

Part 1 General

1.1 GENERAL

- .1 This section covers items common to all sections of Division 23 and is intended only to supplement the requirements of Division 1 and General Conditions of Contract.
- .2 The word "provide" shall mean "Supply and Install".
- .3 Provide materials, equipment and plan of specified design quality and of current models with published ratings for which replacement parts are readily available.
- .4 The codes and standards referred to in the specifications establish the minimum requirements only. The most stringent requirements of the specifications, drawings, codes and standards shall govern. Refer to the latest editions of all applicable codes and standards.

1.2 EQUIPMENT LIST

- .1 Complete list of equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .2 Submit for approval within 10 days after award of contract. Do not order equipment until the equipment list has been approved.

1.3 BREAKDOWN OF COSTS

- .1 Upon notice of contract award, furnish price breakdown of tendered price.

1.4 AS INDICATED

- .1 Means that the item or items specified are shown on the drawings.

1.5 ENERGY CONSUMPTION

- .1 Departmental Representative may reject equipment submitted for approval on basis of performance or energy consumed or demanded.

1.6 EQUIPMENT REQUIREMENTS AND INSTALLATION

- .1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to connecting piping and duct systems and without interference from building structure or other equipment.
- .2 Provide accessible means for lubricating equipment including permanent lubricated bearings.
- .3 Pipe all drain lines to floor drains.

- .4 Equipment, cleanouts, floor drains and like equipment shall be lined-up with the building wall wherever possible.
- .5 Provide 3-valve bypasses on all control valves and pressure reducing valves. As indicated on drawings.
- .6 All mechanical ceiling equipment should be installed within 900mm of ceiling.

1.7 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts and templates for installation by other divisions.

1.8 TRIAL USAGE

- .1 Obtain written permission from Departmental Representative to start and test permanent equipment and systems prior to acceptance by Departmental Representative.
- .2 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing. The Departmental Representative has the right to verify the operation of the following equipment and systems:
 - .1 All air systems.
 - .2 All controls.
 - .3 All seawater systems.
 - .4 All plumbing systems.
 - .5 Vacuum pump systems.
 - .6 HXWS & R piping services.

1.9 PROTECTION OF OPENINGS

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials during trial usage until accepted by Departmental Representative. Provide plastic seals taped over open ended ductwork on a daily basis. Do not store ductwork and equipment outside unless adequately covered.
- .2 Clean and refurbish all equipment and leave in first class operating condition including replacement of all filters as approved by Departmental Representative.

1.10 EQUIPMENT SUPPORT

- .1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Division 23.
- .2 Equipment supports not supplied by equipment manufacturer: fabricate from structural grade steel meeting requirements of Division 05 - Metals. Submit structural calculations with shop drawings.
- .3 Mount hydronic base mounted equipment on chamfered edge housekeeping pads, minimum of 100mm (4") high and larger than equipment dimensions all around. Housekeeping pads to be provided by others and supervised by this division.

1.11 TESTS

- .1 Provide the following supplementary requirements to test specified in mechanical work sections.
 - .1 Give four (4) working days written notice of date for tests.
 - .2 Insulate or conceal work only after testing and approval by Departmental Representative.
 - .3 Conduct tests in presence of Departmental Representative.
 - .4 Bear costs including retesting and making good.
 - .5 Pipe Pressure:
 - .1 General: maintain test pressure without loss for 4 h unless otherwise specified.
 - .2 Test all hydronic systems at 1½ times system operating pressure or minimum 860 kPA (125 psig), whichever is greater.
 - .3 Test fire systems in accordance with authorities having jurisdiction and as specified elsewhere.
 - .6 Equipment: test as specified in relevant sections.
 - .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.
 - .8 Conduct all other tests as specified in other Sections of Division 23.
 - .9 Replace defective material or equipment and repair joints using new material.

1.12 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports, hangers and site fabricated equipment.
- .2 Prime and touch up marred finished paintwork to match original. Do not paint over nameplates.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.13 SPARE PARTS

- .1 Furnish spare parts as follows:
 - .1 One set of mechanical seals and any special tools for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass.
 - .4 One set of V-belts for each piece of machinery.
 - .5 One strainer for each pump.
 - .6 Keep for vandal resistant devices.
- .2 Identify spare part containers as to contents and replacement parts number.
- .3 Turn over spare parts to General Contractor and obtain signal acknowledgement from Departmental Representative and insert same in Operations & Maintenance Manual.

1.14 SPECIAL TOOLS

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers.
 - .1 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.
 - .2 Turn over spare parts to General Contractor and obtain signal acknowledgement from Departmental Representative and insert same in Operations & Maintenance Manual.

1.23 ACCESS DOORS

- .1 Supply access doors for furred ceilings or spaces for servicing equipment and accessories or for inspection of safety, operating or fire devices for installation under section erecting the walls or ceilings. Also supply and arrange for installation of access pits and covers for servicing and inspection of valves, devices which are to be installed below grade or below floor in floor slabs.
- .2 Flush mounted 600mm x 600mm for body entry and 300mm x 300mm for hand entry unless otherwise noted. Doors to open 180E, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps. Doors shall be of approved manufacturer with published literature. Access doors shall be minimum 14 ga. thick.
 - .1 General: Prime coated steel.
 - .2 Special areas such as tiled or marble surfaces: stainless steel.
- .3 Installation:
 - .1 Locate so that concealed items are accessible.
 - .2 Locate so that hand or body entry (as applicable) is achieved.
 - .3 Installation is specified in applicable sections.

1.16 DEMONSTRATION, OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Where specified elsewhere in Division 23 manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instructions in maintenance and operations of the following equipment shall be given by factory trained personnel and for a minimum period of one day or as specified below:
 - .1 Seawater system – one (1) day.
 - .2 Vacuum pump system – one (1) day.
 - .3 Building mechanical system - one (1) day.

1.17 OPERATION AND MAINTENANCE MANUAL

- .1 Provide operation and maintenance data for incorporation into operating and maintenance manuals.
- .2 Definition: detailed information and records of individual products provided by manufacturer or supplier as part of project requirements, and of systems, describing operation and maintenance of each item.
- .3 Operation and maintenance manual to be approved by, and final copies deposited with, Departmental Representative before final inspection.
- .4 Operation data to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .5 Maintenance data shall include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .6 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing.
- .7 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless so directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .8 Additional data:
 - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.18 SHOP DRAWINGS AND PRODUCT DATA

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

- .2 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances. eg. access door swing spaces.
- .3 Shop drawings and product data shall be accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify as to current model production.
 - .5 Certification of compliance to applicable codes.
- .4 When submitting shop drawings use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .5 Keep one (1) copy of shop drawings and product data on site, available for reference purposes at all times.

1.19 CLEANING

- .1 Clean mechanical (building) systems daily.
- .2 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units prior to handover of systems with report. Wipe down exterior of Air Handling Units and wash interior.
- .3 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.
- .4 Balance and adjust all systems and each piece of equipment to operate efficiently.

1.20 AS-BUILT DRAWINGS

- .1 To be read in conjunction with General Conditions of Contract and Section 01 77 00 - Contract Closeout Procedures.
- .2 Site records:
 - .1 Provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur.
 - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection at all times.
 - .5 At the end of the job, obtain a copy of the tender drawing CAD files and update to reflect As-Built conditions.
- .3 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 19mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED

TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).

- .3 Submit to Departmental Representative for approval and make corrections as directed.
- .4 TAB to be performed using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

- .4 Submit copies of as-built drawings for inclusion in final TAB report.

1.21 PENETRATION OF WALL AND FLOOR SLABS

- .1 Wherever pipes and ducts penetrate non-fire rated walls and floor slabs, tightly pack the space between construction and ducts/pipes the full depth with acoustic filler material and seal both sides with acoustic sealant. Where pipes pass through fire rated walls and floor slabs, pack space between the pipe and sleeve with approved fire rated and ULC approved sealant. Where pipes penetrate drywall partitions use sheet metal sleeves.
- .2 Acoustic Filler:
 - .1 Filler material shall be glass fibre or inorganic mineral.
 - .2 Filler material shall not have higher combustion rating than the following:
 - .1 Flame Spread Rating = 25
 - .2 Smoke Development Rating = 0
 - .3 Fuel Contribution Rating = 0
- .3 Acoustic Sealant:
 - .1 Concealed Application:
 - .1 Non-shrinking, non-straining, non-drying and permanently elastic type.
 - .2 Exposed Application:
 - .1 Permanently elastic, paintable acoustic sealant, latex acrylic or acrylic latex type.
- .4 Coordinate all openings in pre-cast wall panels with General Contractor. Provide all opening sizes and sleeve sizes and located marked on pre-cast panel shop drawings. Include for all ventilation, plumbing, sprinkler and other mechanical openings.

1.22 DRAWINGS

- .1 Mechanical drawings are not intended to show structural details or architectural features.
- .2 The Mechanical drawings are not to be scaled.
- .3 Except where dimensioned, indicate general Mechanical layouts only. Because of the small scale of Mechanical drawings, it is not possible to show all offsets, fittings and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves and accessories which are required to meet the conditions.

1.23 SITE SERVICES

- .1 Known Services:
 - .1 Conform to drawings, they represent known existing underground facilities.
 - .2 Discuss with Departmental Representative before starting work and follow his written instructions.
 - .3 Once location is set out, be responsible for all damage thereto during excavation work and for the cost of all repairs and replacements made necessary thereby.
- .2 Unknown Services:
 - .1 Avoid damaging or displacing existing services where exact position is not known, but should any damage occur, advise Departmental Representative in writing for instructions as to repairs.

1.24 EXISTING SITE CONDITIONS

- .1 The contractor shall visit the site of the building in order to examine first hand the existing conditions which may affect his contract. No compensation shall be considered for additional expenditures incurred later through failure to do so.

1.25 EXISTING SYSTEMS AND SERVICES

- .1 The location of existing systems and services as shown on the drawings are approximate only. Ascertain the exact location of these services before commencing with installation. No compensation shall be considered for additional expenses incurred later through his failure to do so.
- .2 Any connection to the existing systems shall be made at a time approved by the Departmental Representative. The contractor shall request for written approval of time when these connections could be made. This contractor shall be responsible for any damage caused to the existing systems by his crew.
- .3 Should existing services be accidentally uncovered and disrupted, make complete restoration immediately and ensure adequate protection to avoid further disruption.
- .4 Unless otherwise specified, restore services on which work is performed to original condition.

1.26 COMMISSIONING OF MECHANICAL

- .1 Upon receipt of written verification from the Departmental Representative that:
 - .1 All systems are complete and operational in all respects.
 - .2 All specified reports and certificates of verification have been submitted and approved.
 - .3 All demonstrations have been completed and documented, a systems' commissioning period will commence.
- .2 During this period of not more than ten working days, a Departmental Representative will verify the operation of all systems. The commissioning process may involve real or simulated conditions to determine the systems full operational capabilities. Copies of all specified reports and documents are to be available on site during the commissioning period.

- .3 During the commissioning process, the on-site foreman of the mechanical subtrade involved in the supervision of the work plus one mechanical contractor are to be on site, providing full time assistance to the commissioning team. In addition, systems suppliers' representatives are to be available to be on site, providing full-time assistance to the commissioning team within forty-eight hours notice to assist in the verification of their respective systems.
- .4 All necessary equipment such as meters, tools, etc. required to fully commission the systems are to be made available to the commissioning team by the Contractor.
- .5 Deficiencies or discrepancies discovered during the commissioning process are to be immediately rectified. Acceptable arrangements for labour and materials will be required to correct deficiencies which prevent the satisfactory completion of the commissioning process.

1.27 TEMPORARY USAGE OF SYSTEM

- .1 Permanent HVAC systems shall not be used for temporary heating and ventilation of the building until the Departmental Representative declares the building complete and dust free.

1.28 CONTRACT CLOSE-OUT

- .1 Our completion of contract provide the following materials for contract close-out.
 - .1 All spare parts (signed off list).
 - .2 Signed off list that contractor's demonstration's have been completed satisfactorily.
 - .3 TAB reports submitted.
 - .4 Contractors O & M manuals submitted.
 - .5 As built drawings submitted.
 - .6 Final Deficiency list-signed off.
 - .7 Equipment start up reports.
 - .8 All test reports carried out during installation.
 - .9 Copies of all warranties.

1.29 PACKAGED EQUIPMENT

- .1 The Mechanical Trade Contractor shall note that whenever packaged Environment is specified it is intended that this equipment shall be a complete package with all necessary accessories for safe operation.
- .2 These accessories shall include all necessary starter, disconnects, relays, transformers, pressure switches, sensors, timers etc. Where subject to the weather, the device shall be enclosed in a "weatherproof" enclosure.
- .3 The Mechanical Trade Contractor shall be responsible for checking with the supplier of all equipment to ensure that the packaged equipment is complete with all necessary accessories. He shall also determine which accessories are factory mounted and which ones are shipped loose with equipment. The Mechanical Trade Contractor shall included in his Tender an amount for all necessary wiring and piping etc. necessary to incorporate any pieces of equipment, which are shipped separately into the job, at no cost to the Owner.

- .4 Disconnect switches shall not obscure manufacturers nameplate data.
- .5 The Mechanical Trade Contractor shall note that this refers to all packaged Equipment including boilers, pump sets, etc. and shall be the responsibility to coordinate this with the supplier of the equipment and to either have the supplier include an amount to ensure the supply and installation of any accessories for the operation of this equipment.

1.30 WASTE MANAGEMENT AND DISPOSAL

- .1 Collect, separate and recycle all site generated waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Coordinate all work related to 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .3 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .4 Collect and separate for disposal, all packaging material in appropriate on-site bins for recycling in accordance with 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

END

PART 1 GENERAL

1.1 GENERAL

- .1 Read and conform to:
 - .1 Comply with Division 1 requirements and documents referred to herein.
 - .2 Section 01 91 13 – General Commissioning Requirements.
 - .3 Section 01 91 31 – Commissioning Cx Plan.
 - .4 Section 01 91 33 – Commissioning Forms.
 - .5 Section 01 91 41 – Commissioning Training.
- .2 Contractor is responsible for proper performance of Work.
- .3 Provide all labour, materials, Products, equipment and services for commissioning of all building systems to ensure building is operating according to requirements of Contract Documents.

1.2 REFERENCES

- .1 ASHRAE Guideline 0-2005 - The Commissioning Process.
- .2 ASHRAE Guidelines 1-19 - Guidelines for Commissioning of Specific Systems.

1.3 COMMISSIONING SUMMARY

- .1 Perform commissioning activities in accordance with requirements of Contract Documents. Activities include, but are not limited to following:
 - .1 Commissioning process shall be performed by Contractor, in accordance with Contract Documents. Contractor shall fully cooperate with Commissioning Authority. Commissioning shall be demonstrated to satisfaction of Commissioning Authority. Commissioning work will be divided into the following phases:
 - .1 Stage 1: Commissioning performed by Contractor on all building items, components, equipment and systems unless otherwise stated, which is a prerequisite requirement for Substantial Performance application. It includes, without limitation, activities such as startup, verification, adjusting and balancing, demonstration and instructions of authorized Commissioning Authority regarding each building system.
 - .2 Stage 2: Commissioning performed by Contractor after Substantial Performance, which includes without limitation activities such as training and fine tuning of building systems through all seasonal occupancy, or other operational conditions to achieve requirements of Contract Documents during 12 months following Substantial Performance to end of Work.

- .3 Stage 3: Successful completion of satisfactory system operation during the first month after Total Completion of the Work.
- .4 Stage 4: Successful completion of satisfactory system operation during the third month after Total Completion of the Work.
- .5 Stage 5: Successful seasonal commissioning of the building.
- .2 Commissioning includes systematic testing, documentation of system in all scope of operations and providing performance data. Provide complete description of all systems operation as well as equipment and material information. Perform additional testing as requested by Department Representative or Commissioning Authority to verify results without any extra cost to Departmental Representative.
- .3 Documentation of system includes system monitoring prior to Substantial Performance which includes tabulating at least for 21 Days of operation all significant system parameters. (such as, Room Temperatures, Hot & Chilled Water Temperatures and/or similar items) Process may involve measurement of those parameters during operation and assessment of results by comparing design values against actual performance values.
- .4 Prepare commissioning plan and program in accordance with recommendations of ASHRAE Guidelines and the specifications to suit Project requirements and comply with contract documents. Provide such plan and program and other relevant documentation in hard copy as well as in electronic format in system acceptable to the Departmental Representative.

