring, and a galvanized molded steel frame or from extruded aluminum.
- .3 Bronze bearings, self-lubricating, adjusted by pressure.
- .4 Clutch control: tie rods made from clad steel, brass pivots and clad steel supports, and containing a control rod out of plated steel.
- .5 Positioner: being appropriate for the damper.
- .6 Height of blades: 100mm maximum.
- .7 Required quality: T.A. Morrison series 1000; but T.A. Morrison insulated series 9000 (for fresh air and exhaust air), or equivalent from Trolec or Penn.

2.8 Fire dampers

- .1 Approved fire damper and carrying a UL or ULC label, and fulfilling the requirements of the Canadian Fire Commissioner (CIC).
- .2 Fire dampers assembled on hinge on the higher part, with simple eccentric shutters, round or square, of the type with articulated or coupled blades, by rolling up or guillotine. Dimensions of the unit calculated so as not to restrict the section of the duct.
- .3

Dampers actuated by fusible link, with counterweight allowing closing and locking in the closed position once the mechanism is activated, or with complete on control with control spring for the type with several shutters, or rolling up assembled in horizontal position in a vertical ventilation duct.

- .4 The complete unit with steel frame and angles of 40 x 40 x 3mm on all it's circumference, on the two sides of the partition of the crossed fire wall.
- .5 Required quality: Nailor Industry or equivalent from Controlled Air Manufacturing ltd., Ruskin (Kerr-Haut), E.H. Price.
Type A dampers (100% free area) for the duct having a maximum height of 300mm, of the type B for greater heights.

2.9 Fittings for testing instruments

- .1 Requires quality: Duro-Dyne IP-2 model.

3. PART 3 – EXECUTION

3.1 Flexible connections

- .1 Install in following locations:
 - .1 Inlets of blowers.
 - .2 Outlets of blowers.
 - .3 Inlets and outlets of exhaust and return air fans.
- .2 Length of connection: 150mm.
- .3 Minimum distance between metal parts when system is in operation: 75mm.
- .4 Install in accordance with SMACNA recommendations.

3.2 Tape and sealing material

- .1 Apply the sealing material in accordance to the SMACNA recommendations and of that of the manufacturer.
- .2 Bathe the tape in the sealing material, than apply at least one coating in accordance to the manufacturers recommendations.

3.3 Access doors

- .1 Dimensions:
 - .1 According to the indications listed in section 230500E.
- .2 Location:
 - .1 At the required locations in order to permit the access to the fire and smoke dampers.
 - .2 At the required locations in order to permit the access to the air flow control.
 - .3 At the required locations in order to permit the access to the necessary devices requiring a periodical maintenance.
 - .4 At the required locations in accordance to the standards.

3.4

Fittings for instrument test ports

.1 General

- .1 For the flow readings, install in accordance with the SMACNA recommendations.
- .2 For the temperature readings, install in accordance with the SMACNA recommendations.
- .3 Install the fittings in accordance with manufacturer's instructions.

.2 Locations:

- .1 For air flow readings:
 - .1 At ducted inlets to roof or wall exhausters.
 - .2 At inlets or outlets of other fan systems.
 - .3 At main and sub-main ducts.

3.5 Fire breakers

.1 Install in accordance with the SMACNA, NFPA recommendations.

.2 Fire dampers and shutters:

- .1 Install the fire dampers in accordance to the NFPA 90A-2002 standard and «SMACNA fire, Smoke and radiation damper installation guide for HVAC systems», 4th edition 1992.
- .2 Complete work without reducing the degree of fire resistance of the wall or partition firebreak.
- .3 If necessary, approve the achieved work prior to dissimulating parts of them.
- .4 Get approve a standard installation.

.3 Adjusting and balancing dampers:

.1 Balancing dampers:

- .1 The contractor will have to supply and install all the necessary balancing registers in order to allow the calibration of the ventilation/air-conditioning systems, and this, even if these dampers all are not shown with the drawings.
- .2 Install dampers in accordance with SMACNA.
- .3 Caulk and seal joints between multiple registers with a UL approved transparent silicone based sealer.

1. PART 1 – GENERAL

1.1 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
 - .2 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-[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 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, [95] (Addendum No.1, November 1997).
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition [1995].
- .6 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181-[96], Standard for Factory-Made Air Ducts and Air Connectors.
- .7 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110-[1986(R2001)], Fire Tests for Air Ducts.

2. PART 2 - PRODUCTS

2.1 General

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

2.2 Metallic – Uninsultated

- .1 Type 1 : spiral wound flexible aluminum or stainless steel as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acceptable products : Flexmaster T/L.

2.3 Metallic - Insulated

- .1 Type 2: spiral wound flexible aluminum with factory applied, 25mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Thermal loss/gain: 1.03 W/m². degrees C mean.
- .3 Acceptable product: Flexmaster T/L – Thermal.

3. PART 3 – EXECUTION

3.1 Duct Installation

- .1 Install thermal insulated flexible ducts in accordance with: CAN/ULC-S110, UL-181, NFPA 90A, NFPA 90B and SMACNA pertinent standards, everywhere indicated on plans and specifically:
 - .1 At cold air intake connections of double and single duct boxes.
 - .2 At diffusers connections at the air distribution discharges.

1. PART 1 – GENERAL

1.1 Reference

- .1 Execute work as per recommendations of SMACNA Standard "Duct liner applications standard".

