NEW TECUMSETH – FIRE STATION #4

6375 14th Line – NTFS #4

6375 14th Line

Alliston, Ontario

L9R 1V4

MECHANICAL SPECIFICATIONS

Part 1 General

1.1 Table of Contents

END OF SECTION

Part 1 General

1.1 GENERAL SPECIFICATIONS

.1 All work performed shall be in accordance with latest edition of the Ontario Building Code, CSA, ASHRAE, NFPA, etc. where codes/standard are present form multiple sources, the most stringent shall be utilized.

.2 The following specifications form an essential part of the contract documents. refer and coordinate with all other divisions, sections, and specifications to provide a complete and operational installation.

.3 For the purpose of these specifications, drawings and contract documents, the word 'provide' refers to the supply, installation, and testing of the respective equipment/components.

.4 Contractor is to report all apparent discrepancies between drawings and specifications of all divisions prior to tender submission. no exceptions will be given to contractors who do not completely understand the scope of work.

.5 All mechanical division work shall be coordinated and scheduled with all other divisions.

.6 This contractor shall visit the site and completely investigate and understand the existing conditions and their relation to the design drawings/documents. No consideration will be given to the contractor for any hindrances to the mechanical installation from site conditions which existed prior to tender submission. As such and where required, the contractor shall provide interference drawings and shall submit them to the consultant for review.

.7 Provide new materials and equipment of acceptable quality that are manufactured in Canada or the United States and bear the approval of recognized North American Standard Associations such as CSA, ASME, etc. the contractor shall maximize the utilization of Canadian equipment, materials, etc.

.8 All equipment, materials, etc. shall be installed in strict accordance with the manufacturer's installation instructions and recommendations.

.9 The mechanical drawings display a general design and installation, therefore the contractor shall obtain clarification from the consultant prior to installation.

.10 These drawings have been prepared for the mechanical division and do not accurately display all electrical, structural, and architectural elements. Refer to other division's drawings for clarification.

.11 In no case shall these drawings be scaled. All rough-in's shall be coordinated with other divisions.

.12 Do not proceed with work outside the scope of the design drawings and specifications without written consent from the owner. this applies to all mechanical division change notices as issued by the consultant.

.13 In regard to mechanical division change notices, contractor shall provide a breakdown including, but not limited to, materials, labour, mark-up, etc. Quotations shall be based on Allpriser for equipment and the mechanical contractors of America, SMACNA, and National Electrical Contractors for labour rates.

.14 Where equipment has been pre-purchased, the mechanical division shall accept all responsibility for equipment delivery, installation, testing and warranty, similar to as if the equipment was purchased by the mechanical division.

.15 The contractor shall warranty all materials, equipment, installation, and quality of workmanship for a minimum of one (1) year unless otherwise noted.

.16 It is the mechanical contractor's responsibility to pay for all charges and damages associated with equipment that is not provided as specified and includes not meeting the manufacturer's ratings, published data and/or the applicable governing standards.

.17 The contractor may submit for alternate materials and equipment only when the specified are not available or will adversely impact the completion schedule. The contractor shall compensate the consultant for their time required to review the alternate submittals. Submit in accordance with this section.

1.2 SUBMITTALS

.1 The contractor shall submit three (3) hard copies of mechanical shop drawings to the consultants for review. Electronic submission of shop drawings shall be deemed acceptable upon approval from consultant. The contractor shall bear all costs associated with the document submittal process.

.2 All shop drawings submitted for review must bear the review stamp of the mechanical contractor. Shop drawings that do not bear the contractor's stamp will, without question, be rejected by the consultant.

.3 shop drawings shall include all information required for the consultant to perform reasonable review of the submittals as the pertain to the mechanical design drawings and specifications.

.4 Shop drawings shall have the same identifying number as noted in the mechanical drawings.

.5 Provide shop drawings with technical submittals on all types of insulation to be installed.

.6 The contractor shall maintain on site one (1) record of mechanical drawings that shall indicate with red lines all project conditions, locations, configurations and any other changes or deviations which may vary from the original contract documents and drawings. In addition, this set shall include revisions as a result of all addendums, change notices, site instructions, etc. Upon completion of the project, the contractor shall submit to the owner and engineer one (1) copy each of a hardcopy and electronic copy (pdf) for review. One (1) set of both copies shall also be included in the closeout document package.

.7 Two (2) copies of operation and maintenance manuals shall be submitted to the consultant for review upon project completion. The manuals shall contain the following where applicable:

- description of each system
- description of each major component of system
- all shop drawings with approval stamps
- equipment manufacturer's installation and operation
- manuals and spare parts list
- wiring diagrams
- lubrication schedule
- equipment identification list with serial numbers
- valve tag schedules and flow diagrams
- final and reviewed balancing reports (air and water)
- water treatment procedure and tests
- control drawings and sequences of operation
- as-built drawings (hardcopy and electronic)
- warranty documentation

Part 2 Products

2.1 NOT NUSED

.1 Not Used

Part 3 Execution

3.1 GENERAL PRACTICE

.1 Periodic inspections of the work will be conducted over the course of the project. All reported deficiencies shall be rectified by the contractor in a timely fashion. Failure to do so will result in the contractor not meeting the requirements of the contract documents.

.2 It shall be the responsibility of the contractor to coordinate all inspections with city and/or municipal officials and all other authorities having jurisdiction.

.3 In regards to temporary services, provide, as required by the authority having jurisdiction, temporary fire protection systems. Refrain from using installed systems from the contract documents as a temporary services. This shall apply to all mechanical systems including HVAC, plumbing and drainage, etc.

.4 This contractor shall be responsible for all cutting, patching, and restoration. Where requested, the contractor shall contract the services of the base building trades at div.15 expense.

.5 Provisions shall be made for the protection of div.15 work until the completion of the project. This may include, but not limited to, covering of equipment openings and ductwork, plumbing fixtures, floor drains, etc.

.6 Upon completion of construction, contractor shall make all final adjustments to equipment as well as remove all protection. All installations shall be cleaned thoroughly and tested for proper operation. Change all air and water filters as required.

.7 In regards to interruption of services, the contractor shall carry out their work in a manner that causes the least disturbance to the owner. Provide notification to the owner in writing with at least 72 hours of the scheduled interruption.

.8 Arrange and pay for the safe disposal of removed items as specified. Provide proof of safe disposal for items such as HVAC refrigerant. Coordinate the time and method of disposal with the owner. For example, clearly indicate the route that will be taken from the inside of the building to the outdoors, as well as the storage location outdoors if applicable.

.9 Where components are to be reused, the contractor shall clean and test the component to ensure proper operation. The consultant shall be notified in the event there is a deficiency with the component.

.10 Perform work so as to cause minimal disturbance to owner and/or adjacent areas. Minimize dust and noise and provide temporary air filters on air handling systems affect by the area of work. All costs associated with damages as a result of the mechanical installation shall be covered by div.15. Maintain safety standards and provide adequate signage for both workers and occupants.

.11 Where cutting or core drilling of the existing concrete structure is required, the mechanical contractor shall contract the services of an experienced and reputable company to carry out x-raying. The results shall be submitted to the base building structural engineer and not cutting or coring shall take place until written approval is received. The contractor shall provide a written request to perform x-raying with at least 72 hours in advance.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

.1 Submit to THE Consultant,
submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples, and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to
Consultant . This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated, and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify theConsultant, in writing
at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work are co-ordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by the Consultant's review of
submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by
the Consultant review.

.10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Refer to CCDC 2 GC 3.11 standard (where applicable).

.2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.3 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.5 Allow 10 business days for the
the Consultant's review of each submission.

.6 Adjustments made on shop drawings by the
Consultant , are not intended to change Contract Price. If
adjustments affect value of Work, state such in writing to the
Consultant prior to proceeding with Work.

.7 Make changes in shop drawings as
Consultant , may require, consistent with Contract Documents. When resubmitting, notify the Consultant in writing of
revisions other than those requested.

.8 Accompany submissions with transmittal letter, in duplicate, containing:

.1 Date.

.2 Project title and number.

.3 Contractor's name and address.

.4 Identification and quantity of each shop drawing, product data and sample.

.5 Other pertinent data.

.9 Submissions include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name and address of:

.1 Subcontractor.

.2 Supplier.

.3 Manufacturer.

.4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.5 Details of appropriate portions of Work as applicable:

.1 Fabrication.

.2 Layout, showing dimensions, including identified field dimensions, and clearances.

.3 Setting or erection details.

.4 Capacities.

.5 Performance characteristics.

.6 Standards.

.7 Operating weight.

.8 Wiring diagrams.

.9 Single line and schematic diagrams.

.10 Relationship to adjacent work.

.10 After the Consultant's review, distribute copies.

.11 Left blank intentionally.

.12 Submit six (6) copies of product data sheets or brochures for requirements requested in specification Sections and as requested by the Consultant , where shop drawings will not be prepared due to standardized manufacture of product.

.13 Submit six (6) copies of test reports for requirements requested in specification Sections and as requested by the Consultant.

.1 Report signed by authorized official of testing laboratory that material, product, or system identical to material, product, or system to be provided has been tested in accord with specified requirements.

.2 Testing must have been within three (3) years of date of contract award for project.

.14 Submit six (6) copies of certificates for requirements requested in specification Sections and as requested by the Consultant.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of project contract complete with project name.