1.4 EVALUATION OF COMMISSIONING WORK

- .1 An amount of 5% of the mechanical/ electrical construction budget will be held back for the mechanical/ electrical commissioning purposes, and the contractor may draw against that hold back on successful completion of their related commissioning tasks.
- .2 The Project Manager will not grant "Substantial Completion" until the Commissioning Authority submits a commissioning report with a recommendation for interim acceptance.
- .3 The Project Manager will withhold payment of a portion of funds in proportion to unfinished commissioning work, as detailed by the Commissioning Authority.

1.5 DEMONSTRATION AND TRAINING

- .1 Instructions - Mechanical:
 - .1 Thoroughly instruct Departmental Representative Authorized Personnel and in safe operation of systems and equipment after installation of Work. Coordinate with Department Representative and arrange commissioning program and schedule for instruction times. Submit a training schedule to Department Representative, minimum 2 weeks prior to start of training.
 - .2 Arrange and pay for services of qualified service engineers and manufacturers' representatives to instruct Departmental Representative on specialized portions of installation, such as refrigeration machines, boilers, automatic controls and water treatment.

- .3 Submit a complete record of instructions as part of maintenance instructions and data book given to Departmental Representative. For each instructional period, supply following data:
 - .1 Date.
 - .2 System or equipment involved.
 - .3 Names of persons giving instructions.
 - .4 Names of persons being instructed.
 - .5 Other persons present.
- .4 Carry out instructional period during a continuous period agreed with Departmental Representative.
- .5 Permit Departmental Representative and authorized representative(s) usage of systems prior to Substantial Performance for purpose of testing and learning operational procedures. This usage shall not affect warranties and no claim for damage shall be made against Department Representative for any injury or breakage to any part or parts of above due to aforementioned tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or quality of performance of any kind.
- .6 At end of training, obtain and submit to Department Representative, signature of authorized Owner stating they understand system and equipment installation, operation and maintenance requirements.
- .7 Obtain and submit to Departmental Representative, letters from manufacturers of equipment and systems indicating their technical representatives have inspected and tested equipment and systems installed and have approved methods of installation, connections and operation.
- .8 Only exception to foregoing requirements for acceptance of equipment and systems, will be 'fine tuning' which may be performed prior to Completion of Contract.
- .9 In conjunction with foregoing requirements, Contractor shall arrange necessary inspections and obtain written approval and acceptance of equipment and systems requiring approval by authorities having jurisdiction, and subsequent correction of those unacceptable items to satisfaction of such authorities.

END

PART 1 GENERAL

1.1 GENERAL INSTRUCTIONS

- .1 Read and conform to:
 - .1 Comply with Division 1 requirements and documents referred to herein.
 - .2 Section 01 91 13 – General Commissioning Requirements.
 - .3 Section 01 91 31 – Commissioning Cx Plan.
 - .4 Section 01 91 33 – Commissioning Forms.
 - .5 Section 01 91 41 – Commissioning Training.

1.2 DEFINITIONS

- .1 Validate: for tests and demonstrations: to witness and validate successful performance demonstration or record deficiencies; to validate after correction successful demonstration; these validations of the tests become references for the Departmental Representative's certification.
- .2 Certify: for documents including as-built drawings: Review for accuracy and completeness or record deficiencies.
- .3 Witness: The Commissioning Authority will observe as required and record summary of test results.
- .4 BAS: refers to the Building Automation System (Similar terms are: EMCS).
- .5 TAB: Testing and Balancing for system verification.
- .6 Commissioning Authority: Commissioning authority in charge of the commissioning process and recommends final acceptance.
- .7 Independent Third Party Agent: Independent agent specialized in installation and testing of the system and retained by the Contractor.

1.3 REFERENCES

- .6 ASHRAE Guidelines 0-2005 – The Commissioning Process.
- .7 ASHRAE Guideline 1- 19 – Guidelines for Commissioning of Specific Systems.

1.4 DOCUMENTS

- .1 In case of discrepancies or conflicts between documents, documents will be governed in the order specified in Division 1.

1.5 COMMISSIONING OBJECTIVES

- .1 Objectives of commissioning process are:
 - .1 To support quality management through monitoring and checking of installation;
 - .2 To verify system performance through testing and commissioning of completed installation;
 - .3 To move completed facility from “static completion” state to optimal “dynamic” operating state;
 - .4 To transfer facility from Contractor to Departmental Representative in such a manner that provision of a quality facility to Departmental Representative been assured.
 - .5 To optimize operating and maintenance through delivery of comprehensive quality training and instruction to personnel as per Section 01 91 41.
 - .6 To assure provision of accurate and useful historical records, such as, as-builts drawings, test certificates, etc. to Departmental Representative. Such records provide important data for operating and maintaining systems as well as for future system testing, maintenance or renovations and to trouble shoot and repair the components of systems.
 - .7 To extend commissioning into operational phase in order to verify performance levels under a range of operating conditions; such as change of seasons. This process will help to avoid unforeseen or hidden operating and maintenance expenses that may develop later on.
 - .8 Monitor operation, performance and maintenance programs; optimize system’s performance under normal operating conditions, partial occupancy, and full occupancy, under the direction and review of Commissioning Authority. This phase lasts throughout warranty period. It may, however, involve activities to ensure completion of:
 - .1 System debugging and optimization.
 - .2 Completion of training and instruction for operating and maintenance personnel as per Section 01 91 41.
 - .3 Completion of all commissioning activities on defective, seasonally-sensitive systems, for varying modes and periodic simulated emergency conditions.
 - .9 Commissioning shall be considered complete when all of the objectives of commissioning, as specified herein, have been achieved.

1.6 COMMISSIONING MEETINGS, SCHEDULING, and REPORTING

- .1 Contractor shall include the commissioning plan in their construction schedule and shall schedule for all tests and equipment start-up in the construction schedule.

- .2 Commissioning meetings shall be scheduled as required. The meetings shall address commissioning related responsibilities as well as all specified testing, documentation, O&M manuals, training, and post construction requirements. The testing schedules and results of all tests shall be reviewed at the meetings.
- .3 Where construction may be completed in phases, allow for the frequency of meetings to correspond to the varying stages of construction of each phase.
- .4 The Contractor shall attend commissioning meetings at regular intervals, as called by the Commissioning Authority.
- .5 The Contractor shall schedule work to include specified Commissioning related tasks. Cooperate with the Commissioning Agent, and coordinate subtrades as required, to successfully demonstrate and verify commissioning related tests.
- .6 The Contractor shall schedule work to include specified Commissioning related testing prior to Personnel demonstration and training, per Section 01 91 41.
- .7 Testing forms and reports associated with the mechanical systems shall be directed to the Departmental Representative and to the Commissioning Authority.
- .8 The forms and reports to be issued shall include:
 - .1 Shop drawings, issued and accepted;
 - .2 Equipment verification forms;
 - .3 Testing forms;
 - .4 Reports resulting from tests;
 - .5 Testing schedule;
 - .6 Minutes of commissioning meetings.

1.7 WARRANTY

- .1 Involvement of Commissioning Authority does not void any guarantees or warranties nor does it relieve Contractor of any contractual responsibilities.

1.8 RESPONSIBILITIES OF COMMISSIONING AUTHORITY

- .1 Responsibilities of Commissioning Authority are as follows:
 - .1 Design Phase:
 - .1 Participate in design team meetings. Obtain Departmental Representative's requirements, philosophy, intent and expected system performance. This will form the basics of the testing and commissioning documents.

- .2 Provide input and feedback to design team with emphasis on testing, commissioning, operation and maintenance of the proposed system and equipment.
- .3 Provide commissioning document to form part of the Bid documents.
- .2 Bid Phase:
 - .1 Review Bid documents, design Drawings and specifications.
 - .2 Documents to ensure the documents have included all the required testing and commissioning requirements.
 - .3 Provide commissioning related comments for incorporation in Contract Documents.
 - .4 Participate in Bid review meetings to ensure Bidders are aware of testing and commissioning requirements.
- .3 Construction Phase:
 - .1 Review Contractor's approved shop drawing submission for commissioning related issues.
 - .2 Prepare commissioning plan based on the contractor's schedule and installation method statement;
 - .3 Monitor, check and inspect the installation throughout the construction stages.
 - .4 Supervise the commissioning, including scheduling.
 - .5 Issue deficiencies reports noting any issues that may have an impact on the commissioning of the equipment or system.
 - .6 Attend construction site meetings as required to discuss commissioning related items and any impact on Project schedule.
 - .7 Set-up and chair commissioning meetings.
 - .8 Witness and validate tests; note deficiencies and issue progress reports.
 - .9 Work with the project team to expeditiously resolve any problems that may arise due to site conditions.
 - .10 Prepare Systems Operating Manual.
 - .11 Co-ordinate with Departmental Representative, training and instructions provided by Contractors, manufacturers and Suppliers.
- .4 Post-Construction Phase:
 - .1 Prepare final report on commissioning, identifying any deficiencies that may be outstanding.
 - .2 Recommendation of any additional training and/or instruction of operating and maintenance personnel deemed necessary over and above that already provided.
 - .3 Complete system checks with Contractor:
 - .1 Once during the first month of building operation.
 - .2 Once during the third month of building operation.
 - .3 Once between the fourth and tenth months in a season opposite to the first or third month visit.

1.10 RESPONSIBILITIES OF DEPARTMENTAL REPRESENTATIVE

- .1 Responsibilities of Departmental Representative are as follows:
 - .1 To retain the services of independent third parties for system verification and certification as required in the document or by applicable codes.
 - .2 To observe on-site installation, start-up and testing equipment and systems.
 - .3 Review contractor's shop drawings submission to ensure that the equipment proposed comply with specifications requirements;
 - .4 Review contractor's installation program to ensure that the installation sequences have been coordinated with the project schedule;
 - .5 Monitor, check and inspect the installation throughout the construction stages to ensure the equipment installation is as approved and the installation method, workmanship, procedures will follow the approved submission and method statement;
 - .6 Inspect the systems installation and issue deficiencies reports. Ensure deficiencies are corrected and certify installation of systems;
 - .7 Review contractor's commissioning plan to ensure the proposed tests, the sequences and method of tests conform to the contract requirements; the testing and commissioning sequences coincide with the project schedule;
 - .8 Review operating and maintenance manuals, balancing and test reports and as-builts for accuracy;
 - .9 Witness tests; note any deficiencies and provide progress report;
 - .10 Certify completion of contractor's commissioning.
 - .11 Operating personnel to attend training and instruction regarding specific components, equipment and systems and as per Section 01 91 41.

1.11 RESPONSIBILITIES OF CONTRACTOR

- .1 Responsibilities of Contractor are as follows:
 - .1 Construction Phase:
 - .1 To manage and ensure entire installation comply with requirements of the Contract Documents;
 - .2 Submit shop drawings complete with Contractor's Stamp of Review;
 - .3 Submit working detail (interference or installation) drawings, as required;
 - .4 Complete commissioning data test forms;
 - .5 Submit installation method statement. This generally includes:
 - .1 Method of equipment delivery to the installation location on site;
 - .2 Prerequisite preparation for delivery, such as completion of the factory testing and the completion of site work to accept this equipment;
 - .3 Installation method and sequences of installing the equipment and the associated connections to the equipment;
 - .6 Submit an installation schedule. This schedule shall include:
 - .1 Time schedule of each activity, with lead and lag time allowed and indicated;
 - .2 Shop drawings and working detail drawings submission;

- .3 Major equipment delivery and factory testing date;
- .4 Coordinated installation activities and sequences in compliance with the General Contractor's project schedule and other trade's installation schedule;
- .5 Schedule of testing and commissioning of the systems and major equipment;
- .7 Submit a commissioning schedule. This schedule shall include:
 - .1 Time schedule for system and equipment commissioning which are in compliance with the timing and sequences of installation schedule stated above. In this schedule allow for additional time for testing and commissioning, such that re-test of the equipment can be performed in a timely manner if required without impacting the overall project schedule or cause delay to Project completion;
 - .2 Dates for completion of required factory tests prior to equipment delivery to the site shall be indicated in the schedule;
 - .3 Prepare and submit testing and commissioning method statements for review and approval;
 - .4 Prepare and submit testing and commissioning record or report forms for review and approval;
- .8 Attend progress and commissioning meetings;
- .9 Promptly rectify or replace reported deficiencies and defects;
- .10 Where required by codes and/or specification, retain manufacturers and/or independent third parties to provide service for testing and certification of the systems and training of personnel as per Section 01 91 41.
- .11 Provide training and instruction to operating personnel as per Section 01 91 41.
- .12 Perform testing and commissioning of equipment and systems to the satisfaction of the Departmental Representative and Commissioning Authority as stated in approved schedule and method described above. Testing and commissioning will be witness by the Commissioning Authority as required. Contractor or his retain agents shall also record procedure and finding in approved test and record forms. Submit test and record forms with the signature of the tester for review and approval to the Departmental Representative and Commissioning Authority;
- .13 Pay for and be responsible for all inspections required by codes, specification and Authorities having Jurisdiction. Obtain and submit all Certificate of Approval for such inspections and verifications;
- .14 Submit for review as-builts drawings including those for location of control devices and wiring and operating and maintenance manuals for each equipment as per the specification requirements;
- .15 Provide Operating and Maintenance Manuals for review by the Departmental Representative and Commissioning Authority with all the testing and commissioning results and reports incorporated;
- .16 Obtain, issue and assign warranties for equipment and systems to the Departmental Representative.

- .17 Provision of all necessary test equipment shall be the responsibility of the contractor. Provide recently validated calibration certificate for all equipment to be used for verification prior to testing and commissioning commencement.
- .2 Post-Construction Phase:
 - .1 Optimize operation according to occupant's needs, using the System Operation Manual prepared by the Commissioning Authority as reference points;
 - .2 Complete all commissioning procedures and activities and performance verification procedures which were delayed or not concluded during the commissioning phase;
 - .3 Complete system checks:
 - .1 Once during the first month of building operation;
 - .2 Once during the third month of building operation;
 - .3 Once between the fourth and tenth months in a season opposite to the first or third month visit;
 - .4 Complete rectification of all deficiencies revealed by these checks. Equipment manufacturers involved in commissioning shall participate in systems checks.
 - .5 Revise all "as-built" and operating and maintenance documents to reflect all changes, modifications, revisions and adjustment upon completion of commissioning;
 - .6 Schedule a question and answer session for the operating and maintenance personnel 3 months after handover of the facility to the Departmental Representative. The duration of this session or sessions will be dictated by the number of questions or concerns that shall be addressed.

1.12 COMMISSIONING INVOLVEMENT

- .1 Commissioning Authority shall direct, witness and validate as required; and Contractor and/or his Suppliers or retained Independent Third Party Agents shall perform the following:
 - .1 Check and ensure installation of systems and equipment to ensure installations are completed and in a proper and safe state ready for testing and commissioning;
 - .2 Run and test the systems and equipment through their design parameters to verify their capabilities in performance, sequencing, safety protection and alarms annunciation;
 - .3 Ensure deficiencies and defects found are rectified and replaced and the systems and equipment re-tested as required;
 - .4 Arrange and provide demonstration and training of personnel as per Section 01 91 41;
 - .5 Issue Operating and Maintenance Manuals for systems and equipment.

1.13 SYSTEMS TO BE COMMISSIONED

- .1 As per Section 01 91 31 – Commissioning Cx Plan.

1.14 TESTING EQUIPMENT

- .1 Contractor and manufacturer shall provide all instrumentation and test equipment necessary to conduct the tests specified during the commissioning process. Contractor shall submit a list of equipment to be used and copies of latest equipment calibration certificates to the Commissioning Authority and Departmental Representative for approval.
- .2 Mechanical Testing Equipment:
 - .1 Following equipment shall be provided but not limited to:
 - .1 Pressure measurements: manometers, pressure gauges;
 - .2 Velocity measurement: pitot tube, propeller or revolving vane manometer, thermo anemometers, hot wire anemometers;
 - .3 Volume or mass flow measurement: venturi, nozzle and orifice flow meter, positive displacement meter;
 - .4 Rotational speed: tachometer;
 - .5 Sound measurement: electronic sound level meter for acoustic measurement with octave band analysis;
 - .6 Vibration measurement: accelerometer;
 - .7 Recording: chart recorder;
 - .8 Electrical measurements: voltmeter, ammeter and wattmeter.