1.2 Scopes of work

- .1 The following ductworks shall be acoustically lined on their inside surfaces:
- .1 New ductwork of supply air at low speed with 13 mm thick insulation.
 - .2 Transfer ducts from a room to the false ceiling or another room, 25 mm thick insulation.
 - .3 Where indicated on drawings.
 - .4 Obtain the approval of the Departmental Representative on a portion of duct before completing the balance.
 - .5 The duct dimensions shown are interior sizes on drawings with acoustic duct liner increase the size of duct to keep the free area indicated on plans.
 - .6 Upon authorization of Departmental Representative, a round duct thermally insulated can replace a rectangular duct with acoustic duct liner. Refer to section 230713E – Duct insulation for details.

2. PART 2 – PRODUCTS

2.1 Duct liner

- .1 General:
- .1 Inert material having less than 3% water adsorbing capacity, as per standard ASTM C 1104, made of inorganic fiberglass with a smooth surface in contact with the air.
 - .2 The liner has to be cleanable and meet the cleaning practices for duct insulated with fibrous products recommended by N.A.I.M.A.
 - .3 The layer in contact with the air has to be pre-treated per an anti-microbial listed by EPA for prevention of fungus and bacterial development.
 - .4 The material does not support, nor encourage growth of mildew, fungi and bacteria.
- .2 Flexible liner having the following characteristics:
- .1 Mineral fiber blanket as per standard ONGC-51.11-92, density of (2 lb/cu.ft) 32 kg/m³, and sound absorption coefficients by ASTM C423 as the following table:

Density	Thickness	125 Hz	250 Hz	500 Hz	1 000 Hz	2 000 Hz	4 000 Hz
32 Kg/m ³	13 mm	0,09	0,14	0,40	0,60	0,73	0,82
32 Kg/m ³	25 mm	0,25	0,35	0,69	0,89	0,96	1,01

- .2 Thermal resistance tested following ASTM C177 standard:

Density	Thickness	Conductance	Resistance	Conductance	Resistance
32 Kg/m ³	13 mm	C = 0,48	R = 2,1	C (SI) = 2,73	R (SE) = 0,37
32 Kg/m ³	25 mm	C = 0,24	R = 4,2	C (SI) = 1,36	R (SE) = 0,74

- .3 Acceptable products: KNAUF DUCTLINER E.M., ou THOUGHGARD R-DuctLiner of Certainteed or Fiberglas or Manville equivalent approved.

- .3 Adhesives
 - .1 Adhesive having a flame spread index of 25 maximum and an smoke developing index of 50 maximum, useable in range of temperatures of -30°C to 93°C and complying to NFPA 90-A.
 - .2 Quality: Duro Dyne 1A-22.
- .4 Fasteners
 - .1 Welding pins on duct, 2 mm diameter, length according to the liner thickness, with nylon or metal retaining sheets of 32 mm sides.
 - .2 Quality: Duro Dyne, series PN pins, retainers series NC.
- .5 Joint tape
 - .1 50 mm large tape mineral fiber, large mesh, polyvinyl embedded.
 - .2 Quality: Duro Dyne FT2.
- .6 Sealer
 - .1 Sealing product of flame spread index of 25 maximum and smoke developing index of 50 maximum, usable in range of temperatures from -30°C to 93°C and complying to NFPA 90-A.
 - .2 Quality: Duro Dyne S-2.

3. PART 3 – EXECUTION

3.1 General

- .1 Where indicated on plans or at the scope of work, cover interior of ducts with acoustical duct liner.
- .2 The dimensions of duct are in fact the inside dimensions after the liner is being installed.
- .3 Fabricate ductwork in lengths making it easy to install liner.

3.2 Interior duct liner

- .1 Install duct liner according to figure 2-19 of SMACNA "Duct Construction Standard" and manufacturer's requirements, with pins in ducts of more than 200 mm (8") large and adhesive on 100% of the surface.

3.3 Joints

- .1 Seal with tape the sides and joints of the liner, the space around pins and all damaged parts. Portions of liner that are seriously damaged shall be replaced upon discretion of Departmental Representative.
- .2 Install the tape as per SMACNA and the following:
 - .1 Sink the tape in the sealer.
 - .2 Apply two (2) layers of sealer on the tape.
- .3 Add a layer of sealer at the ends ahead and at bottom of liner to protect it while keeping the full thickness at joints to avoid crumbling.
- .4 The joints at two (2) duct sections connection with sheet metal squeezing the liner and stapled through the duct will be systematically rejected.

3.4 Salubrity of sections

- .1 Ductwork prepared in the shop and delivered on job site shall be dry, without stripping, nor dirt and capped on both ends with plastic sheets.
- .2 Any section found humid, wet or considered not healthy by the Departmental Representative will be removed systematically from job site and replaced by the contractor, with no additional fees.

1. PART 1 – GENERAL

1.1 Product Data

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Submittal Procedures.
- .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

2. PART 2 – PRODUCTS

2.1 General

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

2.2 Manufactured units

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

2.3 Grilles and diffusers models

- .1 Return/ exhaust grilles GR-1 :
 - .1 Model in aluminium, “egg crate” type, white finish.
 - .2 Acceptable products : EH Price #80/F, of sizes indicated on plans, or equivalent from Titus or Nailor.
- .2 Supply diffusers D-1 :
 - .1 Model in aluminum c/w Square Plenum and round collard white finish.
 - .2 Acceptable products: NAD of sizes and models indicated on plans, no equivalent.

3. PART 3 – EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturers instructions.
- .2 Install with flat head cadmium plated screws in countersunk holes where fastenings are visible.