.15 Submit six (6) electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by the Consultant .

.1 Pre-printed material describing installation of product, system, or material, including special notices and Safety Data Sheets concerning impedances, hazards, and safety precautions.

.16 Submit [6] [electronic] copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Consultant.

.17 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.18 Submit six (6) copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant .

.19 Delete information not applicable to project.

.20 Supplement standard information to provide details applicable to project.

.21 If upon review by the Consultant,
no errors or omissions are discovered or if only minor corrections are made, transparency and/or copies will be returned, and fabrication and installation of work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.22 Left blank intentionally.

1.3 SAMPLES

.1 Submit for review samples in duplicate, or as requested, in respective specification Sections. Label samples with origin and intended use.

.2 Deliver samples prepaid to the
Consultant's business address and/or site office (where applicable).

.3 Notify the Consultant in writing,
at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by
Consultant are not intended to change Contract Price. If adjustments affect value of Work, state such in writing
Consultant prior to proceeding with Work.

.6 Make changes in samples which
Consultant may require, consistent with Contract Documents.

.7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 MOCK-UPS

.1 Erect mock-ups in accordance with 01 45 00 - Quality Control.

1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Submit electronic and hard copy of grey tone and/or colour digital photography, fine resolution, with monthly progress statement and as directed by
Consultant .

.2 Project identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: Four (4) locations.

.1 Viewpoints and their location as determined by Consultant.

.4 Frequency of photographic documentation: monthly or as directed by Consultant.

.1 Upon completion of: excavation, foundation, framing and services before concealment, of Work, and as directed by the Consultant.

1.6 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit [Workers' Compensation Board status].

.2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 QUALITY

.1 Refer to CCDC 2 (where applicable).

.2 Refer to DOC 14 and DOC 15 (where applicable).

.3 Products, materials, equipment, and articles incorporated in Work shall be new, not damaged, or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.

.4 Procurement policy is to acquire, in cost effective manner, items containing highest percentage of recycled and recovered materials practicable consistent with maintaining satisfactory levels of competition. Make reasonable efforts to use recycled and recovered materials and in otherwise utilizing recycled and recovered materials in execution of work.

.5 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility but is precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection.

.6 Should disputes arise as to quality or fitness of products, decision rests strictly with Consultant based upon requirements
of Contract Documents.

.7 Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.

.8 Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

1.2 AVAILABILITY

.1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify theConsultant of such, in order
that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

.2 In event of failure to notify the
Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, the
Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.3 STORAGE, HANDLING AND PROTECTION

.1 Handle and store products in manner to prevent damage, adulteration, deterioration, and soiling and in accordance with manufacturer's instructions when applicable.

.2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.

.3 Store products subject to damage from weather in weatherproof enclosures.

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials, lumber, and other similar materials, on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense and to satisfaction of the Consultant.

.9 Touch-up damaged factory finished surfaces to the Consultant ’s satisfaction. Use touch-up materials to match original.
Do not paint over name plates.

1.4 TRANSPORTATION

.1 Pay costs of transportation of products required in performance of Work.

.2 Transportation cost of products supplied by Owner will be paid for by the Consultant . Unload, handle and store such products.

1.5 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in specifications, install or erect products in accordance with manufacturer's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from manufacturers.

.2 Notify the Consultant in writing, of conflicts between specifications and manufacturer's instructions, so the Consultant will establish course of action.

.3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.

1.6 QUALITY OF WORK

.1 Ensure Quality of Work is of highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify the Consultant if required Work is such as to make it impractical to produce required results.

.2 Do not employ anyone unskilled in their required duties. The Consultant reserves right to require dismissal from site, workers deemed incompetent or careless.

.3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with the Consultant , whose decision is final.

1.7 CO-ORDINATION

.1 Ensure co-operation of workers in laying out Work. Maintain efficient and continuous supervision.

.2 Be responsible for coordination and placement of openings, sleeves, and accessories.

1.8 CONCEALMENT

.1 In finished areas conceal pipes, ducts and wiring in floors, walls, and ceilings, except were indicated otherwise.

.2 Before installation inform the Consultant if there is interference. Install as directed by the Consultant .

1.9 REMEDIAL WORK

.1 Refer to CCDC 2, DOC 14, DOC 15, and Section 01 73 00 - Execution Requirements (where applicable).

.2 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.

.3 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.10 LOCATION OF FIXTURES

.1 Consider location of fixtures, outlets, and mechanical and electrical items indicated as approximate.

.2 Inform the Consultant of conflicting installation. Install as directed.

1.11 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour, and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in affected specification Section.

.4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wood, or any other organic material plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and install neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

1.12 FASTENINGS - EQUIPMENT

.1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

.2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.

.3 Bolts may not project more than one diameter beyond nuts.

.4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

1.13 PROTECTION OF WORK IN PROGRESS

.1 Prevent overloading of parts of building. Do not cut, drill, or sleeve load bearing structural member, unless specifically indicated without written approval of Consultant.

1.14 EXISTING UTILITIES

.1 When breaking into or connecting to existing services or utilities, execute Work at times directed by local governing authorities, with minimum of disturbance to Work, and/or pedestrian and vehicular traffic.

.2 Protect, relocate, or maintain existing active services. When services are encountered, cap off in manner approved by authority having jurisdiction. Stake and record location of capped service.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 PROJECT CLEANLINESS

.1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.

.2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by the Consultant. Do not burn waste materials on site, unless approved by the Consultant .

.3 Clear snow and ice from access to building, bank/pile snow in designated areas only and remove from site.

.4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.5 Provide on-site containers for collection of waste materials and debris.

.6 Provide and use marked separate bins for recycling. Refer to Section 01 74 19 - Waste Management and Disposal.

.7 Dispose of waste materials and debris off site.

.8 Clean interior areas prior to start of finishing work and maintain areas free of dust and other contaminants during finishing operations.

.9 Store volatile waste in covered metal containers and remove from premises at end of each working day.

.10 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

.11 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

.12 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

.1 CCDC 2, GC 3.14 standard.

.2 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.

.3 Remove waste products and debris other than that caused by others and leave Work clean and suitable for occupancy.

.4 Prior to final review remove surplus products, tools, construction machinery and equipment.

.5 Remove waste products and debris other than that caused by Owner or other Contractors.

.6 Remove waste materials from site at regularly scheduled times or dispose of as directed by Consultant . Do not burn waste materials on site, unless approved the Consultant .

.7 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.8 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched, or disfigured glass.

.9 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.

.10 Clean lighting reflectors, lenses, and other lighting surfaces.

.11 Vacuum clean and dust building interiors, behind grilles, louvres, and screens.

.12 Wax, seal, shampoo or prepare floor finishes, as recommended by manufacturer.

.13 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.

.14 Broom clean and wash exterior walks, steps, and surfaces; rake clean other surfaces of grounds.

.15 Remove dirt and other disfiguration from exterior surfaces.

.16 Clean and sweep roofs, gutters, areaways, and sunken wells.

.17 Sweep and wash clean paved areas.

.18 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

.19 Clean roofs, downspouts, and drainage systems.

.20 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

.21 Remove snow and ice from access to building.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE REQUIREMENTS

1. Pre-warranty Meeting:
   - .1 Convene meeting one week prior to contract completion with contractor's representative and Consultant, in accordance with Section 01 31 19 - Project Meetings to:
     - .1 Verify Project requirements.
     - .2 Review manufacturer's installation instructions and warranty requirements.
   - .2 Consultant to establish communication procedures for:
     - .1 Notifying construction warranty defects.
     - .2 Determine priorities for type of defects.
     - .3 Determine reasonable response time.
   - .3 Contact information for bonded and licensed company for warranty work action: provide name, telephone number and address of company authorized for construction warranty work action.
   - .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

1. Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
2. Two (2) weeks prior to Substantial Performance of the Work, submit to the Consultant , four (4) final copies of operating and maintenance manuals in English.
3. Provide spare parts, maintenance materials and special tools of same quality and manufacture as products provided in Work.
4. Provide evidence, if requested, for type, source and quality of products supplied.

1.3 FORMAT

1. Organize data as instructional manual.
2. Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
3. When multiple binders are used correlate data into related consistent groupings.
   - .1 Identify contents of each binder on spine.
4. Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.

5. Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.

6. Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.

7. Text: manufacturer's printed data, or typewritten data.

8. Drawings: provide with reinforced punched binder tab.
   .1 Bind in with text; fold larger drawings to size of text pages.

9. Provide 1:1 scaled CAD files in dxf/dwg format on CD.

1.4 CONTENTS - PROJECT RECORD DOCUMENTS

1. Table of Contents for Each Volume: provide title of project.
   .1 Date of submission; names.
   .2 Addresses, and telephone numbers of consultant and Contractor with name of responsible parties.
   .3 Schedule of products and systems, indexed to content of volume.

2. For each product or system:
   .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.

3. Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.

4. Typewritten Text: as required to supplement product data.
   .1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

5. Training: refer to Section 01 79 00 - Demonstration and Training.

1.5 AS -BUILT DOCUMENTS AND SAMPLES

1. Maintain, in addition to requirements in General Conditions, at site for the Consultant and the Owner one record copy of:
   .1 Contract Drawings.
   .2 Specifications.
   .3 Addenda.
   .4 Change Orders and other modifications to Contract.
   .5 Reviewed shop drawings, product data, and samples.