1.15 DOCUMENTATION

- .1 Contractor shall record test results and procedures on approved record forms and submit the forms together with copies of test certificates to Departmental Representative and Commissioning Authority for review and approval.
- .2 When results are validated, Commissioning Authority shall incorporate those records in his System Operating Manual. He shall also make entry of those test results into appropriate sections of the System Operating and Maintenance Manual as reference for future system/equipment performance tests.

1.16 COMMISSIONING PROCESS

- .1 Commissioning Authority: to perform and complete all work as specified in the “GENERAL” Section of this specification “Responsibilities of Commissioning Authority”.
- .2 Contractors: To perform and complete all works as specified in the “GENERAL” Section of this specification “Responsibilities of Contractor”. In general, it shall include complete

activation of all systems; calibration, test, and verification of performance of all components, equipment and systems; verification of performance of all systems through all specified modes of control and sequence of operation; rectification of deficiencies; recording of test results for submission; demonstration, instruction and training of operating and maintenance personnel as per Section 01 91 41; follow-up during first year of operation for fine tuning and building service monitoring.

- .3 Equipment verification: Contractor shall test and verify proper operation of all equipment and systems prior to start of commissioning and record all results from the test for each piece of equipment. Forms shall be included in the Operating and Maintenance Manual. Equipment data shall include, but is not limited to:
- .1 Manufacturer's name, address and telephone number;
 - .2 Distributors' name, address and telephone number;
 - .3 Make, model number and serial number;
 - .4 Pumps - RPM, impeller sizes, rated flow;
 - .5 Fans - belt type and size, sheave type and size;
 - .6 Electrical - volts, amps, fuse size, overload size;
 - .7 Equipment enclosure type;
 - .8 Switchboard, panel board - volt, rated current, number of phase and fault rating;
 - .9 Any other special characteristics.

1.17 TESTING FOR MECHANICAL SYSTEMS

- .1 Plumbing and Drainage System Testing:
- .1 Plumbing and drainage system shall be tested in accordance with the Canadian Plumbing Code.
 - .2 Contractor shall notify Building Inspector when systems are available for testing. Contractor shall document all tests performed and shall arrange for Building Inspector to sign for tests completed. Forward forms to Departmental Representative and Commissioning Authority for review.
 - .3 When the plumbing system has been completed take a sample of the drinking water, in the presence of the Departmental Representative. Forward the sample to a testing laboratory which shall be approved by the Departmental Representative. Forward the test results to the Departmental Representative and Commissioning Authority. Include for all cost of water analysis.
 - .4 Also perform hydrostatic pressure test and system disinfection for domestic hot and cold water systems.
- .2 Water Treatment Systems:
- .1 Contractor shall employ a Chemical Treatment Specialist who shall assist the Contractor with selection of the chemical treatment system, inspect the installation and test the system. Specialist shall complete manufacturers' testing forms and submit a report to the Departmental Representative.
 - .2 Specialist shall assist Contractor clean all piping systems. Specialist shall take samples and repeat the cleaning process if specification requirements are not met.

- .3 Specialist shall assist Contractor and add chemical immediately after the cleaning process for each system for protection. The specialist shall take samples and repeat the process until specification requirements are met.
 - .4 Specialist shall revisit the site after 1 month of operation of each system and re-test systems.
- .3 Contractor's testing of piping systems (applicable to hydronic circulation, domestic hot and cold water, steam and condensate, sprinkler piping)
- .1 Test all piping systems in accordance with all applicable Plumbing Codes and CSA B149.
 - .2 All other systems not covered by Codes noted above shall be tested and proven tight over a period of 24 hours by a hydrostatic test. Remove fixtures, appliances, devices, vents and gauges and temporarily plug connections as required. Provide temporary by-pass when required.
 - .3 Test pressure for water systems (heating/cooling, domestic cold and hot water, sprinkler piping) shall be:
 - .1 1-1/2 times the system working pressure but not less than 1,035 kPa for a minimum of 2 hours;
 - .2 Test pressure shall be limited to the maximum working pressure of expansion joints and vibration isolators.
 - .4 Repair any leaks or defects and repeat the tests to the satisfaction of the Departmental Representative.
 - .5 After completion of the testing, rough balance the water systems and ensure all coils, converters, etc., are operating approximately to the design conditions to ensure freezing conditions will not occur anywhere. Adjust the circuits by means of the balancing valves.
 - .6 Where multiple branch lines are installed, the flow in these shall be balanced to ensure hot or cold water, as applicable, at all fixtures.
 - .7 All tests for the systems shall be witnessed. Complete the testing forms and forward copies of the tests reports to the Departmental Representative and Commissioning Authority.
 - .8 Co-ordinate with TAB Contractor to ensure all necessary valves required for balancing the system are installed.
 - .9 Notify Departmental Representative and Commissioning Authority in writing that this co-ordination has taken place before installation begins. If Contractor fails to co-ordinate with TAB Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by Contractor at no cost to Departmental Representative
 - .10 Ensure all cooling coil drain pans drain freely and that no standing water remains.
 - .11 Ensure access is provided to all valves and equipment that requires servicing.
 - .12 Contractor is responsible for all equipment operating to design conditions and shall trim impellers, etc., to provide the required conditions, but is not responsible for the final balancing of the system, which shall be carried out by TAB Contractor.
 - .13 Contractor shall make available staff at no extra cost to Departmental Representative as required by TAB Contractor, to correct any deficiencies in the mechanical systems which prevent TAB Contractor from balancing the system.

- .14 Contractor shall provide copies of all shop drawings requested by TAB Contractor.
- .4 The Independent Testing and Balancing Contractor's balancing of water and glycol hydronic systems:
 - .1 Contractor shall co-ordinate with TAB Contractor and provide assistance during balancing process.
 - .2 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.
 - .3 TAB Contractor shall balance the entire water system to ensure all equipment and systems are operating to design conditions. Adjust the circuits by means of the balancing valves and record the balance positions.
 - .4 Each pump shall be checked for design, working and shut-off head conditions. Any pump that varies by more than 10% from the design conditions shall have the impeller trimmed or pump changed until design conditions have been met. Contractor shall pay for impeller trimming.
 - .5 Flow through all heat exchangers and other such equipment shall be balanced to ensure that the pressure drop through the equipment is within 10% of manufacturer's design conditions.
 - .6 Initial balancing of coils shall be used to ensure that the pressure drops are within 10% of manufacturers' design conditions. When both the air and water systems are fully operational, entering air and water and leaving air and water readings shall be taken as close as possible to the peak design conditions to ensure the coil performance meets the design conditions. Coil water working conditions shall only be taken in conjunction with the air flow working conditions for the coil.
 - .7 TAB Contractor shall co-ordinate with Contractor to ensure all necessary devices and valves for control and balancing are installed in all necessary locations. Notify Departmental Representative and Commissioning Authority in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding valves, locations, installation, etc. If TAB Contractor fails to co-ordinate with Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by TAB Contractor at no cost to the Departmental Representative.
 - .8 TAB Contractor shall not disconnect any direct digital control (DDC) device after it has been calibrated. BAS Contractor shall make all necessary adjustments through the control system as requested by TAB Contractor. If TAB Contractor fails to co-ordinate with BAS Contractor and if failure to co-ordinate results in any cost, the cost of any change required shall be paid for by TAB Contractor at no cost to the Departmental Representative.
 - .9 TAB Contractor shall co-ordinate with the EMCS Contractor and receive instruction regarding set-up, calibration and operation of the DDC as it applies to the TAB Contractor work. The EMCS Contractor shall provide the TAB Contractor with a portable operator's terminal for this work.
 - .10 TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.
 - .11 At time of final inspection, recheck, in presence of Departmental Representative and Commissioning Authority, random selections of data recorded in the certified

- report. Points or areas of recheck shall be selected by Departmental Representative/Commissioning Authority and shall be a maximum of 30% of the report data.
- .12 A measured deviation of more than 10% between the verification reading and the reported data will be considered as failing the verification procedure.
- .13 A failure of more than 10% of the selected verification readings will be considered unacceptable and will result in rejection of the report.
- .14 In the event the report is rejected, rebalance all systems, submit new certified reports and perform a re-inspection, all at no cost to the Departmental Representative.
- .15 Following final acceptance of the certified reports by Departmental Representative, permanently mark the settings of all valves and other adjustable devices so that balance set position can be restored if distributed at any time. For circuit balancing valves, record the valve position by the number of turns registered on the valve and lock the valve into that position. Do not mark such devices until after final acceptance.
- .16 Submit 6 copies of the final testing and balancing reports to Departmental Representative. Reports shall be complete with index pages and index tabs and certified by TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Departmental Representative.
- .17 Submit a copy of the report to Commissioning Authority for review. Include in the water balancing report: Types, serial numbers and dates and calibration of all instruments used in balancing report.
- .5 The Independent Testing and Balancing Contractor's balancing of air systems:
- .1 Contractor shall co-ordinate with TAB Contractor and provide assistance during the balancing process.
- .2 Balancing shall not begin until all point to point and EMCS component testing has been satisfactorily completed.
- .3 TAB Contractor shall balance the entire air systems including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition).
- .4 TAB Contractor shall take air measurements, make final adjustments and report upon the air volume at each variable volume box, diffuser, register and grille. Measure the static pressure upstream and downstream of the fan, the fan speed and the motor current.
- .5 Measure the return and supply air flow when mixing dampers are set for full outside air and minimum outside air position.
- .6 Set the minimum position for the mixing dampers. Co-ordinate with EMCS Contractor.
- .7 Contractor shall provide new filters, when the final balancing has been completed.
- .8 Air volumes measured by TAB Contractor shall be within +5% of those shown on Drawings for diffusers, grilles, registers, variable air volume boxes and fans, at both maximum and minimum volumes shown.
- .9 Duct traverse readings shall be taken through access ports. The access ports shall be Duro Dyne IP-1 or IP-2 air tight type. Duct tape is not acceptable.

- .10 The insulation or vapour barrier shall be repaired in an approved manner, if damaged.
- .11 For variable air volume boxes, TAB Contractor shall verify the minimum and maximum air volumes after the VAV boxes are commissioned by the EMCS Contractor.
- .12 In all cases where measurements by TAB Contractor show failure to comply with the drawings and specifications, Contractor at no cost to Departmental Representative shall change fan sheaves, etc., as required, and new balancing measurements shall be taken by TAB Contractor.
- .13 Ensure all thermostats and controls are set to give the specified conditions and include settings in the report.
- .14 Adjust each supply outlet to provide proper throw and distribution in accordance with architectural requirements.
- .15 Fans on all systems shall be set-up to give the minimum discharge pressure required to overcome the resistance of the box, discharge ductwork and diffusers.
- .16 Co-ordinate with Contractor to ensure that all necessary manual and splitter dampers for balancing are installed in all necessary locations. Notify Departmental Representative in writing that this co-ordination has taken place. Include in this letter any recommendations made regarding dampers, locations, installation, etc. If TAB Contractor fails to co-ordinate with Contractor and if failure to co-ordinate results in being unable to balance the systems, the cost of any changes required shall be paid for by TAB Contractor at no cost to Departmental Representative.
- .17 TAB Contractor shall not disconnect any control device after it has been calibrated. EMCS Contractor shall make all necessary adjustments through Building Automation and Controls Systems as requested by TAB Contractor. If TAB Contractor fails to co-ordinate with EMCS Contractor and if failure to co-ordinate results in any cost, the cost of any change required shall be paid for by TAB Contractor at no cost to Departmental Representative.
- .18 TAB Contractor shall co-ordinate with EMCS Contractor and receive instruction regarding set-up, calibration and operation of the DDC as it applies to TAB Contractor work. EMCS Contractor shall provide, TAB Contractor, with a portable operator's terminal for this work.
- .19 TAB Contractor is responsible for balancing the systems to obtain the design conditions and shall repeat the balancing until the required conditions have been met.
- .20 At the time of final inspection, recheck in the presence of Departmental Representative and Commissioning Authority random selections of air quantities and fan data recorded in the certified report. Points or areas for recheck would be selected by Departmental Representative/Commissioning Authority and shall be a maximum of 30% of the report data.
- .21 At the time of verification measure space temperature and relative humidity in a representative number of rooms to verify performance. Tabulate these results and include in certified report as an appendix.
- .22 A measured flow deviation of more than 10% between the verification reading and the reported data will be considered as failing the verification procedure.
- .23 A failure of more than 10% of the selected verification readings will be considered unacceptable and will result in rejection of the report.

- .24 In the event the report is rejected, rebalance all systems, submit new certified reports and re-inspect, all at no cost to Departmental Representative.
- .25 Following final acceptance of the certified report by Departmental Representative, permanently mark the settings of all dampers, splitters and other adjustable devices so balance set position can be restored if distributed at any time. Do not mark such devices until after final acceptance.
- .26 Submit 6 copies of the final testing and balancing report to Departmental Representative. Reports shall be complete with index pages and index tabs and certified by TAB Contractor. Any diagram or single line representation of a mechanical system specifically prepared for this project shall be prepared using a CAD system and shall be acceptable to Departmental Representative.
- .27 Submit a copy of the report to Commissioning Authority for review.
- .28 Include in balancing report:
 - .1 Types, serial numbers and dates of calibration of all instruments used in balancing report;
 - .2 Equipment data, manufacturer and model size, arrangement discharge and class, motor type, horse power, voltage, phase, cycles and full load amps. Location and local identification data;
 - .3 Fan design data, total volume flow rate, static pressure, motor type, RPM, volts, full load amps and outside air flow rate;
 - .4 A complete system schematic with design and actual flow rates at each outlet or inlet. Show room numbers and floors. Duct air quantities: for mains, branches and maximum and minimum for outside air and exhausts, duct size, pressure readings, average velocity, duct recorded flow rates, duct design flow rates. Air inlet and outlets, supply or exhaust outlet identification. Location and number designation;
- .29 Manufacturers' catalogue identification and type, of air inlets and outlets application factors, designated area, design and recorded velocities, design and recorded air flow rates, deflector vane of diffusion cone settings.
- .6 Testing of HVAC and Specialties Equipment and Systems:
 - .1 General:
 - .1 Contractor shall prepare and submit for approval, Commissioning Plan and schedule which includes:
 - .1 Detailed schedule for all individual testing activity. The detail shall include the steps to be taken sequentially and indicate which conditions should be observed and recorded;
 - .2 The status of systems to be able to perform tests;
 - .3 Required testing equipment;
 - .4 Manufacturers' commissioning time for all systems and equipment;
 - .5 Required time for remedial works if necessary;
 - .6 Staged start-up and commissioning of the systems.
 - .2 Start-up and test procedures must be consistent with manufacturer's recommendations contained in the Operating and Maintenance Manual.
 - .3 The start-up report shall record all observations made during the start-up procedures including problems and their resolutions.

- .4 Contractor shall retain the services of the manufacturer's technicians to test the equipment and associated systems. Technician shall record the results of the tests on the testing forms. The tests shall be witnessed by Departmental Representative. When tests have been completed satisfactorily the technician and witnessing authority shall sign the forms. A copy of the forms shall be forwarded to the Departmental Representative. The original shall be inserted into the Operating Manual.
- .5 Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Departmental Representative and the Commissioning Authority.
- .6 Tests which have not been witnessed shall not be accepted and shall be repeated.
- .7 Equipment and systems to be tested shall include but not limited to the following wherever applicable:
 - .1 Plumbing and drainage system including pumps, piping, tanks, solar collectors, pH/ chlorine controllers, acid waste disposal system, etc.
 - .2 Ventilation system including ductwork, air terminals, fans, etc.
 - .3 Seawater System;
 - .4 Vacuum Priming System;
 - .5 Building automation and controls systems;
- .7 Hydronic Systems:
 - .1 Pumps and other equipment's shall be inspected and tested by manufacturer's technician. Technician shall enter the test results on forms provided by manufacturer. Departmental Representative shall witness the final operational test.
 - .2 Technician shall verify heat exchangers and pumps have been installed according to manufacturer's recommendations, shop drawings and the specification.
 - .3 Tests shall include verification of safeties and controls.
- .8 Building Automation and Controls Systems:
 - .1 The Building Automation and Controls Systems shall be fully tested and commissioned by manufacturer's technician to operate in the manner defined by the specifications.
 - .2 EMCS Contractor shall provide a print-out of general and critical alarm lists and all points connected to the Building Automation and Controls Systems. The all point log shall be sub-divided into points per system. One report shall be taken prior to the acceptance test.
 - .3 EMCS Contractor shall provide an operating terminal and sufficient training and instruction to TAB Contractor which will allow them to set-up and balance the water and air systems.
 - .4 A point-to-point testing shall be done by EMCS Contractor. This test shall include, but is not limited to:
 - .1 Ensuring that wiring is accurately connected to appropriate terminals;
 - .2 Checking the function of each control and controlled device (such as the beginning, end and extent of actuator travel);

- .3 Connection integrity between actuator and device;
- .4 Calibration of sensors;
- .5 Output from sensors;
- .6 Operation of relays;
- .7 Data/information integrity at console;
- .8 Remote reset integrity from console to field device;
- .9 Interfacing with other systems such as life safety monitoring system.
- .10 EMCS contractor in conjunction with the mechanical contractor shall create simulated design load conditions for control verification tests.
- .5 Testing procedure shall include but is not limited to:
 - .1 Check and verify that each input point is reporting to the Building Automation and Controls Systems panels and workstations in the normal state and change or state;
 - .2 Create false alarms at each point and provide a print-out of the test;
 - .3 Command each output point, via the workstation and verify the action at the device;
 - .4 Verify that each time of day and optimum start program is operational in software and at the device;
 - .5 Verify that each program is operational in software and at the device(s);
 - .6 Verify that each system graphic is dynamically updating;
 - .7 Test each DDC loop and verify that it is controlling in a stable manner. Create set point changes on output points. False loads shall be introduced to observe the control loops response. Program trend logs at the Building Automation and Controls Systems for a minimum of 30 minutes per control loop with a sampling time of 30 seconds. Provide a print-out of the results. Tune each DDC loop prior to acceptance test. Check each loop again, once during the heating and once during the cooling season and re-tune where necessary;
 - .8 Verify that each report type is functional;
 - .9 Verify that each global program that controls more than 1 system is operating;
 - .10 Verify that all safeties are operating (ie. firestats);
 - .11 Verify valve and damper actuation;
 - .12 Verification of the minimum and maximum settings on VAV boxes (if used);
 - .13 Verify the calibration of each analog input point.
- .6 Any sensor disconnected from the input terminal after completion of the performance test shall be retested.
- .7 EMCS Contractor shall provide a "signed-off" copy of the results of all tests to the Departmental Representative. Acceptance test will not begin until the tests have been reviewed and accepted. Departmental Representative shall witness these tests.
- .8 Provide the calibration procedure for each analog sensor. Physically check the calibration of each analog sensor type using a calibrated instrument prior to testing.

- .9 When all tests have been completed EMCS Contractor shall request the acceptance test procedure shall begin. Departmental Representative shall verify the installation is complete and all tests have been performed and have been successful. EMCS Contractor shall then initiate the acceptance test.
- .10 The acceptance test period shall be 21 Days. EMCS Contractor shall visit the site each morning. Monday to Friday, to review the Building Automation and Controls Systems operation and the building operators log book. The operators log book shall be provided by the EMCS Contractor and shall contain all problems experienced by the Custodians. The log shall show the point name and number, time and date of failure and time of return service. During the first 14 Days of the acceptance test, any operational or equipment failures shall be corrected and the acceptance test shall continue from the date the failure has been corrected. During the last 7 Days of testing, no major failures of any kind will be accepted, or the last 7 Days shall be repeated.
- .11 During the acceptance test Contractor shall print out 1 "all-points" log per day. The logs shall be issued to Departmental Representative for review.
- .12 EMCS Contractor shall set up trend logs and group logs which shall be stored on hard disk for review by Departmental Representative.
- .13 System shall not be accepted or considered substantially complete until all tests are completed and approved.
- .14 EMCS Contractor shall provide a minimum of 2 weeks notice to Departmental Representative prior to testing date.

1.18 OPERATING AND MAINTENANCE MANUAL

- .1 Contractor shall prepare and submit the Operating and Maintenance Manual as detailed in the specification to Departmental Representative 6 weeks prior to beginning of training.
- .2 Contractor shall re-submit the manual should the Departmental Representative find deficiencies. Training shall not begin until the manual has been accepted by the Departmental Representative. One copy of the manual shall be forwarded to Commissioning Authority in good quality, vinyl covered binders.
- .3 Each Mechanical manual shall be organized as follows, but not limited to following:
 - .1 A - Project Directory;
 - .2 B - Fire Protection;
 - .3 C - Heating;
 - .4 D - Cooling
 - .5 E - Air Handling Units;
 - .6 F - Ventilation;
 - .7 G – Computer Room Air Conditioning Systems;
 - .8 H - Building Automation and Controls Systems;
- .4 Project directory shall contain the names, addresses, fax numbers and telephone numbers of Contractors, Subcontractors, manufacturers and manufacturer's representatives.

- .5 Sections B to I shall be divided into the following subsections:
 - .1 Shop drawings (reduced to 216 mm to 290 mm);
 - .2 As-built drawings (reduced to 216 mm to 290 mm);
 - .3 As-built riser diagrams (reduced to 216 mm x 290 mm);
 - .4 Operating procedures;
 - .5 Maintenance procedures;
 - .6 Spare parts list;
 - .7 Trouble shooting guide;
 - .8 Valve chart (where applicable);
 - .9 Filter size chart (where applicable);
 - .10 Equipment lists;
 - .11 Testing and verification forms;
 - .12 Certification forms.
- .6 Section I shall be sub-divided into the following sub-sections:
 - .1 Shop drawings;
 - .2 As-built control sequences;
 - .3 As-built panel layout and points list;
 - .4 All point log per system;
 - .5 Operating procedures for all equipment and systems;
 - .6 Maintenance procedures for all equipment;
 - .7 Spare parts list;
 - .8 Software licensing agreements;
 - .9 Software manuals;
 - .10 Software disks;
 - .11 Point data and program disks;
 - .12 Testing and verification forms.
- .7 Operating procedures shall be the recommended manufacturer's operating procedures for the equipment.
- .8 Maintenance procedures shall include Scope of Work, frequency of activity, parts required and necessary documentation.
- .9 Spare parts list shall be manufacturer's recommended list for maintenance purposes.
- .10 Trouble shooting guide shall be manufacturer's recommendation for equipment.
- .11 Equipment list shall include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes.

- .12 Operating and Maintenance Manual shall be submitted to the Departmental Representative in three (3) copies.

1.19 SYSTEMS OPERATING MANUAL

- .1 The Systems Operating Manual will be used by the maintenance personnel to assist them in the daily operation of the systems.
- .2 Systems Operating Manual shall be prepared by Commissioning Authority using data collected by Contractor and test results.
- .3 Each section describing a system will contain as a minimum:
 - .1 A basic description of the system;
 - .2 System location and areas it serves;
 - .3 A basic description of operations;
 - .4 Electrical services and locations;
 - .5 EMCS points alarm limits and setpoints;
 - .6 Time of Day schedules;
 - .7 A schematic of the system.
- .4 Commissioning Authority shall provide a copy of the Systems Operating Manual to Departmental Representative.

1.20 OPERATOR TRAINING AND INSTRUCTIONS

- .1 Contractor and equipment manufacturers shall provide operator training for each mechanical system and equipment.
- .2 The training and instruction shall be provided by qualified technicians and shall be conducted in a classroom setting at the equipment or system.
- .3 Training and instruction will begin when the Operating and Maintenance Manual has been approved and delivered to Departmental Representative.
- .4 Each session shall be structured to cover:
 - .1 The Operating and Maintenance Manual;
 - .2 Operating procedures;
 - .3 Maintenance procedures;
 - .4 Trouble-shooting procedures;
 - .5 Manufacturer's or service representative's name, address and phone number.

- .5 Contractor shall prepare a detailed training and instruction plan. This plan shall include the outline of all sessions and identification of the training presenters.
- .6 Submit the plan including a copy of training manual for Commissioning Authority's review and approval.
- .7 Provide course documentation for up to 6 people.
- .8 The sessions shall be co-ordinated and videotaped by the Commissioning Authority.
- .9 Training and instruction shall be provided for the following systems wherever applicable:

SYSTEM	MINIMUM TRAINING DURATION
Heating and Ventilation Systems	1 Days
Building Automation and Controls Systems	1 Days
Other Mechanical Systems	See Specs.

- .10 The minimum training and instruction for the Building Automation and Controls Systems shall include:
 - .1 A 1 Day class session at manufacturer's local office for 2 of maintenance personnel;
 - .2 A walk-through of the installation for all maintenance personnel to review the installation and equipment;
 - .3 Operation of the central computer;
 - .4 Operation of portable terminals;
 - .5 Control sequences;
 - .6 Report set-up and generation;
 - .7 Managing the system;
 - .8 Maintenance requirements.
- .11 Training and instruction requirement for the mechanical system shall include a walk-through of building by Contractor. During the walk-through the Contractor shall:
 - .1 Identify equipment;
 - .2 Identify starters associated with equipment;
 - .3 Identify valves and balancing dampers;
 - .4 Identify access doors;
 - .5 Review general maintenance of equipment;
 - .6 Review drain points in pipework systems;
 - .7 Identify maintenance items.

- .12 When each session has been completed, the Commissioning Authority shall sign to certify completion.

1.21 SYSTEMS DEMONSTRATION AND TURNOVER

- .1 System demonstration and turnover to the Departmental Representative shall occur when:
 - .1 The installation is complete;
 - .2 Acceptance test conducted by the Departmental Representative has been successfully completed;
 - .3 Commissioning Authority system testing has been successfully complete;
 - .4 Training and instruction has been completed;
 - .5 Operating and Maintenance Manual have been accepted;
 - .6 Shop drawings have been updated;
 - .7 As-built drawings have been completed.
- .2 Systems demonstration shall be conducted by Contractor and manufacturers. The demonstration shall cover all operation and maintenance requirements and a physical demonstration of equipment installation and operation.

1.22 TESTING FORMS

- .1 Contractor and manufacturers shall provide information required to complete forms listed in this Section and any other additional data sheets not included in this specification, but required for the mechanical and electrical systems of this Project. All forms to be supplied by Commissioning Authority.
- .2 Commissioning index form shall be maintained by Commissioning Authority to track progress of the commissioning requirements.
- .3 Mechanical testing and verification forms to be completed are as follows wherever applicable, but not limited to:
 - .1 Commissioning index form;
 - .2 Drainage testing form;
 - .3 Equipment test form;
 - .4 Piping pressure test form;
 - .5 System and equipment warranty dates form;
 - .6 System verification form;
 - .7 Test identification form;
 - .8 Testing and start-up schedule form;
 - .9 Air handling unit data sheet;
 - .10 Chemical treatment data sheet;

- .11 Coil data sheet;
- .12 Compressor data sheet;
- .13 Controller device data sheet;
- .14 Controls data sheet;
- .15 Damper data sheet;
- .16 Fan data sheet;
- .17 Filter data sheet;
- .18 Cooling tower data sheet;
- .19 Computer Room A/C unit data sheet;
- .20 Heat exchanger data sheet;
- .21 Humidifier data sheet;
- .22 Pressure reducing valve data sheet;
- .23 Pump data sheet;
- .24 Radiant heating panel data sheet;
- .25 Self-contained air conditioning unit data sheet;
- .26 Heater data sheet
- .27 Heat pump data sheet.

1.23 EQUIPMENT AND SYSTEM WARRANTIES

- .1 Equipment and system warranties shall be as defined in Division 01.
- 2 Contractor shall fill-out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to Division 1, Division 25, Division 26 and Division 33 of the specification for the requirements during the warranty period.
- .4 Contractor shall re-visit the building during the warranty period with Departmental Representative and the Commissioning Authority. During these visits the performance of the system shall be reviewed. These visits shall occur:
 - .1 Once during the tenth month of building operation;
- .5 The Departmental Representative shall organize these visits.
- .6 At these meetings Departmental Representatives and Commissioning Authority shall review the performance of the systems. If the performance is satisfactory then no further action need to be taken. If unsatisfactory then Contractor will be instructed to correct deficiencies, at his cost, to the satisfaction of Departmental Representative.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .3 Section 23 05 00 - Common Work Results for HVAC.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
 - .1 ASHRAE 90.1-01, Energy Code for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers' Advisory Council (EEMAC).

1.3 SECTIONS INCLUDES

- .1 Electrical work to conform to Division 26 including the following:
 - .1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - .2 Control wiring and conduit shall be done by Division 25 to standards set out in Division 26.
 - .3 Division 26 shall leave designated breakers in power panels throughout the building where Division 25 will tie in to Division 25 power requirements.

1.4 SHOP DRAWINGS

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

1.5 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 33 00 - Submittal Procedures.

1.6 WASTE MANAGEMENT AND DISPOSAL

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

- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of corrugated cardboard, polystyrene, plastic, packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 PRODUCTS

2.1 GENERAL

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

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Departmental Representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W (1/2 HP) : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .4 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 575 V, unless otherwise specified or indicated.

2.3 TEMPORARY MOTORS

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

PART 3 EXECUTION

3.1 INSTALLATION

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

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittals.
- .2 Indicate on manufacturers catalogue literature the following:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Mini ball valves.
 - .4 Syphons.
 - .5 Wells.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Thermometers and pressure gauges to operate at mid point of scale or range.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 225mm (9") scale length: to CAN/CGSB 14-GP-2A.
- .2 Thermometers shall read temperatures in °F and °C both.

2.3 REMOTE READING THERMOMETERS

- .1 100mm (4") mercury activated dial type: to CAN/CGSB-14.5, stainless steel bourdon tube, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass case for wall mounting.

2.4 THERMOMETER WELLS

- .1 For copper pipe use copper or bronze.
- .2 For steel pipe use stainless steel.
- .3 For seawater piping use titanium.

2.5 PRESSURE GAUGES

- .1 100mm (4"), dial type: CGSB 91-GP-3, having 1/2 of 1% accuracy unless otherwise specified.
- .2 Provide mini ball valves and:
 - .1 Snubber for pulsating operation.
 - .2 Diaphragm for corrosive service.

PART 3 EXECUTION

3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.
- .2 Install engraved lamicoid nameplates as specified in Section 23 05 53 – Mechanical Identification, identifying medium.

3.2 THERMOMETERS

- .1 Install in wells on all piping. Provide heat conductive material for inside of well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 On seawater intake and discharge piping.

- .2 In other locations as indicated.
- .3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.
 - .2 Domestic water entrance.
 - .3 In other locations as indicated.
- .2 Use extensions where pressure gauges are installed through insulation.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate on manufacturers catalogue literature the following:
 - .1 Upper attachment.
 - .2 Middle attachment.
 - .3 Pipe attachment.
 - .4 Riser clamps.
 - .5 Shields and saddles.
 - .6 Sway braces.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 Closeout Procedures.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.
- .2 Support from top of structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

2.2 UPPER ATTACHMENTS

- .1 Concrete:
 - .1 Inserts for cast-in-place concrete: galvanized steel wedge to MSS-SP58, type 18. ULC listed for pipe 19mm (3/4") through 200mm (8").
 - .2 Carbon steel plate with clevis, for surface mount: malleable iron socket and expansion case and bolt. Minimum two (2) expansion cases and bolts for each hanger.
- .2 Steel Beam (bottom flange):
 - .1 Cold piping 50mm (2") and under: malleable iron C clamp to MSS-SP58, type 19. ULC listed.
 - .2 Cold piping 65mm (2-1/2") and larger and all hot piping: malleable iron beam clamp to MSS-SP58, type 28 or 29. ULC listed.
- .3 Steel Beam (top):
 - .1 Cold piping 50mm (2") and under: malleable iron "top of beam" C clamp to MSS-SP58, type 19. ULC listed.
 - .2 Cold piping 65mm (2-1/2") and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58, type 25. ULC listed.
- .4 Steel Joist:
 - .1 Cold piping 50mm (2") and under: steel washer plate with double locking nuts.
 - .2 Cold piping 65mm (2-1/2") and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
- .5 Steel Channel or Angle (Bottom):
 - .1 Cold piping 50mm (2") and under; malleable iron C clamp to MSS-SP58, type 23. ULC listed.
 - .2 Cold piping 65mm (2-1/2") and larger and all hot piping; universal channel clamp ULC listed.
- .6 Steel Channel or Angle (top):
 - .1 Cold piping 50mm (2") and under; malleable iron "top of beam" C clamp to MSS-SP58, type 19. ULC listed.

- .2 Cold piping 65mm (2-1/2") and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP58, type 25. ULC listed.
Acceptable Manufacturer:

2.3 MIDDLE ATTACHMENT

- .1 Carbon steel threaded rod black electro-galvanized for mechanical rooms finish.