.6 Field test records.

.7 Inspection certificates.

.8 Manufacturer's certificates.

2. Store record documents and samples in field office apart from documents used for construction.

.1 Provide files, racks, and secure storage.

3. Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.

.1 Label each document "PROJECT RECORD" in neat, large, printed letters.

4. Maintain record documents in clean, dry and legible condition.

.1 Do not use record documents for construction purposes.

5. Keep record documents and samples available for inspection by Consultant .

1.6 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS

1. Record information on set of [blue line] [black line] opaque drawings, and in copy of Project Manual, provided by Consultant.

2. Use felt tip marking pens, maintaining separate colours for each major system, for recording information.

3. Record information concurrently with construction progress.

.1 Do not conceal Work until required information is recorded.

4. Contract Drawings and shop drawings: mark each item to record actual construction, including:

.1 Measured depths of elements of foundation in relation to finish first floor datum.

.2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.

.3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.

.4 Field changes of dimension and detail.

.5 Changes made by change orders.

.6 Details not on original Contract Drawings.

.7 Referenced Standards to related shop drawings and modifications.

5. Specifications: mark each item to record actual construction, including:

.1 Manufacturer, trade name, and catalogue number of each product actually installed particularly optional items and substitute items.

.2 Changes made by Addenda and change orders.

6. Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

7. Provide digital photos, if requested, for site records.

1.7 FINAL SURVEY

1. Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.8 EQUIPMENT AND SYSTEMS

1. For each item of equipment and each system include description of unit or system, and component parts.
    .1 Give function, normal operation characteristics and limiting conditions.
    .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
2. Panel board circuit directories: provide electrical service characteristics, controls, and communications.
3. Include installed colour coded wiring diagrams.
4. Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
    .1 Include regulation, control, stopping, shut-down, and emergency instructions.
    .2 Include summer, winter, and any special operating instructions.
5. Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
6. Provide servicing and lubrication schedule, and list of lubricants required.
7. Include manufacturer's printed operation and maintenance instructions.
8. Include sequence of operation by controls manufacturer.
9. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
10. Provide installed control diagrams by controls manufacturer.
11. Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
12. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

13. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

14. Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS.

15. Underground and/or Aboveground storage tank inspection documentation, registration, forms, decommissioning and removal in accordance with CEPA SOR/2008-197.

16. Additional requirements: as specified in individual specification sections.

1.9 MATERIALS AND FINISHES

1. Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
    .1 Provide information for re-ordering custom manufactured products.

2. Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

3. Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

4. Additional requirements: as specified in individual specifications sections.

1.10 MAINTENANCE MATERIALS

1. Spare Parts:
    .1 Provide spare parts, in quantities specified in individual specification sections.
    .2 Provide items of same manufacture and quality as items in Work.
    .3 Deliver to site or to the location as directed; place and store.
    .4 Receive and catalogue items.
        .1 Submit inventory listing to the Consultant .
        .2 Include approved listings in Maintenance Manual.
    .5 Obtain receipt for delivered products and submit prior to final payment.

2. Extra Stock Materials:
    .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
    .2 Provide items of same manufacture and quality as items in Work.
    .3 Deliver to site or location as directed; place and store.
    .4 Receive and catalogue items.
        .1 Submit inventory listing to the Consultant .

.2 Include approved listings in Maintenance Manual.

.5 Obtain receipt for delivered products and submit prior to final payment.

3. Special Tools:
   - .1 Provide special tools, in quantities specified in individual specification section.
   - .2 Provide items with tags identifying their associated function and equipment.
   - .3 Deliver to site or location as directed; place and store.
   - .4 Receive and catalogue items.
     - .1 Submit inventory listing to the Consultant .
     - .2 Include approved listings in Maintenance Manual.

1.11 DELIVERY, STORAGE AND HANDLING

1. Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration.
2. Store in original and undamaged condition with manufacturer's seal and labels intact.
3. Store components subject to damage from weather in weatherproof enclosures.
4. Store paints and freezable materials in a heated and ventilated room.
5. Remove and replace damaged products at own expense and for review by the Consultant .

1.12 WARRANTIES AND BONDS

1. Develop warranty management plan to contain information relevant to Warranties.
2. Submit warranty management plan, 30 days before planned pre-warranty conference, to the Consultant approval.
3. Warranty management plan to include required actions and documents to assure that the Consultant receives warranties to which it is entitled.
4. Provide plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
5. Submit, warranty information made available during construction phase, to the Consultant for approval prior to each monthly pay estimate.
6. Assemble approved information in binder, submit upon acceptance of work and organize binder as follows:

.1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.

.2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

.3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten (10) days after completion of applicable item of work.

.4 Verify that documents are in proper form, contain full information, and are notarized.

.5 Co-execute submittals when required.

.6 Retain warranties and bonds until time specified for submittal.

7. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.

8. Conduct joint 4-month and 9-month warranty inspection, measured from time of acceptance, by the Consultant.

9. Include information contained in warranty management plan as follows:

.1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers, or suppliers involved.

.2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, and commissioned systems such as fire protection, alarm systems, sprinkler systems, lightning protection systems, etc.

.3 Provide list for each warranted equipment, item, feature of construction or system indicating:

.1 Name of item.

.2 Model and serial numbers.

.3 Location where installed.

.4 Name and phone numbers of manufacturers or suppliers.

.5 Names, addresses and telephone numbers of sources of spare parts.

.6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.

.7 Cross-reference to warranty certificates as applicable.

.8 Starting point and duration of warranty period.

.9 Summary of maintenance procedures required to continue warranty in force.

.10 Cross-Reference to specific pertinent Operation and Maintenance manuals.

.11 Organization, names and phone numbers of persons to call for warranty service.

.12 Typical response time and repair time expected for various warranted equipment.

.4 Contractor's plans for attendance at 9 month post-construction warranty inspections.

.5 Procedure and status of tagging of equipment covered by extended warranties.

.6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

10. Respond in timely manner to oral or written notification of required construction warranty repair work.

11. Written verification to follow oral instructions.

.1 Failure to respond will be cause for the Consultant to proceed with action against Contractor.

1.13 WARRANTY TAGS

1. Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Consultant.

2. Attach tags with copper wire and spray with waterproof silicone coating.

3. Leave date of acceptance until project is accepted for occupancy.

4. Indicate following information on tag:

.1 Type of product/material.

.2 Model number.

.3 Serial number.

.4 Contract number.

.5 Warranty period.

.6 Inspector's signature.

.7 Construction Contractor.

Part 2 Products

2.1 NOT USED

1. Not Used.

Part 3 Execution

3.1 NOT USED

1. Not Used.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:

.1 Verify installed equipment, systems and integrated systems operate in accordance with Contract Documents and design criteria and intent.

.2 Ensure appropriate documentation is compiled into the BMM.

.3 Effectively train O&M staff.

.2 Contractor assists in Cx process, operating equipment, and systems, troubleshooting and making adjustments as required.

.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.

.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

.3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.2 COMMISSIONING OVERVIEW

.1 Section 01 91 13.13 - Commissioning Plan.

.2 For Cx responsibilities refer to Section 01 91 13.13 - Commissioning Plan.

.3 Cx to be a line item of Contractor's cost breakdown.

.4 Cx activities supplement field quality and testing procedures described in relevant technical sections.

.5 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

.6 The Consultant will issue Interim Acceptance Certificate when:

.1 Completed Cx documentation has been received, reviewed for suitability, and approved by the Consultant .

.2 Equipment, components, and systems have been commissioned.

.3 O&M training has been completed.

1.3 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

.1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required the Consultant to ensure effective performance.

.2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.4 PRE-CX REVIEW

.1 Before Construction:

.1 Review Contract Documents, confirm by writing the Consultant .

.1 Adequacy of provisions for Cx.

.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:

.1 Co-ordinate provision, location, and installation of provisions for Cx.

.3 Before start of Cx:

.1 Have completed Cx Plan up-to-date.

.2 Ensure installation of related components, equipment, sub-systems, systems is complete.

.3 Fully understand Cx requirements and procedures.

.4 Have Cx documentation shelf-ready.

.5 Understand completely design criteria and intent and special features.

.6 Submit complete start-up documentation to the Consulta nt.

.7 Have Cx schedules up-to-date.

.8 Ensure systems have been cleaned thoroughly.

.9 Complete TAB procedures on systems, submit TAB reports the Consultant for review and approval.

.10 Ensure "As-Built" system schematics are available.

.4 Inform the Consultant in writing of discrepancies and deficiencies on finished works.

1.5 CONFLICTS

.1 Report conflicts between requirements of this section and other sections to the Consultant before start-up and obtain clarification.

.2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.

.1 Submit no later than four (4) weeks after award of Contract:

.1 Name of Contractor's Cx agent.

.2 Draft Cx documentation.

.3 Preliminary Cx schedule.

.2 Request in writing to the Consultant for changes to submittals and obtain written approval at least eight (8) weeks prior to start of Cx.

.3 Submit proposed Cx procedures the Consultant where not specified and obtain written approval at least eight (8) weeks prior to start of Cx.

.4 Provide additional documentation relating to Cx process required the Consultant .

1.7 COMMISSIONING DOCUMENTATION

.1 Refer to Section 01 91 13.16 - Commissioning Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use.

.2 The Consultant to review and approve Cx documentation.

.3 Provide completed and approved Cx documentation to the Consultant .