2.4 PIPE ATTACHMENT

- .1 Cold piping, steel or cast iron: hot piping steel, with less than 25mm (1") horizontal movement; hot piping, steel, with more than 25mm (12") middle attachment (rod) length: adjustable clevis to MSS-SP58, type 1. ULC listed.
- .2 Cold copper piping; hot copper piping with less than 25mm (1") horizontal movement; hot copper piping with more than 300mm (12") middle attachment (rod) length: adjustable clevis to MSS-SP58, type 1. Copper plated.
- .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25mm (1"); hot steel piping with middle attachment (rod) 300mm (12") or less; pipe roller to MSS-SP58, type 43.
- .4 Bottom supported hot piping, steel and copper: pipe roller stand to MSS-SP58, type 45.

2.5 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized black carbon steel to MSS-SP58, type 42. ULC listed.
- .2 Copper pipe: carbon steel copper finished to MSS-SP58, type 42.

2.6 SADDLES AND SHIELDS

- .1 Cold piping 32mm (1-1/4") and over: protection shield with high density insulation under shield with uninterrupted vapour barrier. The "Buckaroo" system is an acceptable alternative to protection shields with high density insulation.
- .2 Hot piping over 100mm (4"): protective saddle with insulation under saddle. Saddle to be tack welded to pipe.

PART 3 EXECUTION

3.1 HANGER SPACING

- .1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
 - .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code, Provincial Code, or authority having jurisdiction.
 - .2 Copper piping: up to NPS 1/2: every 1.5m (5'-0").
 - .3 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
 - .4 Within 300mm (12") of each horizontal elbow.
 - .5 Seawater PVC & HDPE piping: spacing in accordance with manufacturers recommendations.

Pipe Size: NPS	Maximum Rod Diameter	Maximum Spacing Steel	Spacing Copper
up to 32mm (1-1/4)	9mm (3/8")	2.1m (7'-0")	1.8m (6'-0")
38mm (1-1/2)	9mm (3/8")	2.7m (9'-0")	2.4m (8'-0")
50mm (2)	9mm (3/8")	3.0 (10'-0")	2.7m (9'-0")
65mm (2-1/2)	12mm (1/2")	3.6m (12'-0")	3.0m (10'-0")
75mm (3)	12mm (1/2")	3.6m (12'-0")	3.0m (10'-0")
90mm (3-1/2)	12mm (1/2")	3.9m (13'-0")	3.3m (11'-0")
100mm (4)	15mm (5/8")	4.2m (14'-0")	3.6m (12'-0")
125mm (5)	15mm (5/8")	4.8m (16'-0")	
150mm (6)	22mm (7/8")	5.1m (17'-0")	
200mm (8)	22mm (7/8")	5.8m (19'-0")	
250mm (10)	22mm (7/8")	6.7m (22'-0")	
300mm (12)	22mm (7/8")	7.0m (23'-0")	

3.2 HANGER INSTALLATION

- .1 Offset hanger so that rod is vertical in operating position.
- .2 Adjust hangers to equalize load.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Provide separate shop drawings for each isolated system complete with performance and product data.

1.4 GENERAL

- .1 Provide vibration isolators under all moving and rotating equipment. Maximum transmissibility: 2% max.
- .2 Provide elastomeric pads between non-vibrating equipment connected to vibrating equipment via piping and the mechanical room floor.
- .3 Provide vibration isolation mounts, resilient pipe guides and resilient penetration sleeves/seals for all piping within mechanical rooms or within 15.250m (50') total pipe length (whichever is longer) connected to major equipment. Isolated from the building structure by means of spring isolators or inertia bases.
- .4 Provide following services for correction of excessive vibration.
 - .1 Adjust and set springs that are not operating properly.

- .2 Replace springs required to reduce the vibration levels to within design limits.
- .5 Vibration isolators shall be of the type and having static deflection as noted on the drawings. The springs selected shall have the required static deflection when 2/3 solid.
- .6 All vibration isolators supporting one particular piece of equipment shall be selected for equal deflections. All nuts and bolts and washers shall be zinc electroplated. Vibration isolation equipment for outdoor applications shall be neoprene coated or cadmium plated.
- .7 All vibration isolators and equipment bases shall be by one manufacturer.

1.5 QUALITY ASSURANCE

- .1 Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- .2 Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.
- .3 Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- .4 Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- .5 Should any rotating equipment cause excessive noise or vibration, the contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- .6 Upon completion of the work, the Departmental Representative, shall inspect the installation and shall inform the installing contractor of any further work that may be completed. Make all adjustments as directed by the Departmental Representative that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

1.6 SPEED & BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

- .1 Fans and other rotating mechanical equipment must not operate at speeds in excess of 80% of their true critical speed.
- .2 Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS peak-to-peak)
under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
over 2000 rpm	1

PART 2 PRODUCTS

2.1 SPRING ISOLATORS

- .1 Type SL Spring Isolators
 - .1 Freestanding and laterally stable without any housing. All mounts shall have levelling bolts. Spring diameter shall not be less than 0.8 compressed height of the spring at rated load. Each isolator shall be mounted on a double layer of 8mm (5/16") thick ribbed or waffle neoprene separated by a 1.6129mm (16 ga.) stainless steel plate. A square bearing plate shall be provided to load the pad uniformly in the range of 275 kPa to 345 kPa (40 to 50 psi).
- .2 Type SLR Spring Isolators
 - .1 Open, stable pair of steel springs and include vertical travel limit stops to control extension when weight is removed. The housing of the spring unit shall serve as a blocking during erection of equipment. Unit isolator base plate shall be complete with two layers of 8mm (5/16") thick ribbed or waffle pattern neoprene pads separated by a 1.6129mm (16 ga.) stainless steel plate. Base plate shall be sized to load the pad uniformly in the range of 275.8 kPa to 345 kPa (40 to 50 psi).
- .3 Type NSN Pads
 - .1 Double layer of 12mm (½") thick 50 durometer neoprene separated by 7mm (1/4") thick steel plate.

2.2 SPRING HANGERS

- .1 Type SH Spring Hangers
 - .1 Vibration hangers shall contain a steel spring set in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. Spring diameters and hanger box lower hole sizes shall be large enough to permit the rod to swing through a 30° arc before contacting the hole and short circuiting the spring.
- .2 Type SHR Spring Hangers
 - .1 Type SHR spring hangers shall contain a laterally stable steel spring and 8mm (5/16") deflection neoprene element in series. A neoprene neck shall be provided where the rod passes through the steel box supporting the isolator mount to prevent metal to metal contact. Spring diameter and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting

the hole and short circuiting the spring.

2.3 EQUIPMENT BASES

.1 Type S Steel Base

- .1 Where called for on the drawings, equipment shall be mounted on Type "S" primed steel base. Frames shall consist of structural steel sections, sized, spaced and connected to form a rigid base which will not twist, rack, deform or deflect in any manner that will negatively effect the operation of the supported equipment or performance of the vibration isolation mounts. Frames shall include side mounting brackets for attachment to Unit SL or SLR spring isolator. The clearance between the underside of the steel base and top of the building shall be at least 50mm (2").

.2 Type C Concrete Inertial Base

- .1 Formed from stone aggregate concrete cast between appropriate steel reinforced perimeter structural steel channels, complete with steel reinforced concrete. Inertia block thickness shall not be less than 1/12th the longest dimension of the mounted equipment. Provide side clearance between underside of the inertia base and top of building structure under operating conditions.

2.4 FLEXIBLE PIPE CONNECTIONS

- .1 Flexible pipe connections shall be fabricated multiple plys of nylon cord, fabric and neoprene, vulcanized so as to become inseparable and homogenous. Straight connections shall be formed in a double sphere shape. Elbow connections shall have a single sphere shape at the curve of the unit. Flexible connections shall be able to accept compressive, elongative, transverse, and angular movements.
- .2 The flexible connections shall be selected and specially fitted, if necessary, to suit the system temperature, pressure and fluid type. No rods or cables shall be used to control extension of the connector.
- .3 Connectors for pipe sizes NPS 2 or smaller shall have threaded female union couplings on each end. Larger sizes shall be fitted with metallic flange couplings.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install vibration isolation equipment in accordance with manufacturers' instructions and adjust mountings to level equipment.
- .2 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.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring

mounts or spring hangers with 25mm (1") minimum static deflection as follows:

- .1 Up to NPS 4: first 3 points of support.
- .2 NPS 5 to NPS 8: first 4 points of support.
- .3 NPS 10 and Over: first 6 points of support.
- .4 First point of support shall have a static deflection of twice deflection of isolated equipment, but not more than 100mm (4").
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to a rigid system at the operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.
- .6 Drilled or power driven anchors or fasteners not permitted for use with seismic control measures.

3.2 SITE VISIT

- .1 Manufacturer to visit site and provide Departmental Representative with written certification that installation is in accordance with manufacturer's instructions, make adjustments and corrections in accordance with all written reports including final.
- .2 Provide Departmental Representative with notice 24 h in advance of visit.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 REFERENCES

- .1 Do Identification work in accordance with CGSB 24-GP-3a, Identification and Classification of Piping Systems.
- .2 Provide ULC and CSA registration plates as required by respective agency.

1.4 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit samples and lists of proposed wording for approval before engraving.

PART 2 PRODUCT

2.1 MANUFACTURERS NAMEPLATES

- .1 Each piece of equipment shall have a metal nameplate mechanically fastened to equipment, with raised or recessed letters. Nameplates to be located so that they are easily read. Do not insulate or paint over plates.
- .2 Include registration plates (eg. Pressure vessel, Underwriters' Laboratories and CSA approval) as required by respective agency and as specified. The supplier shall indicate size, equipment model, manufacturer's name, serial number, voltage, cycle, phase and power of motors.

2.2 SYSTEM NAMEPLATES

- .1 Major equipment to be identified with laminated plastic plates with black face and white centre (lettering) of minimum size 90mm x 38mm x 2.5mm (3-1/2" x 1-1/2" x 3/32") nominal thickness, engraved with 12mm (1/2") high lettering.
- .2 Nameplates to be fastened securely with pop rivets or screws in conspicuous place. Where nameplates cannot be mounted, such as on cool surfaces, provide standoffs.
- .3 Equipment type, number and service or areas or zone of building it serves to be identified.

2.3 PIPE IDENTIFICATION

- .1 Medium in piping to be identified as indicated below showing name and service, including temperature and pressure as indicated below, and directional flow arrows where relevant.
- .2 Colour Bands, Arrows and Wrap Mark:
 - .1 Plastic coated cloth material with protective over coating and waterproof contact adhesive undercoating, suitable for continuous operating temperature of 148.9°C(300°F) and intermittent temperature of 204.4°C (400°F).
 - .2 50mm (2") wide tape single wrap around pipe or pipe covering with ends overlapping one pipe diameter but not less than 25mm (1") for colour bands. Tape is to be cut, not torn.
 - .3 Block capital letters 50mm (2") high for pipes of 75mm (3") nominal and larger o.d. including insulation and not less than 19mm (3/4") high for smaller diameters to be used.
 - .4 Direction arrows 150mm (6") long by 50mm (2") wide for piping of 75mm (3") nominal or larger o.d. including insulation and 100mm (4") long by 19mm (3/4") wide for smaller diameters to be used. Double headed arrows to be used where direction of flow is reversible.
 - .5 Waterproof and heat resistant plastic marker tags to be used for pipes and tubing of 19mm (3/4") nominal and smaller o.d.
 - .6 Use black pipe marker letters and direction arrows. Use white on red background for fire protection pipe markers.

- .7 Use wrap mark in lieu of colour band, arrows and stencils.
- .3 Stencilled Identification
 - .1 Provide stencilled identification using a first quality environmentally friendly paint and colour bands. Letters shall be a minimum of 50mm (2").
- .4 Location Identification
 - .1 Markers and classifying colours on piping systems to be located so they can be seen from floor or platform.
 - .2 Piping runs to be identified at least once in each room.
 - .3 Do not exceed 15.250m (50'-0") between identification in open areas.
 - .4 Both sides where piping passes through walls, partitions and floors to be identified.
 - .5 Where piping is concealed in pipe chase or other confined space, point of entry and leaving, and at each access opening to be identified.
 - .6 Piping to be identified at starting and ending points of runs and at each piece of equipment.
 - .7 Identify branch, equipment or building served after each valve. (ie, heating zones are to be identified in Boiler Rooms).
 - .8 Provide primary and secondary colour banding.

Pipe Marker Legend	Valve Tag Legend	Primary Colour	Second Colour
Domestic Cold Water	DCW	Green	None
Domestic Hot Water Supp.	D.H.W.S.	Green	None
Domestic Hot Water Recirculation	D.H.W.R.	Green	None
Storm Sewer	Stm. S.	Green	None
Sanitary Sewer	San. S.	Green	None
Vent (Plumbing)	V.P.	Green	None
Seawater Supply	SWS	Yellow	Black
Seawater Return	SWR	Yellow	Black
Heat Exchange Water Supply	HXWS	Yellow	Black
Heat Exchange Water Return	HXWR	Yellow	Black

- .5 Valves
 - .1 50mm (2") laminated plastic plates (tags) with corner hole shall be provided for all valves and installed with nonferrous chains, "S" hooks or heavy duty plastic tie wraps. Tags shall have horizontal 12mm (1/2") letters accurately aligned and machine engraved into the core. Required for all valves and operating controllers.
 - .2 Provide one valve chart for each Operations and Maintenance Manual and one chart framed and wall mounted.
 - .3 Valves in systems to be numbered consecutively.
- .6 Buried Pipe Identification
 - .1 Use detectable Identoline underground warning tape colour coded to pipe service for full length of pipe.
 - .2 Bury to manufacturers recommendations.

- .3 Identify all systems, equipment, components, controls and sensors. Inscription to identify function.
- .7 Duct Identification
 - .1 50mm (2") high black stencilled letters to be used, i.e., "Fresh Air", "Supply", "Return", "Sanitary Exhaust", "Kitchen Exhaust", with directional flow arrow and Fan System No.
 - .2 Maximum distance between markings not to exceed 15m (50'-0").
 - .3 Locate identification on long straight runs in Mechanical Rooms so that at least one is clearly visible from any one viewpoint in usual operating areas or walking aisles, adjacent to all changes in direction, at least once in each room, on both sides of visible obstructions, on both sides of walls, floors and partitions, at each piece of equipment and beside each access door.
 - .4 Stencil over final finish only.
 - .5 Identify system to include air handling unit number.
- .8 Controls Equipment Identification
 - .1 Electrically fed equipment supplied by Division 25 (excluding that noted in .2, below) shall be identified as per Division 26 identification requirements.
 - .2 Intermediate and end control devices including sensors, controllers, monitoring devices, etc., shall be identified with laminated plastic plates as noted for System nameplates above. The plates shall be fastened securely with pop rivets or screws. Where rivets or screws are not feasible, provide heavy duty plastic tie wraps. As a minimum control device identification shall correspond to descriptors provided in the approved shop drawings with respect to panel designation or DDC point name.

PART 3 EXECUTION

3.1 GENERAL

- .1 Do identification work in accordance with CGSB 24-GP-3a except where specified otherwise.

3.2 LOCATION OF NAMEPLATES

- .1 In conspicuous location to facilitate easy reading from operating floor and to properly identify equipment and/or system.
- .2 Provide stand-offs for nameplates on hot surfaces and insulated surfaces.
- .3 Do not insulate or paint over plates.

3.3 PIPING

- .1 Locations:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries,

- and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking aisles and not at more than 15.250m (50') intervals.
- .2 Adjacent to all changes in direction.
- .3 At least once in each small room through which piping passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of any separation such as walls, floors and partitions.
- .6 Where piping is concealed in pipe chase, ceiling space, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
- .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. Where this is not possible, place identification as close to valve as possible, preferably on upstream side.
- .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
- .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.

3.4 DUCTWORK

- .1 Stencil over final finish only.
- .2 Locations of ductwork identification:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, and tunnels so that at least one is clearly visible from any one viewpoint in operating areas or walking isles and not at more than 15.250m (50') intervals.
 - .2 Adjacent to all changes in direction.
 - .3 At least once in each small room through which ductwork passes.
 - .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of any separation such as walls, floors and partitions.
 - .6 Where ductwork is concealed in duct chase, gallery or other confined space, at entry and leaving points and adjacent to each access opening.
 - .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 dampers. Where this is not possible, place identification as close to damper as possible, preferably on upstream side.
 - .9 Legend to be easily and accurately readable from usual operating areas and all readily accessible points.
 - .10 Plane of legend to be approximately at right angles to most convenient line of sight with consideration of operating positions, lighting conditions, reduced visibility of colour or legends caused by dust and dirt and risk of physical damage.
 - .11 Beside each access door.