1.8 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.16 - Construction Progress Schedule - Critical Path Method (CPM), 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart.

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

.1 Approval of Cx reports.

.2 Verification of reported results.

.3 Repairs, retesting, re-commissioning, re-verification.

.4 Training.

1.9 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings: Section 01 32 16.16 - Construction Progress Schedule - Critical Path Method (CPM), 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart and as specified herein.

.2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.

.3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.

.4 At 60% construction completion stage. Section 01 32 16.16 - Construction Progress Schedule - Critical Path Method (CPM), 01 32 16.19 - Construction Progress Schedule - Bar (GANTT) Chart. The Consultant to call a
separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:

.1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.

.2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.

.5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.

.6 Meeting will be chaired by the
Consultant, Contractor, Cx Agent, who will record and distribute minutes.

.7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.10 STARTING AND TESTING

.1 Contractor assumes liabilities and costs for inspections. Including disassembly and re-assembly after approval, starting, testing, and adjusting, including supply of testing equipment.

1.11 WITNESSING OF STARTING AND TESTING

.1 Provide 14 days notice prior to commencement.

.2 The Consultant to witness of
start-up and testing.

.3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers, and equipment manufacturers.

1.12 MANUFACTURER'S INVOLVEMENT

.1 Factory testing: manufacturer to:

.1 Coordinate time and location of testing.

.2 Provide testing documentation for approval by the
Consultant .

.3 Arrange for the
Consultant to witness tests.

.4 Obtain written approval of test results and documentation from the
Consultant before delivery to site.

.5 Obtain manufacturers installation, start-up, and operations instructions prior to start-up of components, equipment and systems and review with the Consultant.

.6 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.

.7 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.2 Integrity of warranties:

.1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.

.2 Verify with manufacturer that testing as specified will not void warranties.

.3 Qualifications of manufacturer's personnel:

.1 Experienced in design, installation and operation of equipment and systems.

.2 Ability to interpret test results accurately.

.3 To report results in clear, concise, logical manner.

1.13 PROCEDURES

.1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.

.2 Conduct start-up and testing in following distinct phases:

.1 Included in delivery and installation:

.1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.

.2 Visual inspection of quality of installation.

.2 Start-up: follow accepted start-up procedures.

.3 Operational testing: document equipment performance.

.4 System PV: include repetition of tests after correcting deficiencies.

.5 Post-substantial performance verification: to include fine-tuning.

.3 Correct deficiencies and obtain approval the Consultant after distinct phases have been completed and before commencing next phase.

.4 Document require tests on approved PV forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by the Consultant . If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:

.1 Minor equipment/systems: implement corrective measures approved by the Consultant .

.2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved the Consultant .

.3 If evaluation report concludes that major damage has occurred, the Consultant shall reject equipment.

.1 Rejected equipment to be remove from site and replace with new.

.2 Subject new equipment/systems to specified start-up procedures.

1.14 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to the Consultant for approval before commencement of commissioning.

.2 Start-up documentation to include:

.1 Factory and on-site test certificates for specified equipment.

.2 Pre-start-up inspection reports.

.3 Signed installation/start-up check lists.

.4 Start-up reports,

.5 Step-by-step description of complete start-up procedures, to permit the Consultant to repeat start-up at any time.

1.15 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit the Consultant for approval before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.16 TEST RESULTS

.1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.

.2 Provide manpower and materials, assume costs for re-commissioning.

1.17 START OF COMMISSIONING

.1 Notify the Consultant at least 21 days prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.18 INSTRUMENTS / EQUIPMENT

.1 Submit to the Consultant for review and approval:

.1 Complete list of instruments proposed to be used.

.2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.

.2 Provide the following equipment as required:

.1 2-way radios.

.2 Ladders.

.3 Equipment as required to complete work.

1.19 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:

.1 Under [actual] [accepted simulated] operating conditions, over entire operating range, in all modes.

.2 On independent systems and interacting systems.

.2 Cx procedures to be repeatable and reported results are to be verifiable.

.3 Follow equipment manufacturer's operating instructions.

.4 EMCS trending to be available as supporting documentation for performance verification.

1.20 WITNESSING COMMISSIONING

.1 The Consultant to witness activities and verify results.

1.21 AUTHORITIES HAVING JURISDICTION

.1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.

.2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.

.3 Provide copies to the Consultant within 5 days of test and with Cx report.

1.22 COMMISSIONING CONSTRAINTS

.1 Since access into secure or sensitive areas will be very difficult after occupancy it is necessary to complete Cx of occupancy, weather, and seasonal sensitive equipment and systems in these areas before issuance of the Interim Certificate, using, if necessary, simulated thermal loads.

1.23 EXTRAPOLATION OF RESULTS

.1 Where Cx of weather, occupancy, or seasonal-sensitive equipment or systems cannot be conducted under near-rated or near-design conditions, extrapolate part-load results to design conditions when approved by the Consultant in accordance with equipment manufacturer's instructions, using manufacturer's data, with manufacturer's assistance and using approved formula.

1.24 EXTENT OF VERIFICATION

.1 Laboratory areas:

.1 Provide manpower and instrumentation to verify up to 100 % of reported results.

.2 Elsewhere:

.1 Provide manpower and instrumentation to verify up to 30 % of reported results, unless specified otherwise in other sections.

.3 Number and location to be at discretion of the Consultant.

.4 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.

.5 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.

.6 Perform additional commissioning until results are acceptable to the Consultant.

1.25 REPEAT VERIFICATIONS

.1 Assume costs incurred by the Consultant for third and subsequent verifications where:

.1 Verification of reported results fail to receive the Consultant approval.

.2 Repetition of second verification again fails to receive approval.

.3 The Consultant deems Contractor's request for second verification was premature.

1.26 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

1.27 DEFICIENCIES, FAULTS, DEFECTS

.1 Correct deficiencies found during start-up and Cx to satisfaction of the Consultant .

.2 Report problems, faults or defects affecting Cx to the Consultant in writing. Stop Cx until problems are rectified. Proceed with written approval from the Consultant .

1.28 COMPLETION OF COMMISSIONING

.1 Upon completion of Cx leave systems in normal operating mode.

.2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.

.3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by the Consultant.

1.29 ACTIVITIES UPON COMPLETION OF COMMISSIONING

.1 When changes are made to baseline components or system settings established during Cx process, provide updated Cx form for affected item.

1.30 TRAINING

.1 In accordance with Section 01 79 00.13 - Demonstration and Training for Building Commissioning.

1.31 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

.1 Supply, deliver, and document maintenance materials, spare parts, and special tools as specified in contract.

1.32 OCCUPANCY

.1 Cooperate fully with the Consultant during stages of acceptance and occupancy of facility.

1.33 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and PV if:

.1 Accuracy complies with these specifications.

.2 Calibration certificates have been deposited with the Consultant .

.2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.34 PERFORMANCE VERIFICATION TOLERANCES

.1 Application tolerances:

.1 Specified range of acceptable deviations of measured values from specified values or specified design criteria. Except for special areas, to be within +/- 10% of specified values.

.2 Instrument accuracy tolerances:

.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:

.1 Unless otherwise specified actual values to be within +/- 2 % of recorded values.

1.35 OWNER'S PERFORMANCE TESTING

.1 Performance testing of equipment or system by Consultant will not relieve Contractor from compliance with specified start-up and testing procedures.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with this section.

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.2 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.3 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

1.2 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

.1 Operation and maintenance manual approved by, and final copies deposited with, Engineer before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 Maintenance data to include:

.1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required and task time.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Superior performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit [2] copies of draft Operation and Maintenance Manual to Engineer for approval, including electronic form also. Submission of individual data will not be accepted unless directed by Engineer.

.2 Make changes as required and re-submit as directed by Engineer.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.5 Make available in electronic form.

.8 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.3 Submit to Engineer for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

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

.10 Submit as-built drawings in electronic form as well in PDF and CAD formats.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers.

.3 Furnish one commercial quality grease gun, grease, and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

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

3.4 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests and submit report as described in PART 1 -ACTION AND INFORMATIONAL SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION

.1 Engineer will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Use operation and maintenance manual, as-built drawings, and audio-visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

3.6 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

3.7 INSULATION

.1 Refer to Section 23 07 19 – HVAC Piping Insulation for application of insulation to Plumbing Systems.

3.8 PROTECTION

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for plumbing products and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.1 Indicate on drawings to indicate materials, finishes, method of anchorage, [number of anchors, dimensions, construction and assembly details and accessories.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturers' Field Reports: manufacturers' field reports specified.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with 22 05 00 - Common Work Results for Plumbing.

.2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year, and capacity.

.2 Details of operation, servicing, and maintenance.

.3 Recommended spare parts list.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 FLOOR DRAINS

.1 Floor Drains and Trench Drains: to CSA B79.

.2 Refer to Plumbing Fixture Schedule on mechanical drawings for equipment specifications.

2.2 ROOF DRAINS

.1 Refer to Plumbing Fixture Schedule on mechanical drawings for equipment specifications.

2.3 CLEANOUTS

.1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

.2 Access Covers:

.1 Wall Access: face or wall type, polished nickel bronze round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

.2 Floor Access: round cast iron body and frame with adjustable secured nickel bronze top and:

.1 Plugs: bolted bronze with neoprene gasket.

.2 Cover for Unfinished Concrete Floors: nickel bronze round, gasket, vandal-proof screws.

.3 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.

.4 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

2.4 NON-FREEZE WALL HYDRANTS

.1 Refer to Plumbing Fixture Schedule on mechanical drawings for equipment specifications.

2.5 NON-FREEZE GROUND HYDRANT

.1 Refer to Plumbing Fixture Schedule on mechanical drawings for equipment specifications.

2.6 WATER HAMMER ARRESTORS

.1 Provide equal to Zurn 1260XL low lead model.

2.7 BACK FLOW PREVENTERS

.1 Preventers: to CSA-B64 Series, application as indicated Backflow Device Schedule and mechanical drawings.

2.8 VACUUM BREAKERS

.1 Breakers: to CSA-B64 Series, vacuum breaker, atmospheric, where indicated.

2.9 PRESSURE REGULATORS

.1 Capacity: as indicated on drawings.

.2 Up to NPS1-1/2 bronze bodies, screwed: to ASTM B62.

.3 NPS2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class B.

.4 Semi-steel spring chambers with bronze trim.

2.10 BACKWATER VALVES

.1 Coated extra heavy cast iron or Galvanized body with bronze seat, revolving bronze flapper and threaded cover.

.2 Access:

.1 Surface access.

.2 Access pipe with cover: maximum 300 mm depth.

.3 Steel housing with gasketed steel cover.

.4 Concrete access pit with cover, as indicated.

2.11 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

2.12 WATER MAKE-UP ASSEMBLY

.1 Complete with backflow preventer and pressure gauge on inlet and outlet, pressure reducing valve to CSA B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.

2.13 WATER METERS

.1 Accessories: remote readout device.

2.14 TRAP SEAL PRIMERS

.1 Brass, with integral vacuum breaker, NPS 1/2 solder ends, NPS 1/2 drip line connection. Provide as indicated on mechanical drawings.

2.15 STRAINERS

.1 860 kPa, Y type with 20 mesh, monel wire mesh, bronze or stainless-steel removable screen.

.2 NPS2 and under, bronze body, screwed ends, with brass cap.

.3 NPS2 1/2 and over, cast iron body, flanged ends, with bolted cap.

2.16 GREASE INTERCEPTORS

.1 Capacity: as indicated in plumbing fixture schedule.

.2 Refer to Plumbing Fixture Schedule on mechanical drawings for equipment specifications.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with the Ontario Building Code (OBC) and local authority having jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

3.3 CLEANOUTS

.1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.

.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

3.4 NON-FREEZE WALL HYDRANTS

.1 Install 600 mm above finished grade or as indicated.

3.5 NON-FREEZE GROUND HYDRANT

.1 Install with top of box flush with ground or deck and with drainage connection to discharge as indicated.

3.6 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures where fast-closing valves are present, such as water closet and urinal flush valves.

3.7 BACK FLOW PREVENTERS

.1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code:

.1 Drains.

.2 Backwater Valves.

.3 Water Make-up Assembly.

.4 Grease Interceptors.

.2 Pipe discharge to terminate over nearest drain or service sink.

3.8 BACKWATER VALVES

.1 Install where indicated.

3.9 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Install at bottom of risers, at low points to drain systems, and as indicated.

3.10 TRAP SEAL PRIMERS

.1 Install for floor drains and elsewhere, as indicated.

.2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of consultant.

.3 Install plastic tubing to floor drain.

3.11 STRAINERS

.1 Install with sufficient room to remove basket for maintenance.

3.12 GREASE INTERCEPTORS

.1 Install with sufficient space, as indicated, for maintenance.

3.13 WATER METERS

.1 Install water metre provided by local water authority.

.2 Install water metre as indicated.

3.14 WATER MAKE-UP ASSEMBLY

.1 Install on valved bypass.

.2 Pipe discharge from relief valve to nearest floor drain.

3.15 START-UP

.1 Timing: start-up only after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

3.16 TESTING AND ADJUSTING

.1 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.2 Application tolerances:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

.3 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.4 Floor drains:

.1 Verify operation of trap seal primer.

.2 Prime, using trap primer. Adjust flow rate to suit site conditions.

.3 Check operations of flushing features.

.4 Check security, accessibility, removability of strainer.

.5 Clean out baskets.

.5 Vacuum breakers, backflow preventers, backwater valves:

.1 Test tightness, accessibility for O&M of cover and of valve.

.2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.

.3 Verify visibility of discharge from open ports.

.6 Roof drains:

.1 Check location at low points in roof.

.2 Check security, removability of dome.

.3 Adjust weirs to suit actual roof slopes, meet requirements of design.

.4 Clean out sumps.

.5 Verify provisions for movement of roof systems.

.7 Access doors:

.1 Verify size and location relative to items to be accessed.

.8 Cleanouts:

.1 Verify covers are gas-tight, secure, yet readily removable.

.9 Water hammer arrestors:

.1 Verify proper installation of correct type of water hammer arrester.

.10 Wall, ground hydrants:

.1 Verify complete drainage, freeze protection.

.2 Verify operation of vacuum breakers.

.11 Pressure regulators, PRV assemblies:

.1 Adjust settings to suit locations, flow rates, pressure conditions.

.12 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.13 Grease interceptors:

.1 Activate, using manufacturer's recommended procedures and materials.

.14 Hose bibbs, sediment faucets:

.1 Verify that flow and pressure meet design criteria.

.2 Check for leaks, replace compression washer if required.

.15 Hydronic system water Make-up Assembly:

.1 Verify flow, pressure, and connection.

.16 Water meters:

.1 Verify location and accessibility.

.2 Test metre reading accuracy.

3.17 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with 22 05 00 - Common Work Results for Plumbing.

.2 Training: provide training in accordance with 22 05 00 - Common Work Results for Plumbing.

3.18 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

3.19 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheet for fixtures and equipment.

.3 Shop Drawings.

- .1 Submit shop drawings to indicate:
  - .1 Equipment, including connections, fittings, control assemblies and ancillaries. Identify whether factory or field assembled.
  - .2 Wiring and schematic diagrams.
  - .3 Dimensions and recommended installation.
  - .4 Pump performance and efficiency curves.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturers' Field Reports: manufacturers' field reports specified.

.7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 22 05 00 - Common Work Results for Plumbing:

- .1 Manufacturers name, type, model year, capacity, and serial number.
- .2 Details of operation, servicing, and maintenance.
- .3 Recommended spare parts list with names and addresses.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

- .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect materials from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MATERIALS

.1 Materials and resources in accordance with Section 22 05 00 - Common Work Results for Plumbing.

2.2 DOMESTIC HOT WATER CIRCULATING PUMPS

.1 Make, model, capacity, construction, motor: as indicated on drawings.

.2 Supports: provide as recommended by manufacturer.

2.3 DOMESTIC WATER BOOSTER SYSTEM

.1 Make, model, capacity, construction, motor: as indicated on drawings.

.2 Valves: to Section 22 11 16 - Domestic Water Piping.

.3 Supports: install complete package on factory fabricated structural steelwork.

.4 Anchor Bolts and Templates:

.1 Supply for installation by other Divisions.

.5 Control Panel: Supplied with pump package.

2.4 SUMP PUMP SUBMERSIBLE

.1 Make, model, capacity, construction, motor: as indicated on drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Make piping and electrical connections to pump and motor assembly and controls as indicated.

.2 Ensure pump and motor assembly do not support piping.

.3 Align vertical pit mounted pump assembly after mounting and securing cover plate.

.4 Place 150 mm sand under sump pit tank.

3.3 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Check power supply.

.2 Check starter protective devices.

.2 Start-up, check for proper and safe operation.

.3 Check settings and operation of hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature, and other protective devices.

.4 Adjust flow from water-cooled bearings.

.5 Adjust impeller shaft stuffing boxes, packing glands.

3.4 START-UP

.1 General:

.1 Procedures:

.1 Check power supply.

.2 Check starter O/L heater sizes.

.3 Start pumps, check impeller rotation.

.4 Check for safe and proper operation.

.5 Check settings, operation of operating, limit, safety controls, over-temperature, audible/visual alarms, other protective devices.

.6 Test operation of hands-on-auto switch.

.7 Test operation of alternator.

.8 Adjust leakage through water-cooled bearings.

.9 Adjust shaft stuffing boxes.

.10 Adjust leakage flow rate from pump shaft stuffing boxes to manufacturer's recommendations.

.11 Check base for free-floating, no obstructions under base.

.12 Run-in pumps for 12 continuous hours.

.13 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.14 Adjust alignment of piping and conduit to ensure full flexibility.

.15 Eliminate causes of cavitation, flashing, air entrainment.

.16 Measure pressure drop across strainer when clean and with flow rates as finally set.

.17 Replace seals if pump used to degrease system or if pump used for temporary heat.

.18 Verify lubricating oil levels.

3.5 REPORTS

.1 Include:

.1 PV results on approved PV Report Forms.

.2 Product Information report forms.

.3 Pump performance curves (family of curves) with final point of actual performance.

3.6 TRAINING

.1 Training of O&M Personnel, as required.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Closeout Submittals:

.1 Submit maintenance and engineering data for incorporation into manual specified in Section 22 05 00 - Common Work Results for Plumbing:

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 PIPING

.1 Domestic hot, cold and recirculation systems, within building.