3.5 VALVES AND CONTROLLERS

- .1 Secure tags with non-ferrous chains or closed "S" hooks for valves and operating controllers.

- .2 Install one (1) copy of flow diagram and valve schedule mounted in frame with non-glare glass where directed by Departmental Representative. Provide one copy in each operating and maintenance instruction manual.
- .3 Consecutively number valves in system.

3.6 BURIED PIPE IDENTIFICATION

- .1 Use Detectable Identoline underground warning tape colour coded to pipe service for full length of pipe.
- .2 Bury to manufacturer's recommendations.

END

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 all other work as specified in this section.
- .2 TAB shall be carried out by an independent Agency registered member of AABC.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Names of all personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative within 14 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 all other related systems under all 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 PREVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of all 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 25.

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 only when each phase of project is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Division 25.
 - .4 All provisions for TAB installed and operational.
 - .5 Start-up, verification for proper, normal and safe operation of all 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 All outlets installed, volume control dampers open.

- .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

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

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, three (3) copies sample of rough TAB sheets. Make changes and resubmit if necessary 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 AABC.
- .2 TAB report to show all 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 D-ring binders, complete with index tabs.

1.16 VERIFICATION

- .1 All reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 30% of all 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 all access doors, lock all devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark all 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 only when final TAB Report received and approved by Departmental Representative.

1.19 AIR SYSTEMS SMACNA, ASHRAE

- .1 Standard: TAB to be to most stringent standards of AABC, SMACNA, ASHRAE.
- .2 General: measurements as required by referenced standards, including, but not limited to, the following:
 - .1 Measurements:
 - .1 Air velocity.
 - .2 Static pressure.
 - .3 Velocity pressure.

- .4 Temperature:
 - .1 Wet bulb.
 - .2 Dry bulb.
- .5 Cross sectional area.
- .6 RPM.
- .7 Electrical power:
 - .1 Voltage.
 - .2 Current draw.
- .2 Location of equipment measurements:
 - .1 Inlet and outlet of each:
 - .1 Fan.
 - .2 Coil.
 - .3 Filter.
 - .4 Damper.
 - .5 Other auxiliary equipment.
 - .3 Location of system measurements at:
 - .1 Main ducts.
 - .2 Main branch ducts.
 - .3 Sub-branch ducts.
 - .4 Each supply, exhaust and return air inlet and outlet.
 - .5 Terminal Unit.
 - .6 Other auxiliary equipment.
 - .7 All areas served by system.
- .4 All locations for systems measurements shall be identified and be readily accessible for future testing agencies.

1.20 HYDRONIC SYSTEMS

- .1 General: measurements as required by referenced standards, including, but not limited to, following:
 - .1 Measurements:
 - .1 Flow.
 - .2 Pressure.
 - .3 Temperature.
 - .4 Specific gravity.
 - .5 RPM.
 - .6 Electrical power:
 - 1. Voltage.
 - 2. Current draw.
 - .2 Location of equipment measurements:
 - .1 Inlet and outlet for each:
 - 1. Pumps.
 - .3 Location of system measurements at:
 - .1 Supply and return each primary and secondary loop of following hydronic systems:
 - 1. Seawater System.

1.21 SCHEDULING OF AIR BALANCING

- .1 The final air balancing report must be submitted a minimum of three (3) weeks before the substantial completion date.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 REFERENCES

- .1 Meet NFPA 90A-2009. Maximum flame spread rating of 25 and maximum smoke developed ratings of 50 in accordance with NFPA 255-2006 and CAN4-S102-M83 for all components of insulation system. Manufacturers tested in accordance with ASTM C411-05.

1.4 SHOP DRAWINGS

- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittals Procedures.
- .3 Submit for approval manufacturer's catalogue literature related to installation.

1.5 DEFINITIONS

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- .2 Manufacturers to be tested in accordance with ASTM C411.

2.2 D-2 FIBREGLAS RIGID WITH VAPOUR BARRIER

- .1 Application: All size ductwork for the following:
 - .1 All fresh air intake ductwork and plenums. Thickness: 50mm.
 - .2 All exhaust air ductwork and plenums from fan or damper to louver. Thickness 50mm.
- .2 Manufacturer:
 - .1 CGSB 51-GP-10M, rigid mineral fibre board; CGSB 51-GP-52M vapour barrier, jacket and facing Manufacturer.

2.3 FASTENINGS

- .1 Tape: self adhesive, 100mm (4") wide, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
- .2 Contact adhesive: quick-setting, non-flammable fire resistive to adhere fibrous glass to ducts. Flame spread 15, smoke development 0.
- .3 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
- .4 For Canvas:
 - .1 Washable adhesive for cementing canvas lagging cloth to duct insulation.
- .5 Pins:
 - .1 Weld pins 1.58mm (1/6") diameter, with 38mm (1-1/2") diameter head for installation through the insulation. Length to suit thickness of insulation.
 - .2 Weld pins 38mm (1-1/2") diameter, for installation prior to applying insulation. Length to suit thickness of insulation. Nylon retain clips 30mm (1-1/4") square.
 - .3 Acceptable Manufacturer:

2.4 JACKETS

- .1 Canvas:
 - .1 Apply in exposed areas: ULC listed plain weave, cotton fabric at 200 g/m2 (11 oz/ft2).

PART 3 EXECUTION

3.1 APPLICATION

- .1 Apply insulation after required tests have been completed and approved by Departmental Representative. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation Manufacturers, accessories and finishes to manufacturer's recommendations and as specified.
- .2 Vapour barriers and insulation to be unbroken over full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves and supports.
- .3 Use stand-offs for all duct mounted control accessories.
- .4 Apply 1.005mm (20 ga.) thick galvanized sheet metal corners to all ductwork in mechanical rooms.

3.2 INSTALLATION

- .1 General:
 - .1 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
 - .2 Adhere and seal vapour barrier using vapour seal adhesives.
 - .3 Stagger longitudinal and horizontal joints, on multi-layered insulation.
- .2 Mechanical fastenings:
 - .1 On rectangular ducts, use 50% coverage of insulating cement and weld pins at not more than 200mm (8") centres, but not less than 2 rows per side and bottom.

3.3 SIZING

- .1 Provide fire retardant coating on canvas jackets.
- .2 Fire retardant coating shall be U.L. approved.
- .3 Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for painting.

END

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Meet NFPA 90A-2009. Maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with NFPA 255-2006 and CAN4-S102-M83 for all components of insulation system. Materials tested in accordance with ASTM C411-05.

1.2 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.3 WASTE MANAGEMENT AND DISPOSAL

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

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

1.5 DEFINITIONS

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

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Apply temporary protective coating to finished surfaces. Remove coating after erection. Do not use coatings that will become hard to remove or leave residue.
- .2 Leave protective covering in place until final cleaning of building.

PART 2 PRODUCTS

2.1 GENERAL

- .1 All components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN4-S102.
- .2 Materials to be tested in accordance with ASTM C411.

2.2 P-1 FORMED MINERAL FIBRE TO 200°C

- .1 Application: for piping valves and fittings on:
 - .1 Domestic hot water, temperature 60°C.
 - .2 Domestic hot water recirculation, temperature 60°C.
- .2 Materials:
 - .1 CGSB 51-GP-9M, rigid mineral fibre sleeving for piping.
- .3 Thickness: See Table (Minimum Pipe Insulation Thickness), Item 3.5.1.

2.3 P-2 FORMED MINERAL FIBRE WITH VAPOUR BARRIER TO 85°C

- .1 Application: for piping, valves and fittings on:
 - .1 Domestic cold water, temperature 4°C.
 - .2 Seawater System Piping located inside pumphouse.
- .2 Material:
 - .1 CGSB 51-GP-9M, rigid mineral fibre sleeving for piping and CGSB 51-GP-52M, vapour barrier jacket and facing material.
 - .2 Thickness: See Table (Minimum Pipe Insulation Thickness), Item 3.5.1.
 - .3 50mm (2") thick for main piping NPS 4 and larger.

2.4 FASTENINGS

- .1 For insulation systems P-1 and P-2:
 - .1 Tape: self adhesive, aluminum, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
 - .2 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.

- .3 Lagging adhesive: fire retardant coating.
- .2 For vapour barriers:
 - .1 Quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
- .3 All adhesives shall be U.L. listed and suitable for application as per insulation manufacturers' recommendations.

2.5 INSULATION CEMENT

- .1 To CAN/CGSB-51.12.

2.6 JACKETS

- .1 Canvas:
 - .1 3.3 kg/m2.
 - .2 On concealed valves and fittings: ULC listed plain weave cotton fabric at 3.3 kg/m2.
- .2 PVC:
 - .1 Apply in accordance with CGSB 51-GP-53M.
 - .1 4 mm thick minimum.
 - .2 Application: Use PVC moulded coverings on mechanical grooved coupling joints and fittings only.
 - .3 PVC jacket must meet 25 flame spread and 50 smoke developed rating.
 - .4 Application: on fittings only.
- .3 Light Gauge Aluminum:
 - .1 Light gauge aluminum jacket, caulk sealed and fastened with stainless steel cinch straps.
 - .2 Fasten all cinch straps on top of pipe.
 - .3 Application: on all exterior piping.
 - .4 Thickness to be 6 mil.

PART 3 EXECUTION

3.1 APPLICATION

- 1. Apply insulation after required tests have been completed and approved by Departmental Representative. Insulation and surfaces shall be clean and dry when installed and during application of any finish. Apply insulation materials, accessories and finishes in accordance with manufacturer's recommendations and as specified herein.

2. On piping with insulation and vapour barrier, install high density insulation under hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.

3.2 INSTALLATION

1. Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
2. Preformed: sectional up to 300 mm, sectional or curved segmented above 300 mm.
3. Multi-layered: staggered butt joint construction.
4. Vertical pipe over 75mm (3"): insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter, locate on 4.6m centres.
5. Seal and finish exposed ends and other terminations with insulating cement.
6. Orifice plate mounting flanges, flanges and unions at equipment, expansion joints, valves, other components requiring regular maintenance: install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.
7. Insulation is not required for chrome plated piping and fittings.

3.3 FASTENINGS

1. Secure pipe insulation by tape at each end and centre of each section, but not greater than 450mm on centres.

3.4 SIZING

1. Provide fire retardant coating on canvas jackets.
2. Fire retardant coating shall be U.L. approved.
3. Coat canvas covering exposed in finished spaces with diluted coat of lagging adhesive. Provide a total of two coats of lagging adhesive. Dilution of lagging adhesive as per manufacturer's recommendations for priming.

3.5 THICKNESS

1. MNECB Table of Minimum Pipe Insulation Thickness as follows:

Service	MINIMUM PIPE INSULATION THICKNESS MM / (")				
	Pipe Size				
	Run outs up to 50mm/(2")	Up to 25mm(1")	30 to 50mm (1-1/4" to 2")	65-100mm (2-1/2" -4")	150mm and Up (6" and Up)
Domestic Hot Water	25mm (1")	25mm (1")	25mm (1")	38mm (1½")	38mm (1½")
Domestic Cold Water	25mm (1")	25mm (1")	25mm (1")	25mm (1")	25mm (1")
Seawater Piping Inside	25mm (1")	25mm (1")	38mm (1½)	38mm (1½)	38mm (1½")

3.6 REFRIGERANT PIPING

1. Insulation shall fit in snug contact with pipe and be installed in accordance with manufacturer's recommendations.
2. Stagger joints on layered insulation.
3. Slip insulation on tubing before tubing sections and fittings are assembled, keeping slitting of insulation to a minimum.
4. Seal joints in insulation.
5. Insulate flexible pipe connectors.
6. Provide 150mm (6") long, 20 ga. Galvanized steel sleeve around pipe insulation at each support.
7. Extend insulation through pipe support clamps.
8. Insulation shall have "slit" joint seams placed on bottom of pipe. Use manufacturer's recommended adhesive to seal joints.
9. Insulate fittings with sheet insulation and as recommended by Manufacturer.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 - General Requirements.
- .2 Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .3 Section 23 05 29 - 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 (ASTM International):
 - .1 ASTM B209M-01, 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 C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-95 (2001), Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
 - .7 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .8 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .9 ASTM C795-92 (1998) e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .10 ASTM C921-89 (R1996), Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB):
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CGSB 51-GP-53M-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Thermal Insulation Association of Canada (TIAC):
 - .1 National Insulation Standards 1992 (R1999).
- .5 Underwriters Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102-M88 (R2000), Surface Burning Characteristics of Building Materials and Assemblies.

1.3 PRODUCT DATA

- .1 Submit Product Data in accordance with sections of Section 01 33 00 – Submittal Procedures.

1.4 SAMPLES

- .1 Submit samples in accordance with sections of Section 01 33 00 – Submittal Procedures.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on ½" plywood board. Affix typewritten label beneath sample indicating service.

1.5 MANUFACTURER'S INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance sections of Section 01 33 00 – Submittal Procedures.
- .2 Installation instructions to include procedures to be used and installation standards to be achieved.

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE AND HANDLING

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

1.8 WASTE MANAGEMENT AND DISPOSAL

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

- .5 Divert unused adhesive materials from landfill to official hazardous material collections site approved by Departmental Representative.
- .6 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

1.9 DEFINITIONS

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

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 DEMOUNTABLE INSULATION

- .1 Application: Seawater pumps, water meter bodies.
- .2 Material:
 - .1 CGSB-51-GP-2M, block rigid hydrous calcium silicate thermal insulation.
- .3 Thickness: 25mm.
- .4 Insulation shall be made to required shape, demountable w/ hinged or doweled construction with 0.6mm thick aluminum alloy outer lined.
- .5 Insulation pads with 50mm thick insulation will be acceptable.

2.3 FASTENINGS

- .1 For Vapour Barriers:
 - .1 Quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10 smoke development 0.
- .2 For Canvas:
 - .1 Washable adhesive for cementing canvas lagging cloth to equipment insulation.

2.4 JACKETS

- .1 Canvas:
 - .1 Apply on all equipment inside the building: compact, firm ULC listed heavy plain weave, cotton fabric at 200g/m2.

2.5 COLD EQUIPMENT

- .1 Insulate all cold equipment including strainers. Insulation to be 50mm thick complete with vapour barrier.

2.6 CEMENT

- .1 Thermal insulating and finish:
 - .1 To: ASTM C449/C449M.
 - .2 Hydraulic setting or air drying on mineral wool, to ASTM C449.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Apply insulation after all tests have been completed and approved by the Departmental Representative.
- .2 Surface to be clean and dry during installation of insulation and finishes.
- .3 If not specified herein, application to be to manufacturer's recommendations.
- .4 Maintain uninterrupted integrity of vapour barrier.
- .5 Apply high density insulation under supports and hangers.

3.2 INSTALLATION

- .1 Insulation supports where welding or bolting is permitted:
 - .1 Angle anchors: weld or bolt to equipment at lowest point of insulation. Thereafter, locate every 4.6 meters. vertically.
 - .2 Welded steel clips: at 200mm maximum on centers, but not less than two (1) rows per side.
- .2 Insulation:
 - .1 Multi-layered: staggered butt joints and expansion joints in insulation, secured with wire or bands at 400mm center intervals.
- .3 Expansion joints in insulation: Leave 25mm space in each layer at 5.5m intervals. Pack space tightly with mineral fibre.
- .4 Insulation at bolts, studs, nuts, instrumentation: bevel to permit removal without damage to insulation or finish.
- .5 Fastenings: secure insulation with stainless steel wire at 900mm on center before application of finishing cement.
- .6 Vapour barriers: adhere and seal with vapour seal adhesive.

- .7 Finishes:
 - .1 Cement: apply over insulation in 2-6mm thick layers, reinforced by 25mm mesh galvanized steel wire netting.
 - .2 Canvas: sewn and pasted on to all insulation and over cement finishes. Seams inconspicuously placed.
- .8 Do not insulate over nameplates, data plates, etc. Provide smooth bevelled edges at the name and data plates.
- .9 Install in accordance with TIAC National Standards:
 - .1 Cold equipment: To TIAC Code 1503-C.
- .10 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .11 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .12 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports outside vapour retarder jacket.
- .13 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

END

PART 1 GENERAL

1.1 GENERAL

- .1 This section to be read in conjunction with Section 22 05 00 – Common Work Results for Plumbing, 23 05 00 – Common Work Results for Mechanical and Division 1.