.1 Above ground:

.1 Copper tube, hard drawn, type L: to ASTM B88M.

.2 Buried or embedded:

.1 Copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints

2.2 FITTINGS

.1 Bronze pipe flanges and flanged fittings, Class 150: to ANSI/ASME B16.24.

.2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI/ASME B16.18.

.4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

.5 NPS 2 and larger:

.1 ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242

.6 NPS 1 ½ and smaller:

.1 Wrought copper to ANSI/ASME B16.22 or cast copper to ANSI/ASME B16.18; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.

2.3 JOINTS

.1 Rubber gaskets, latex-free 1.6 mm thick: to AWWA C111.

.2 Bolts, nuts, hex head, and washers: to ASTM A307, heavy series.

.3 Solder: 95/5 tin copper alloy lead-free.

.4 Teflon tape: for threaded joints.

.5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM flush seal gasket. Gasket to be classified in accordance with ANSI/NSF 61 for potable water service. Couplings to be manufactured to copper-tube dimensions. Flaring of tube or fitting ends to accommodate IPS sized couplings is not permitted.

.6 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner.

2.4 GATE VALVES

.1 NPS 2 and under, soldered:

.1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze

.2 NPS 2 and under, screwed:

.1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze

.3 NPS 2-1/2 and over, in mechanical rooms, flanged:

.1 Rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, OS&Y bronze trim specified Section 23 05 23.02 - Valves - Cast Iron

.4 NPS 2-1/2 and over, other than mechanical rooms, flanged:

.1 Non-rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check

2.5 GLOBE VALVES

.1 NPS2 and under, soldered:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 23.01 - Valves - Bronze

.2 Lock-shield handles.

.2 NPS 2 and under, screwed:

.1 To MSS-SP-80, Class 150, 1 MPa, bronze body, screwed over bonnet, renewable composition disc as specified Section 23 05 23.01 - Valves - Bronze.

.2 Lock-shield handles.

2.6 SWING CHECK VALVES

.1 NPS 2 and under, soldered:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, re-grindable seat as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 and under, screwed:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, re-grindable seat as specified Section 23 05 23.01 - Valves - Bronze.

.3 NPS 2-1/2 and over, flanged:

.1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, regrind or renewable seat, bronze disc, bolted cap specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.7 BALL VALVES

.1 NPS 2 and under, screwed:

.1 Class 150.

.2 Bronze body, chrome plated brass ball, PTFE adjustable packing, brass gland, steel lever handle as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 and under, soldered:

.1 To ANSI/ASME B16.18, Class 150.

.2 Bronze body, chrome plated brass ball, PTFE adjustable packing, brass gland, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23.01 - Valves - Bronze.

2.8 BUTTERFLY VALVES

.1 NPS 2-1/2 and over:

.1 To MSS-SP-67, Class 200.

.2 Cast iron body, ductile iron chrome plated disc, stainless steel stem, EPT liner.

.2 NPS 2-1/2 and over, grooved ends:

.1 Class 300, bubble tight shut-off, bronze body.

.2 Operator:

.1 NPS [4] and under: lever handle.

.2 NPS [6] and over: gear operated.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install in accordance with Ontario Building Code (OBC) and local authority having jurisdiction.

.2 Install pipe work in accordance with Section 23 05 15 - Common Installation Requirements for HVAC Pipework, supplemented as specified herein.

.3 Assemble piping using fittings manufactured to ANSI and Standard Council of Canada (SCC) standards

.4 Install CWS piping below and away from HWS and HWC and other hot piping to maintain temperature of cold-water, as low as possible.

.5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

.6 Buried tubing:

.1 Lay in well compacted washed sand in accordance with AWWA Class B bedding

.2 Bend tubing without crimping or constriction. Minimize use of fittings.

.7 Valves

.1 Isolate equipment, fixtures, and branches with ball valves.

.2 Balance recirculation system using lock-shield globe valves. Mark settings and record on as-built drawings on completion.

3.3 PRESSURE TESTS

.1 Conform to requirements of Section 22 05 00 - Common Work Results for Plumbing.

.2 Test pressure: greater of one times maximum system operating pressure or 860 kPa.

3.4 FLUSHING AND CLEANING

.1 Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean copper to Ontario potable water guidelines. Let system flush for additional 2 h, then draw off another sample for testing.

3.5 PRE-START-UP INSPECTIONS

.1 Systems to be complete, prior to flushing, testing and start-up.

.2 Verify that system can be completely drained.

.3 Ensure that pressure booster systems are operating properly.

.4 Ensure that air chambers, expansion compensators are installed properly.

3.6 DISINFECTION

.1 Flush out, disinfect and rinse system to AWWA C651, the requirements of authority having jurisdiction and the approval of the engineer.

.2 Upon completion, provide laboratory test reports on water quality to the engineer for approval.

3.7 START-UP

.1 Timing: Start up after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

.3 Start-up procedures:

.1 Establish circulation and ensure that air is eliminated.

.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.

.3 Bring HWS storage tank up to design temperature slowly.

.4 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.

.5 Check control, limit, safety devices for normal and safe operation.

.4 Rectify start-up deficiencies.

3.8 PERFORMANCE VERIFICATION

.1 Timing:

.1 After pressure and leakage tests and disinfection completed, and certificate of completion has been issued by authority having jurisdiction.

.2 Procedures:

.1 Verify that flow rate and pressure meet Design Criteria.

.2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.

.4 Sterilize HWS and HWC systems for Legionella control.

.5 Verify performance of temperature controls.

.6 Verify compliance with safety and health requirements.

.7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.

.8 Confirm water quality is consistent with the supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.

.4 Reports:

.1 Provide testing in accordance with the Ontario Building Code and industry best practices.

.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.9 OPERATION REQUIREMENTS

.1 Co-ordinate operation and maintenance requirements including cleaning and maintenance of specified materials and products with Section 23 05 15 - Common Installation Requirements for HVAC Pipework.

.5 Operational requirements to include:

.1 Cleaning materials and schedules.

.2 Repair and maintenance materials and instructions.

3.10 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish, and limitations.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 COPPER TUBE AND FITTINGS

.1 Above ground sanitary, storm and vent piping Type DWV to: ASTM B306.

.1 Fittings.

.1 Cast brass: to CAN/CSA-B125.

.2 Wrought copper: to CAN/CSA-B125.

.2 Solder: lead free, tin-95:5, type TA, to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

.1 Buried sanitary, storm and vent minimum NPS 2 to CAN/CSA-B70, with one layer of protective coating of bituminous.

.1 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.

.2 Stainless steel clamps.

.2 Hub and spigot:

.1 Neoprene gasket: to CSA B70.

.2 Cold caulking compounds.

.2 Above ground sanitary, storm and vent to CAN/CSA-B70:

.1 Joints:

.1 Mechanical joints: Neoprene or butyl rubber compression gaskets with stainless steel clamps.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.2 In accordance with Section 23 05 15 - Common installation requirements for HVAC pipework.

.3 Install in accordance with The Ontario Building Code and the local authority having jurisdiction.

3.3 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil and re-seal.

.3 Verify that cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system, and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 PIPING AND FITTINGS

.1 For buried and above ground DWV piping to:

.1 CAN/CSA B1800

2.2 JOINTS

.1 Solvent weld for PVC: to ASTM D2564

.2 Solvent weld for ABS: to ASTM D2235

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.2 In accordance with Section 23 05 15 - Common installation requirements for HVAC pipework.

.3 Install in accordance with The Ontario Building Code and the local authority having jurisdiction.

3.3 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil and re-seal.

.3 Verify cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

.4 Ensure fixtures are properly anchored, connected to system, and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

1.2 CLOSEOUT SUBMITTALS

.1 Provide maintenance data in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Include:

.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.

.2 Details of operation, servicing, maintenance.

.3 List of recommended spare parts.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

1.4 WARRANTY

.1 Contractor hereby warrants domestic water heaters in accordance with CCDC2, but for number of years specified for each product.

Part 2 Products

2.1 ELECTRIC WATER HEATER

.1 To CAN/CSA C22.2 No.110, CAN/CSA-C191 and CAN/CSA-C309 for glass-lined storage tanks.

.2 Refer to Electric Hot Water Heater Schedule on mechanical drawings for equipment specifications.

.3 [3] year warranty certificate.

2.2 GAS (ATMOSPHERIC) WATER HEATER

.1 To ANSI Z21.10.1/CSA 4.1 and ANSI Z21.10.3/CSA 4.3.

.2 Refer to gas Hot Water Heater Schedule on mechanical drawings for equipment specifications.

.3 3-year warranty certificate.

2.3 GAS (POWER BURNER) WATER HEATER

.1 To ANSI Z21.10.1/CSA 1-4.1 and ANSI Z21.10.3/CSA 1-4.3.

.2 Refer to gas Hot Water Heater Schedule on mechanical drawings for equipment specifications.

.3 [3] year warranty certificate.

2.4 OIL FIRED WATER HEATER

.1 To CAN/CSA B140.0 and CSA B140.12.

.2 Refer to gas Hot Water Heater Schedule on mechanical drawings for equipment specifications.

.3 [10] year warranty certificate.

2.5 STEAM - STORAGE

.1 Tank:

.1 Steel fabricated to CSA B51, and provincial regulations.

.2 Refer to Steam Boiler Schedule on mechanical drawings for equipment specifications.

.2 Heater:

.1 Refer to Steam Boiler Schedule on mechanical drawings for equipment specifications.

.3 Accessories: heater bundle vacuum breaker.

.4 Steam control valve:

.1 Self actuating, modulating valve, bronze body, 860 kPa, two-ply thermostatic bellows and copper capillary tubing with bulb in well, tight shut-off, removable composition disc, temperature adjustment setting.

2.6 STEAM - INSTANTANEOUS

.1 Shell and tube type: to CSA B51, and provincial regulations. 90/10 copper/nickel heat exchanger with stainless steel flanges.

.1 Ensure unit is designed for 1034 kPa working pressure for both tube and shell circuits.

.2 Refer to Steam Boiler Schedule on mechanical drawings for equipment specifications.

.2 Control valve:

.1 Self actuating, modulating valve, cast iron body if flanged ends, bronze body if screwed ends, 860 kPa, two-ply thermostatic bellow and copper capillary tubing with bulb in well, tight disc shut-off, removable composition disc, temperature adjustment setting.

2.7 DHW HEATER AND STORAGE TANK

.1 DHW heater:

.1 General: packaged unit to ASME standards, stamped for 1100 kPa WP. Provide CGA certification.

.2 Refer to Electric Hot Water Heater Schedule on mechanical drawings for equipment specifications.

.2 Storage tank:

.1 Refer to Storage Tank Schedule on mechanical drawings for equipment specifications.

.2 Extended warranty: [10] years. Provide certificate.

2.8 TRIM AND INSTRUMENTATION

.1 Drain valve: NPS 1 with hose end.

.2 Thermometer: 100 mm dial type with red pointer and thermowell filled with conductive paste.

.3 Pressure gauge: 75 mm dial type with red pointer and shut-off cock.

.4 Thermowell filled with conductive paste for control valve temperature sensor.

.5 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.

.6 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install in accordance with the Ontario Building Code and the local authority having jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's factory trained, certified Engineer to start up DHW heaters.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish, and limitations.

.1 Indicate fixtures and trim:

.1 Dimensions, construction details, roughing-in dimensions.

.2 Factory-set water consumption per flush at recommended pressure.

.3 (For water closets, urinals): minimum pressure required for flushing.

1.2 CLOSEOUT SUBMITTALS

.1 Closeout Submittals:

.1 Submit maintenance and engineering data for incorporation into manual specified in Section 22 05 00 - Common Work Results for Plumbing:

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series

.2 Trim, fittings: manufacture in accordance with CSA B125.3

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: as indicated.

.1 Water closets:

.1 As indicated on plumbing fixture schedule.

.2 Water Closet Flush Valves:

.1 As indicated on plumbing fixture schedule.

.3 Electronic Water Closet Flush Valves:

.1 As indicated on plumbing fixture schedule.

.4 Water Closet Seats.

.1 As indicated on plumbing fixture schedule.

.5 Urinals:

.1 As indicated on drawings

.6 Urinal Electronic Flush Valves:

.1 As indicated on plumbing fixture schedule.

.7 Washroom Lavatories:

.1 As indicated on plumbing fixture schedule.

.8 Washroom Lavatory Trim

.1 As indicated on plumbing fixture schedule.

.9 Washroom Lavatory Electronic Trim:

.1 As indicated on plumbing fixture schedule.

.10 Fixture piping:

.1 Hot and cold-water supplies to fixtures:

.1 Chrome plated flexible supply pipes with handwheel stop, reducers, escutcheon.

.2 Waste:

.1 Brass P trap with clean out on fixtures not having integral trap.

.2 Chrome plated in exposed places.

.11 Chair carriers:

.1 Factory manufactured floor-mounted carrier systems for wall-mounted fixtures.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Mounting heights:

.1 Standard: in accordance with the Ontario Building Code and architectural drawings, measured from finished floor.

.2 Wall-hung fixtures: in accordance with the Ontario Building Code and architectural drawings, measured from finished floor.

.3 Barrier-free: in accordance with CSA B651.

3.3 ADJUSTING

.1 Conform to water conservation requirements specified this section.

.2 Adjustments:

.1 Adjust water flow rate to design flow rates.

.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Adjust flush valves to suit actual site conditions.

.4 Adjust urinal flush timing mechanisms.

.5 Set controls of automatic flush valves for WCs and urinals to prevent unnecessary flush cycles.

.3 Checks:

.1 Water closets, urinals: flushing action.

.2 Aerators: operation, cleanliness.

.3 Vacuum breakers, backflow preventers: operation under all conditions.

.4 Thermostatic controls:

.1 Verify temperature settings, operation of control, limit, and safety controls.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish, and limitations.

1.2 CLOSEOUT SUBMITTALS

.1 Provide maintenance data in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Include:

.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.

.2 Details of operation, servicing, maintenance.

.3 List of recommended spare parts.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: architectural drawings to govern.

.5 Fixtures to be product of one manufacturer.

.6 Trim to be product of one manufacturer.

.1 Service sinks:

.1 As indicated on plumbing fixture schedule.

.2 Mop sinks:

.1 As indicated on plumbing fixture schedule.

.3 Stainless steel counter top sinks.

.1 As indicated on plumbing fixture schedule.

.4 Laundry tubs:

.1 As indicated on plumbing fixture schedule.

.5 Group wash fountains:

.1 As indicated on plumbing fixture schedule.

.6 Fixture piping:

.1 Hot and cold-water supplies to each fixture:

.1 Chrome plated flexible supply pipes each with handwheel stop, reducers, escutcheon.

.2 Waste:

.1 Brass P trap with clean out on each fixture not having integral trap.

.2 Chrome plated in all exposed places.

.7 Chair carriers:

.1 Factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Mounting heights:

.1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.

.2 Wall-hung fixtures: as per the Ontario Building Code and architectural drawings, measured from finished floor.

.3 Barrier-free: to comply with the Ontario Building Code and CAN/CSA-B651.

3.3 ADJUSTING

.1 Conform to water conservation requirements specified this section.

.2 Adjustments:

.1 Adjust water flow rate to design flow rates.

.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Checks:

.1 Aerators: operation, cleanliness.

.2 Vacuum breakers, backflow preventers: operation under all conditions.

.3 Wash fountains: operation of flow-actuating devices.

.4 Thermostatic controls:

.1 Verify temperature settings, operation of control, limit, and safety controls.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 22 05 00 - Common Work Results for Plumbing.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish, and limitations.

1.2 CLOSEOUT SUBMITTALS

.1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in 22 05 00 - Common Work Results for Plumbing.

.2 Include:

.1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.

.2 Details of operation, servicing, maintenance.

.3 List of recommended spare parts.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.3.

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: architectural drawings to govern.

.5 Fixtures in any one location to be product of one manufacturer and of same type.

.6 Trim in any one location to be product of one manufacturer and of same type.

.1 Baths:

.1 As indicated on plumbing fixture schedule.

.2 Individual shower stall showerhead.

.1 As indicated on plumbing fixture schedule.

.3 Group or Gang showers:

.1 As indicated on plumbing fixture schedule.

.4 Fixture piping:

.1 Hot and cold-water supplies to each fixture.

.1 Chrome plated rigid supply pipes each with handwheel stop, reducers, escutcheon.

.2 Waste:

.1 Brass P trap with cleanout on each fixture not having integral trap.

.2 Chrome plated in all exposed places.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Mounting heights:

.1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.

.2 Barrier-free: to comply with CAN/CSA B651.

3.3 ADJUSTING

.3 Conform to water conservation requirements specified this section.

.4 Adjustments:

.1 Adjust water flow rate to design flow rates.

.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.5 Checks:

.1 Aerators: operation, cleanliness.

.2 Vacuum breakers, backflow preventers: operation under all conditions.

.6 Thermostatic controls:

.1 Verify temperature settings, operation of control, limit, and safety controls.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Shop Drawings:

.1 Indicate on drawings:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.2 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

1.2 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

.1 Operation and maintenance manual approved by, and final copies deposited with, Engineer before final inspection.

.2 Operation data to include:

.1 Control schematics for systems including environmental controls.

.2 Description of systems and their controls.

.3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

.4 Operation instruction for systems and component.

.5 Description of actions to be taken in event of equipment failure.

.6 Valves schedule and flow diagram.

.7 Colour coding chart.

.3 Maintenance data to include:

.1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.

.2 Data to include schedules of tasks, frequency, tools required and task time.

.4 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.5 Approvals:

.1 Submit [2] copies of draft Operation and Maintenance Manual to Engineer for approval, including electronic form also. Submission of individual data will not be accepted unless directed by Engineer.

.2 Make changes as required and re-submit as directed by Engineer.

.6 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.7 Site records:

.1 Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use distinct colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.5 Make available in electronic form.

.8 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.3 Submit to Engineer for approval and make corrections as directed.

.4 Perform testing, adjusting, and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

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

.10 Submit as-built drawings in electronic form as well in PDF and CAD formats.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Furnish spare parts as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket set for each heat exchanger.

.4 One glass for each gauge glass.

.5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers.

.3 Furnish one commercial quality grease gun, grease, and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MATERIALS

.1 HVAC and R Equipment:

.1 Refrigerant:

.1 HCFC based refrigerant.

.2 HFC based refrigerant.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Engineer.

.2 Inform Engineer of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Engineer.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Prime and touch up marred finished paintwork to match original.