1.2 DESCRIPTION OF SYSTEM

- .1 This section applies to the following services:
 - .1 Seawater piping services located inside pumphouse building.
 - .2 Vacuum pump piping services.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop drawings shall include technical literature on systems components floor plan including the equipment room layout, schematic flow diagrams of system with all pipe sizing and the components identified by manufacturers' names and model numbers.

1.4 MAINTENANCE DATA & SERVICE

- .1 Provide maintenance data in English for the seawater and vacuum system for incorporation into maintenance manuals specified in the Section 01 78 00 – Closeout Submittals.
- .2 Provide as-built information as required in Section 23 05 00 – Common Work Results for HVAC.

PART 2 PRODUCTS

2.1 PIPE AND FITTINGS

- .1 All above ground piping and fittings shall be PVC Schedule 80, Type 1, Grade 1, conforming to ASTM D1784 and CSA B137.7 complete with solvent weld, threaded, or flanged connections.

2.2 VALVES

- .1 Butterfly Valves:
 - .1 Valves to be PVC body, EPDM O-Rings, wafer type, 1034 kPa (150 psi) WOG, stainless steel stems, solid plastic disc, PP lever operator with steel core – 150mm and under; heavy duty waterproof gear operators – 200mm and over; EPDM seats and seals, flanged ends.
 - .2 Valves at equipment to be lug type.
- .2 Check Valves:
 - .1 Valves to be PVC body, EPDM O-Rings, swing disc type, 860 kPa (125 psi) flanged ends, bolted cover.

- .3 Globe Valves:
 - .1 Valves to be PVC body, EPDM O-Rings, composition disc type, 1034 kPa (150 psi) screwed bonnet, flanged/screwed ends.
- .4 Ball Valves:
 - .1 Valves to be PVC body, EPDM O-Rings, flanged/screwed ends.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Check and locate equipment upon arrival; level and make secure.
- .2 Install according to piping layout. Make provisions for pipe movement during operation. Pipe drains to nearest drain.
- .3 Ensure that proper clearance around equipment permits performance of service maintenance, that height clearance for piping is adequate. Check final location with Engineer, if different from that shown, prior to installation.
- .4 Should deviations beyond allowable clearances arise, request and follow the Departmental Representative's directive.
- .5 Inspect and remove any foreign matter from, and clean internals of, all equipment.
- .6 Piping General:
 - .1 Install straight, parallel and close to walls and ceilings with specified pitch.
 - .2 Install groups of piping parallel to each other, spaced to permit application of identification and service access.
 - .3 Where pipe sizes differ from connections sizes of equipment, install reducing fittings close to equipment.
 - .4 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
 - .5 Install flanges to permit removal of equipment without disturbing piping systems.
 - .6 Install drain valves at all low points.

3.2 TESTING

- .1 Test piping in accordance with procedures outlined in Sections 22 05 00 – Common Work Results for Plumbing and 23 05 00 - Common Work Results for Mechanical and as specified herein.

3.3 SOLVENT WELDING OF PVC PIPE

- .1 Use solvent cement recommended by pipe manufacturer.
- .2 Do not solvent weld pipe under the following conditions:
 - .1 If it is raining.

- .2 If the atmospheric temperature is below 5° C.
- .3 If under direct exposure to sun at atmospheric temperatures above 30° C.
- .3 Follow manufacturers' recommendations completely.
- .4 Solvent Welding:
 - .1 Deburring and Bevelling:
 - .1 All burrs, chips, filings, etc., shall be removed from both the pipe I.D. and O.D. before joining. Use a lineoleum knife, deburring tool or a half-round, coarse file to remove all burrs.
 - .2 All pipe ends should be bevelled for ease of socketing and to minimize the chances of wiping the solvent cement from the I.D. of the fitting as the pipe is socketed.
 - .2 Cleaning: Using a clean, dry cotton rag, wipe away all loose dirt and moisture from the I.D. and O.D. of the pipe end and the I.D. of the fitting. DO NOT ATTEMPT TO SOLVENT WELD (WHEN IT IS RAINING) WET SURFACES.
 - .3 Fitting Preparation Prior to solvent welding, all fittings and couplings should be removed from their cartons and exposed for at least one hour to the same temperature conditions as the pipe in order to assure that they are thermally balanced before joining.
 - .4 Priming: Using a natural bristle (hog) brush of the correct width as recommended by manufacturer, apply a complete coating of CPS Primer to the entire I.D. surface of the fitting socket and to an equivalent area on the O.D. of the pipe end. This will clean and etch the surfaces. If necessary, wipe surfaces to remove any remaining foreign matter and apply a liberal second coat of primer to thoroughly roughen surfaces.
 - .5 Solvent Cement Application: Using another natural bristle brush of the same width, brush CPS's appropriate type solvent cement into the fitting's socket and onto the O.D. of the pipe end as follows:
 - .1 To the Pipe: Dip brush in cement and flow the cement liberally once around entire surface of pipe O.D. to a width of slightly more than the equivalent socket depth of the fitting.
 - .2 To the Fitting: Dip brush into cement and brush a light but complete coating once around entire depth of socket surface (avoid excessive cement application so that there is no chance of a cement build-up inside the fitting or pipe when the pipe is socketed).
 - .3 To the Pipe: Apply another liberal coating onto pipe O.D. Purpose of double coat to pipe end is to ensure that cement is liberally applied, and that any gap in the interference fit of the joint is thoroughly welded. There is no concern about applying too much cement on the pipe, because any excess will be beaded out of the face of the fitting where it may be easily wiped away.
 - .6 Joining: Immediately, upon finishing cement application and before it starts to set, insert the pipe to the full socket depth while rotating the pipe or fitting a 6-12mm (1/8 to 1/4) turn to ensure complete and even distribution of the cement. In larger diameter pipe, i.e. 150mm (6") size and above, this twist action may be omitted. Hold joint together for a minimum of 10 to 15 seconds to make sure that pipe does not move or back out of the socket.
 - .7 Excess Cement: Immediately, after joining and before joint is gently set back onto

a level surface, wipe off all excess cement from the entire circumference of the pipe and fitting, including all cement that has beaded out at the face of the fitting and any other globs of cement that have been accidentally dropped onto the pipe or fitting.

- .8 Allow 48 hours of joint drying time before the joint is moved or subjected to any appreciable internal or external pressure.

END

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Materials, equipment selection, installation and start up for hydronic system pumps.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 29 - Health and Safety Requirements.
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 01 91 13 – General Commissioning Requirements.

1.3 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).
 - .1 Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC).
- .3 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-B214-01, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers Association (NEMA).
 - .1 NEMA MG 1-2003, Motors and Generators.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
- .4 Submit product data of pump curves for review showing point of operation.
- .5 Indicate piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .6 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

1.7 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

PART 2 PRODUCTS

2.1 EQUIPMENT

- .1 Do component selection and sizing to: CAN/CSA-B214.

2.2 VERTICAL IN-LINE CIRCULATORS FOR SEAWATER

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with flanged suction and discharge connection. All wetted surfaces to be coated with corrosion resistant epoxy enamel for seawater use.
- .2 Impeller: 316 S.S, fully enclosed and dynamically balanced.
- .3 Shaft: 316 Stainless Steel with integral thrust collar.
- .4 Seal Assembly: outside balanced seal design and rated for 93.3°C maximum.
 - .1 Rotating face to match system fluid.
 - .2 Sintered silicone carbide stationary face.
 - .3 Stainless steel rotating hardware.
 - .4 Viton secondary/shaft seal elastomer.
 - .5 Flush Line: 10mm braided stainless steel complete with vent and 50 micron inline cartridge filter.
- .5 Coupling: high tensile aluminum, rigid self-aligning.
- .6 Motor & Controller: NEMA Premium to NEMA MG 1 table 12.12, resilient mounted, ODP enclosure. Motor suitable for variable speed operation. Provide mounting feet for future VSD installation.
- .7 Capacity: as indicated on drawings.

- .8 Design pressure: 1200KPa.

2.3 VACUUM PUMP PRIMING SYSTEMS

- .1 Provide vacuum priming system for seawater piping system and seawater pumps P12-1a , P12-1b & P12-1c.
- .2 Tank mounted vacuum priming system includes two high efficiency vacuum pumps, a duplex control panel with automatic controls, a horizontal vacuum receiver, and all interconnecting piping and wiring for single point connections. All external ferrous metals will be protected by a uniform coating of industrial enamel. The entire system shall be run tested to ensure proper operation.
- .3 Performance: This system shall prime a 2605 litres (92 cubic foot) inlet volume of seawater to a 4.6 M (15 ft) vertical lift in approximately 1 minute with both vacuum pumps running. The prime will then be automatically maintained with only one vacuum pump normally running, as needed. Each vacuum pump has a maximum flow of 16.56 l/s (35 ACFM) and is rated to 101.3 kPa (29.9" Hg) vacuum. This system shall be sized to be fully redundant.
- .4 Pump Assembly
- .1 Qty 2--Air-cooled, oil-lubricated rotary vane vacuum pump.
 - .2 Qty 2--Electric motor, 2.23 Kw (3.0 HP), 575 volt, 60 Hz, 3-phase, TEFC enclosure, CSA .
 - .3 Qty 2--Built-in air/oil separation system.
 - .4 Qty 2--Secondary inlet check valve.
 - .5 Qty 2--Built-in gas ballast valve for increased moisture handling ability.
 - .6 Qty 2--AutoPurge isolation valve to accommodate long, trouble free maintenance, electrically actuated, NEMA 4X, CSA.
 - .7 Qty 2--Inlet filter with replaceable polyester element.
 - .8 Qty 2--Vacuum release valve with silencer to accommodate trouble free maintenance.
 - .9 Qty 2--Oil drain line with valve to accommodate trouble free maintenance.
 - .10 Qty 2--Stainless steel flex connector.
 - .11 Qty 2--Semi-synthetic vacuum pump oil.
- .5 Air Receiver:
- .1 Qty 1--Horizontal ASME receiver tank, 454 Litres (120 Gallon), galvanized steel CRN.
 - .2 Qty 2--Fork truck lifting rails.
 - .3 Qty 1--Receiver sight level gauge.
 - .4 Qty 1--High water level switch for automatic shutdown.
 - .5 Qty 1--Receiver drain valve.
 - .6 Qty 1--System isolation valve.
 - .7 Qty 1--Vacuum release valve with silencer to accommodate trouble free maintenance.
 - .8 Qty 1--Vacuum gauge, 100mm (4") dial, liquid filled.

- .6 Automatic Duplex Control Panel (575 volt, 60 Hz, 3-phase):
 - .1 Qty 1--NEMA 4 enclosure w/ cUL 508 panel shop label.
 - .2 Qty 1—Main disconnect switch.
 - .3 Qty 2—IEC style full voltage starter with overload protection and reset switch.
 - .4 Qty 1—Control voltage transformer.
 - .5 Qty 1—Power supply, 24 VDC.
 - .6 Qty 2--Green LED pump running light.
 - .7 Qty 2--H-O-A selector switch.
 - .8 Qty 1--Red LED alarm light with reset button.
 - .9 Qty 1--Alarm horn with silence button, 90 dB(A).
 - .10 Qty 3--Dry contacts for remote alarms (low vacuum, pump failure, & receiver flooded alarms).
 - .11 Qty 1--Vacuum transducer.
 - .12 Qty 1--Micro-processing controller providing HMI, lead/lag control, automatic alternation, AutoPurge, frequent start protection, and an illuminated LCD panel to display the following information:
 - .1 System operation status
 - .2 Running hours for each pump
 - .3 Vacuum level
 - .4 Low vacuum alarm
 - .5 Vacuum receiver flooded alarm (initiates emergency shutdown)
 - .6 Pump start failure alarm.
 - .13 Qty 1-- Ethernet adaptor to connect to micro-processing controller to building EMCS system.
- .7 Qty 3 - Heavy duty priming valve including a cast iron body with fusion bonded epoxy coating, 316 stainless steel trim, and CSA approved weatherproof SPDT level switch kit for proof of prime signal.
- .8 Qty - 1 Inline water trap with 25mm (1") FPT isolation valves, corrosion resistant aluminum head, clear polycarbonate housing to show accumulated liquid, internal baffle, stainless steel screen, ball float, elastomer seat, vacuum release valve, drain valve, and vacuum gauge.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Do Work in accordance with CAN/CSA-B214.
- .2 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement. Furnish anchor bolts with sleeves. Place level, shim unit and grout. Align coupling in accordance with manufacturer's recommended tolerance. Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.2 VACUUM PUMP PRIMING SYSTEM

- .1 Execution:
 - 1. Installation of complete vacuum priming system and its components shall be done by qualified personnel in accordance with manufacturer's installation recommendations.
 - 2. Provide piping services between vacuum and seawater piping system in accordance with manufacturer's recommendations. Size valve and piping in accordance with manufacturer's recommendations and as required to suit system performance.
 - 3. Provide one priming valve for each pump connected to the priming system.
 - 4. Provide manufacturer's start-up and testing services by qualified factory trained personnel. Submit start-up reports to Department Representative.
 - 5. Qualified factory trained personnel to participate in commissioning activities and provide training instructions as indicated in these documents.

3.3 VACUUM PUMP PRIMING SYSTEM

- .1 General:
 - .1 In accordance with Section 01 19 13 – General Commissioning Requirements; supplemented as specified herein.
 - .2 In accordance with manufacturers recommendations.
- .2 Procedures:
 - .1 Vacuum pump priming system to be completely tested and operational prior to start-up of seawater pumps.
 - .2 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .3 After starting pump, check for proper, safe operation.
 - .4 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .5 Check base for free-floating, no obstructions under base.
 - .6 Run-in pumps for 12 continuous hours.
 - .7 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .8 Eliminate air from scroll casing.
 - .9 Adjust water flow rate through water-cooled bearings.

- .10 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
- .11 Adjust alignment of piping and conduit to ensure true flexibility at all times.
- .12 Eliminate cavitation, flashing and air entrainment.
- .13 Adjust pump shaft seals, stuffing boxes, glands.
- .14 Measure pressure drop across strainer when clean and with flow rates as finally set.
- .15 Replace seals if pump used to degrease system or if pump used for temporary heat.
- .16 Verify lubricating oil levels.

3.4 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 In accordance with Section 01 91 13 – General Commissioning Requirements supplemented as specified herein.
- .2 Exclusions:
 - .1 This paragraph does not apply to small in-line circulators.
- .3 Assumptions: these PV procedures assume that:
 - .1 Manufacturer's performance curves are accurate.
 - .2 Valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH):
 - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
 - .2 Measure using procedures prescribed in the Standard.
 - .3 Where procedures do not exist, discontinue PV, report to Departmental Representative and await instructions.
- .5 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .7 Commissioning Reports: In accordance with Section 01 91 13 – General Commissioning Requirements supplemented as specified herein. Reports to include:
 - .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Report forms as specified Section 01 91 13 – General Commissioning Requirements: Report Forms and Schematics.
 - .3 Pump performance curves (family of curves).

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 REFERENCES

- .1 SMACNA HVAC - Duct Construction Standards, Metal and Flexible, 2005.
- .2 SMACNA HVAC - Duct Leakage Test Manual, 1985.
- .3 ASHRAE Handbook - Fundamentals, and Systems Volumes.
- .4 ASTM A480/A480M-10A - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .5 ASTM A525M-91A- Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, (Metric).

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product and in accordance with Section 01 77 00 – Closeout Procedures.
- .2 Indicate following:

- .1 Sealants
- .2 Tape
- .3 Proprietary Joints

1.5 GENERAL

- .1 This Section is applicable to ductwork up to 750 Pa. (3" w.g).

PART 2 PRODUCTS

2.1 SEAL CLASSIFICATION

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

2.2 SEALANT

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

2.3 TAPE

- .1 Polyvinyl treated, open weave fibreglas tape, 50mm (2") wide.

2.4 LOW PRESSURE DUCTWORK

- .1 All supply ductwork in mechanical rooms and for VAV systems is to be constructed for 747 Pa (3.0"w.g.) operating pressure. Supply ductwork for constant volume systems is to be constructed for 498 Pa (2.0" w.g.) operating pressure. All return and exhaust ductwork to be constructed for 498 Pa (2.0" w.g.) operating pressure. Ductwork designed for 498 Pa (2.0" w.g.) operating pressure shall be constructed as per Table 1-5, SMACNA HVAC Duct Construction Standards.
- .2 Duct sizes 483mm (19") wide and larger with more than 0.929m² (10 sq. ft.) or embraced panel shall be beaded or cross broken. This shall also apply to 1.005mm (20 gauge) or less thickness and 747 Pa (3.0" w.g.) or less.
- .3 Concealed round branch ducts up to 406mm (16") diameter may be constructed with longitudinal seams. Concealed round branch ducts over 406mm (16") and all exposed

round ducts shall be factory fabricated conduit consisting of helically wound galvanized steel strips with spiral lock seams. Fittings for these conduits shall be fabricated of 1.005mm (20 gauge) galvanized sheet steel with butt welded seams of standard dimensions. Long radius elbows shall be used where space permits. Where 90° take-offs are necessary, conical T's shall be used.

2.5 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A525M, Z90 zinc coating.
- .2 Thickness: to ASHRAE and SMACNA.
- .3 Fabrication: ducts and fittings configuration in accordance with recommendation of SMACNA and ASHRAE.
- .4 Joints: to ASHRAE Class B seal.

2.6 ALTERNATE TRANSVERSE DUCT JOINT SYSTEM

- .1 Alternate transverse duct joint system shall include angles, corners, metal cleats, closed cell neoprene gaskets, corner clips and integral mastic sealant.
- .2 Alternate transverse duct joint system shall be installed as per manufacturer's recommendations.
- .3 When the gasket is applied around the corner of the alternate transverse duct joint system, reverse direction twice in order to apply three layers of the gasket at each corner.
- .4 Use bolts at the corners or 'no-bolt' corner clips.
- .5 Use metal drive cleats on all four sides of the joints. Cleats to be 150mm (6") long and 457mm (18") on centers.

2.7 HANGERS AND SUPPORTS

- .1 Hangers and Supports:
 - .1 Fabricate strap hangers to same material as duct. Hanger configuration to SMACNA duct.
 - .2 Rod and angle hangers: galvanized steel to SMACNA details with cadmium plated black iron rods to SMACNA details.
 - .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel decks or use power actuated fasteners. All fasteners in Natatorium to be zinc plated.

PART 3 EXECUTION

3.1 GENERAL

- .1 Do work in accordance with SMACNA standards.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .3 Support all risers.
- .4 Install breakaway joints in ductwork on each side of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Ground across flexible connector with No. 2/0 braided copper strap.
- .7 Install balancing dampers at all branch ducts and as indicated.
- .8 Install fire dampers to NFPA 90A.
- .9 Make fresh air intake ducts watertight up to end of transition. Fit drain connections on bottom with minimum 32mm (1-1/4") pipe to nearest funnel drain.
- .10 Hangers shall be galvanized steel angles with supporting rods, locking nuts and washers to the following table:

Duct Size	Angle Size	Rod Size	Spacing
Up to 762mm (Up to 30")	25mm x 25mm x 3mm (1" x 1" x 1/8")	6mm (1/4")	3.048m (10'-0")
787mm to 1067mm (31" to 42")	38mm x 38mm x 3mm (1-1/2" x 1-1/2" x 1/8")	6mm (1/4")	3.048m (10'-0")
1092mm to 1524mm (43" to 60")	38mm x 38mm x 3mm (1-1/2" x 1-1/2" x 1/8")	10mm (3/8")	3.048m (10'-0")
1549mm to 1829mm (61" to 72")	50mm x 50mm x 3mm (2" x 2" x 1/8")	10mm (3/8")	2.621m (8'-6")
1854mm to 2438mm (73" to 96")	50mm x 50mm x 5mm (2" x 2" x 3/16")	10mm (3/8")	2.621m (8'-6")
2438mm and Over (97" and Over)	50mm x 50mm x 6mm (2" x 2" x 1/4")	10mm (3/8")	2.621m (8'-6")

- .11 Ductwork shall be free from pulsation or objectionable noises.
- .12 All vertical ducts in shafts shall be rigidly supported with steel angle. In no case shall angles be less than 38mm x 38mm x 6mm (1-1/2" x 1 1/2" x 1/4").
- .13 Where ducts over 610mm (24") wide are shown passing through masonry walls provide lintels and a continuous 38mm x 38mm x 6mm (1-1/2" x 1 1/2" x 1/4") galvanized steel angle frame which shall be bolted to the construction and made air-tight to the same by applying caulking compound. Sheet metal at these locations shall be bolted to the angle

iron.

- .14 During construction, seal all openings with polyethylene and tape at all times to protect from entrance of dirt, dust, etc.

3.2 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake and exhaust plenums.
 - .2 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer.
- .3 Fit base of riser with 150mm (6") deep drain sump and 32mm (1-1/4") drain connected, with deep seal trap and trap primer and discharging to open funnel drain.

3.3 FRESH AIR AND EXHAUST OPENINGS

- .1 Install to SMACNA details.
- .2 Reinforce and brace air outlets and intakes for wind speed as per NBC for location.
- .3 Provide air inlet openings with 1.6129mm (16 gauge) thick 25mm (1") wire mesh screen and air outlet openings with 12mm (1/2") mesh screwed aluminum bird screens.
- .4 Slope plenum floors to drain.

3.4 INSTRUMENT AND TEST HOLES

- .1 Install 25mm (1") test plugs with chain and cap, where required to accommodate testing and balancing instruments.

3.5 DUCT LEAKAGE

- .1 Ductwork shall be free of audible leaks in quiet ambient.

3.6 PROTECTION OF DUCT OPENINGS

- .1 Seal and protect all open ends of ductwork during construction.

3.7 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 (1) coat of sealant to manufacturer's recommendations.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.4 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Manufacture in accordance with CSA B228.1.

2.2 FLEXIBLE CONNECTIONS

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

2.3 ACCESS DOORS IN DUCTS

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum .853mm (22 gauge) thick complete with sheet metal angle frame and sealing gaskets.
- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum .853mm (22 gauge) thick complete with sheet metal angle frame and 25mm (1") thick rigid glass fibre insulation and sealing gaskets.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300mm x 300mm (12" x 12"): 2 sash locks complete safety chain.
 - .2 300mm x 457mm (12" x 18"): 4 sash locks complete with safety chain.
 - .3 457mm x 1016mm (18" x 40"): piano hinge and minimum 2 sash locks.
 - .4 Doors over 1016mm (40"): piano hinge and 2 handles operable from both sides.
 - .5 Hold open devices.

2.4 TURNING VANES

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

2.5 INSTRUMENT TEST PORTS

- .1 1.6129mm (16 gauge) thick steel zinc plated after manufacturer.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28.575mm (1-1/8") minimum inside diameter. Length to suit insulation thickness.

- .4 Neoprene mounting gasket.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 150mm (6").
 - .3 Minimum distance between metal parts when system in operation: 75mm (3").
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on each side of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
 - .6 Provide a grounding strap at each flexible connection.
- .2 Access Doors:
 - .1 Size:
 - .1 600mm x 600mm (24" x 24") for person size entry.
 - .2 600mm x 600mm (24" x 24") for servicing entry.
 - .3 300mm x 300mm (12" x 12") for viewing.
 - .4 As indicated.
 - .2 Location:
 - .1 At fire and smoke dampers.
 - .2 At control dampers.
 - .3 At devices requiring maintenance.
 - .4 At locations required by code.
 - .5 Elsewhere as indicated.
 - .6 At 9.144m (30 ft). intervals.
 - .7 At elbows with turning vanes.
 - .8 Fresh air and exhaust air plenums.
 - .9 At bottom of risers.
 - .10 Before and after coils.
 - .11 At filters.
 - .12 At fans.
 - .13 At automatic dampers.
- .3 Instrument test ports.
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locations:
 - .1 For traverse readings:
 - .1 At ducted inlets to roof and wall exhausters.

- .2 At inlets and outlets of other fan systems.
 - .3 At main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental Representative.
 - .3 And as indicated.
- .4 Turning vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.
 - .2 Provide where long radius turns or two 45° elbows cannot be used because of space considerations.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 GENERAL

- .1 This section applies to operating dampers.

1.4 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00– Submittal Procedures.
- .2 Indicate the following:
 - .1 Performance data.

1.5 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 77 00 – Closeout Procedures.

1.6 CERTIFICATION OF RATINGS

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

PART 2 PRODUCTS

2.1 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi-leaf, steel construction with nylon bearings, centre pivoted spring assisted or counter-weighted, as indicated.

2.2 RELIEF DAMPERS

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 10 Pa static pressure.

2.3 DAMPER

- .1 Sizes:
 - .1 Blades maximum 150mm wide x 1219mm long (6" wide and 48" long).
 - .2 Modular maximum 1219mm x 2438mm (48" wide x 96" high).
 - .3 Multiple sections with stiffening mullions and jack shafts.
- .2 Materials:
 - .1 Frame: 2.752mm (12 gauge) thick galvanized sheet steel.
 - .2 Blades: two sheets .853mm (22 gauge) thick or 1.6129mm (16 gauge) thick galvanized sheet steel, insulated.
 - .3 Bearings: oil impregnated sintered nylon. Provide additional thrust bearings for vertical blades.
 - .4 Linkage and shafts: zinc plated steel.
 - .5 Seals: replaceable neoprene seals or "ss" spring on side, top and bottom of frame and along all blade edges and blade ends.
- .3 Provide performance characteristics as follows:
 - .1 5 l/s (10 cfm) per sq. ft. max. allowable leakage against 1000 kPa (145 psi) static pressure.
 - .2 Temperature range -40°C to 93°C.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with Silicon sealant.
- .4 Upon system start-up, ensure that dampers operate properly.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00- Common Work Results HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 REFERENCES

- .1 AMCA 99-2010 - Standards Handbook.
- .2 ANSI/AMCA 210-2007 - Laboratory Methods of Testing Fans for Rating.
- .3 AMCA 300- 2008 - Reverberant Room Method for Sound Testing of Fans.
- .4 AMCA 301-2008 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 ANSI/ASHRAE 51-2007 - Laboratory Methods of Testing Fans for Rating.
- .6 CGSB 1-GP-181M-2008 - Coating, Zinc Rich, Organic, Ready Mixed.

1.4 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product data to include fan curves and sound rating data, showing point of operation.

- .3 Indicate the following: motors, wheels, bearings, shafts.

1.5 OPERATION AND MAINTENANCE DATA

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 77 00 - Closeout Procedures.

1.6 MAINTENANCE MATERIALS

- .1 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into each operating manual.

1.7 MANUFACTURED ITEMS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.
- .2 Provide confirmation of testing.

PART 2 PRODUCTS

2.1 DIRECT DRIVEN BACKWARD INCLINED CENTRIFUGAL INLINE FANS

- .1 General Description:
1. Base fan performance at standard conditions (density 0.075 Lb/ft³).
 2. Normal operating temperature up to 54.4° C (130 ° F).
 3. Applications include: intake, exhaust, return, or make-up air systems.
 4. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
- .2 Wheel:
1. Non-overloading, backward inclined centrifugal wheel.
 2. Constructed of aluminum.
 3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
 4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.
 5. Single thickness blades are securely riveted or welded to a heavy gauge back plate and wheel cone.
- .3 Motors:
- .1 Electronically Commutated Motor
 - .1 Motor enclosures: Open type.

- .2 Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
- .3 Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
- .4 Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
- .5 Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
- .6 Motor shall be a minimum of 85% efficient at all speeds.
- .4 Housing/Cabinet Construction
 - .1 Construction material: Aluminum.
 - .2 Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars
 - .3 Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
- .5 Housing Supports and Drive Frame:
 - .1 Housing supports are constructed of structural steel with formed flanges.
 - .2 Drive frame is welded steel which supports the motor.
- .6 Duct Collars:
 - .1 Square design to provide a large discharge area.
 - .2 Inlet and discharge collars provide easy duct connection.
- .7 Access Panel:
 - .1 Two sided access panels, permit easy access to all internal components.
 - .2 Located perpendicular to the motor mounting panel.
- .8 Options/Accessories:
 - .1 Hi-Pro Polyester- one part coating which yields a hard, durable surface resistant to salt water, chemical fumes and moisture.
 - .2 Finishes:
 - .3 Coating type: Hi-Pro Polyester.
- .9 Isolation:
 - .1 Type: Spring hanger Kit

PART 3 EXECUTION

3.1 FAN INSTALLATION

- .1 Install fans as indicated and in compliance with manufacturer's recommendations. Complete with resilient mountings and flexible electrical leads.
- .2 Install flexible connector bands between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 25mm (1") flex between ductwork and fan during running.
- .3 Install fan restraining snubbers where indicated on drawings. Flex connectors shall not be in tension during running.
- .4 Provide sheaves required for final air balance.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material, in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Divert unused metal materials from landfill to metal facility as approved by Departmental Representative.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
- .2 Indicate the following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.

1.4 MAINTENANCE MATERIALS

- .1 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

1.5 MANUFACTURED ITEMS

- .1 Grilles, registers and diffusers shall be product of one manufacturer for generic type.

1.6 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

PART 2 PRODUCTS

2.2 GENERAL

- .1 Standard product to meet capacity, throw, noise level, throat and outlet velocity as indicated.
- .2 Provide volume control dampers on all supply diffusers and concealed operators.
- .3 Sizes indicated are nominal. Provide correct standard product nearest to nominal for capacity throw, noise level, throat and outlet velocity.
- .4 Furnish factory prime coated steel frames for setting into fire protecting membrane. At aluminum diffusers, registers and grilles, provide 1.2mm thick minimum steel collar up to fire damper or fire stop flap, for suspending from the basic structure independently of membrane pierced to maintain fire protection membrane integrity.
- .5 Where penetrating fire partitions, provide approved steel sleeve attached to structure and secured in accord with NFPA 90A-1978. Where penetrating fire walls provide 3.510mm (10 gauge) thick steel sleeve with angle iron perimeter frame to NFPA 90A-2009.
- .6 Frames:
 - .1 Steel: standard cold rolled steel with exposed joints welded and ground flush and completely closed.
 - .2 Aluminum: satin finish with mechanical fasteners and completely closed corners.
 - .3 Provide full perimeter sponge rubber gaskets.
 - .4 Provide plaster frames as plaster stops set into gypsum board at all locations.
 - .5 Provide concealed fasteners and operators.
- .7 Finish:
 - .1 Off white baked enamel unless otherwise indicated.

2.3 RETURN / EXHAUST AIR GRILLES / REGISTERS

- .1 Type "RG/EG" Return Exhaust Air Grilles
 - .1 Heavy Duty Extruded aluminium construction with 45 degree deflection, 13mm blade spacing, 32mm border.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with cadmium plated screws in countersunk holes where fastenings are visible.

END

PART 1 GENERAL

1.1 RELATED SECTIONS

- .1 Division 01 – General Requirements.
- .2 Section 23 05 00 – Common Work Results for HVAC.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittals Procedures.
- .2 Indicate the following:
 - .1 Louvre free area.
 - .2 Louvre water penetration.

1.4 CERTIFICATION OF RATINGS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

1.5 TEST REPORTS

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

PART 2 PRODUCTS

2.1 STATIONARY LOUVRES

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: storm proof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm (60").
- .4 Frame, head, sill and jamb: 100mm (4") deep one piece extruded aluminum, minimum 2.953mm (12 gauge) thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500mm (60") maximum centres.
- .6 Fastenings: stainless steel (Society of Automotive Engineers) SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.
- .7 Screen: 12mm (½") exhaust, 19mm (¾") intake mesh, 1.6mm (1/16") dia. wire aluminum birdscreen on inside face of louvers face of louvers in formed U-frame.
- .8 Finish: factory applied enamel. Colour: to Architects approval.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 In accordance with manufacturers and SMACNA recommendations.
- .2 Reinforce and brace air vents, intakes and goosenecks as indicated.
- .3 Anchor securely into openings. Seal with caulking all around to ensure weather tightness.
- .4 Slope all plenums to drain through louvers. Flush inside of plenums with 100% coverage of blueskin "peel and stick" waterproofing. Lap Blueskin of plenum to drain to outside the wall assembly waterproofing.
- .5 Inspect all louvers to duct connections to ensure there is no ridge or fold that will retain water.
- .6 Contractor to provide field fabricated thermally insulated blank-off panel on all un-used louver openings. Panel construction shall be pan-in-Pan with 1.6mm aluminium sheet

metal and 100mm thick semi rigid, non-combustible mineral wool, thermal insulation board, R-4.2 per 25mm and sealed to make water proof. Silicone exterior side of panel to match louver colour. Seal and mechanically fasten blank off panel to the interior face of louver.

END