.2 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

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

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION

.1 Engineer will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Use operation and maintenance manual, as-built drawings, and audio-visual aids as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections.

.5 Engineer will record these demonstrations on video tape for future reference.

3.6 CLEANING

.1 Progress Cleaning: Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

3.7 PROTECTION

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals: in accordance with Section 23 05 00 Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheets. Include product characteristics, performance criteria, and limitations.

.3 Quality Control:

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual in accordance with Section 23 05 00 Common Work Results for HVAC.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 GENERAL

.1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 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.

.3 Motors 373 W [1/2 HP] and larger: Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise [40] degrees C, 3 phase, 575 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.

.3 For motors under 7.5 kW [10 HP]: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW [10 HP] and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

.8 Supply one set of spare belts for each set installed in accordance with Section 23 05 00 Common Work Results for HVAC.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives:

.1 Expanded metal screen welded to steel frame.

.2 Minimum 1.2 mm thick sheet metal tops and bottoms.

.3 [38] mm diameter holes on both shaft centres for insertion of tachometer.

.4 Removable for servicing.

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.5 Guard for flexible coupling:

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

.2 Securely fasten in place.

.3 Removable for servicing.

.6 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.

.2 Net free area of guard: not less than 80% of fan openings.

.3 Securely fasten in place.

.4 Removable for servicing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

.1 Site Tests: conduct tests and submit report as described in Section 23 05 00 Common Work Results for HVAC.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit Manufacturer's Field Reports as described in Section 23 05 00 Common Work Results for HVAC.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, as directed in Section 23 05 00 Common Work Results for HVAC.

3.4 CLEANING

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 Common Work Results for HVAC.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish, and limitations.

1.2 DELIVERY, STORAGE AND HANDLING

.3 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.4 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181

.1 Primers, paints, and coatings: in accordance with manufacturer's recommendations for surface conditions.

.2 Primer: maximum VOC limit [250] g/L.

.3 Paints: maximum VOC limit [150] g/L.

.2 Sealants:

.1 Sealants: maximum VOC limit SCAQMD Rule 1168.

.3 Sealants: maximum VOC limit SCAQMD Rule 1168.

.4 Adhesives: maximum VOC limit SCAQMD Rule 1168.

.5 Fire Stopping: in accordance ULC, NFPA and the Ontario Building Code.

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

.1 Provide clearance around systems, equipment, and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, components.

3.4 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap, and chain.

3.5 AIR VENTS

.1 Install manual air vents to CAN/CSA B139 at all high points in each piping system(s).

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

.1 Install pipework to CAN/CSA B139.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed piping, equipment, rectangular cleanouts, and similar items parallel or perpendicular to building lines.

.8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible [and as indicated].

.12 Ream pipes, remove scale and other foreign material before assembly.

.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.14 Provide for thermal expansion as indicated.

.15 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.6 Use gate, ball, or butterfly valves at branch take-offs for isolating purposes except where specified.

.7 Install butterfly valves on chilled water and related condenser water systems only.

.8 Install butterfly valves between weld neck flanges to ensure full compression of liner.

.9 Install ball valves for glycol service.

.10 Use chain operators on valves NPS 2 1/2 and larger, where installed more than 2400 mm above floor in Mechanical Rooms.

.16 Check Valves:

.1 Install silent check valves [on discharge of pumps] [and] [in vertical pipes with downward flow] and as indicated.

.2 Install swing check valves in horizontal lines [on discharge of pumps] and as indicated.

3.8 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

.2 Material: Schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere:

.1 Provide space for fire stopping.

.2 Maintain the fire-resistance rating integrity of the fire separation.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

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

3.9 ESCUTCHEONS

.6 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.7 Construction: one piece type with set screws.

.1 Chrome or nickel-plated brass or type 302 stainless steel.

.8 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

.1 Coordinate the installation of fire stopping around pipes, insulation and adjacent fire separation.

.2 Pipes subject to movement: conform to fire stop system design listing to ensure pipe movement without damaging fire stopping material or installation.

.3 Insulated pipes: ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush system in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

.2 Before start-up, clean interior of piping systems supplemented as specified in relevant mechanical sections.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Engineer 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for a longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Engineer.

.6 Pay costs for repairs or replacement, retesting, and making good. Engineer to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Engineer.

3.13 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by building personnel.

.2 Request written approval by building personnel 10 days minimum, prior to commencement of work.

.3 Contractor shall demonstrate a responsibility for damage to existing plant by this work.

3.14 CLEANING

.1 Remove surplus materials, excess materials, rubbish, tools, and equipment.

.2 Waste Management: separate waste materials for reuse and recycling.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 Common Work Results for HVAC.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Manufacturer, model number, line contents, pressure and temperature rating.

.2 Movement handled, axial, lateral, angular and the amounts of each.

.3 Nominal size and dimensions including details of construction and assembly.

1.2 CLOSEOUT SUBMITTALS

.1 Provide maintenance and operation data including servicing requirements, including special requirements, stuffing box packing, lubrication, and recommended procedures.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 SLIP TYPE EXPANSION JOINTS

.1 Application: for axial pipe movement, as indicated.

.2 Repacking: under full line pressure.

.3 Body and packing housings: Class 150, 1MPa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with [raised face [slip-on] [weld neck] flanges to match pipe] [ends for welding].

.4 Slip or traverse sleeves: carbon steel pipe to ATM A53/A53M, Grade B.

.5 Anchor base: construction steel, welded to body.

.6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.

.7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.

.8 Packing rings: 6 minimum, PTFE or graphite impregnated non-asbestos.

.9 Thermal plastic packing: PTFE or graphite impregnated non-asbestos slug supplied loose.

.10 Lubricating fittings: pet cocks with grease nipple.

.11 Plunger body and plunger:

.1 Plunger body: heavy wall carbon steel welded to body.

.2 Plunger: carbon steel with hex head for use with socket wrench.

.12 Lubricant: to manufacturer's recommendations.

.13 Lubricant gun: complete with hose assembly.

2.2 BELLOWS TYPE EXPANSION JOINTS

.1 For axial, lateral, or angular movements, as indicated.

.2 Maximum operating pressure: 1034 kPa.

.3 Maximum operating temperature: 260 degrees C.

.4 Type A: controlled, free flexing, factory tested to 1-½ times maximum working pressure. Provide test certificates.

.5 Bellows:

.1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

.6 Reinforcing or control rings:

.1 2-piece nickel iron.

.7 Ends:

.1 Raised face, flanges to match pipe.

.8 Liner:

.1 Austenitic stainless steel in direction of flow.

.9 Shroud:

.1 Carbon steel, painted.

2.3 GROOVED END EXPANSION JOINTS

.1 Packless, Gasketed, Slip, Expansion Joints:

.1 2413 kPa maximum working pressure.

.2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.

.3 PTFE modified polyphenylene sulfide coated slide section.

.4 Suitable for axial end movement to 75 mm.

.2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

2.4 FLEXIBLE CONNECTION

.3 Application: to suit motion.

.4 Minimum length in accordance with manufacturer's recommendations to suit offset.

.5 Inner hose: stainless steel corrugated.

.6 Braided wire mesh stainless steel.

.7 Diameter and type of end connection: to match pipe diameter.

.8 Operating conditions:

.1 Working pressure: 1034 kPa.

.2 Working temperature: 260 degrees C.

.3 To match system requirements.

.9 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.5 ANCHORS AND GUIDES

.1 Anchors:

.1 Provide as indicated.

.2 Alignment guides:

.1 Provide as indicated.

.2 To accommodate specified thickness of insulation.

.3 Vapour barriers, jackets to remain uninterrupted.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install expansion joints with cold setting. Make record of cold settings.

.2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.

3.3 PIPE CLEANING AND START-UP

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

3.4 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 13 - Performance Verification HVAC Systems.

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date and status.

.1 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 GENERAL

.1 Design point to be at mid-point of scale or range.

.2 Ranges: as required.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length: to CAN/CGSB-14.4 and ASME B40.200.

.1 Resistance to shock and vibration.

2.3 REMOTE READING THERMOMETERS

.1 100 mm diameter mercury-free, liquid filled activated dial type: to CAN/CGSB-14.5 and ASME B40.200, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel, phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Siphon for steam service.

.2 Snubber for pulsating operation.

.3 Diaphragm assembly for corrosive service.

.4 Gasketed pressure relief back with solid front.

.5 Bronze stop cock.

.6 Oil filled for high vibration applications.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC fan installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 GENERAL

.1 Install thermometers and gauges so they can be easily read from floor or platform.

.1 If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.3 THERMOMETERS

.1 Install in wells on piping. Include heat conductive material inside well.

.2 Install in locations [as indicated] and on inlet and outlet of:

.1 Heat exchangers.

.2 Water heating and cooling coils.

.3 Water boilers.

.4 Chillers.

.5 Cooling towers.

.6 DHW tanks.

.3 Install wells as indicated for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

3.4 PRESSURE GAUGES

.1 Install in locations as follows:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Upstream and downstream of control valves.

.4 Inlet and outlet of coils.

.5 Inlet and outlet of liquid side of heat exchangers.

.6 Outlet of boilers.

.7 In other locations as indicated.

.2 Install gauge cocks for balancing purposes and elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.5 NAMEPLATES

.1 Install engraved lamacoid nameplates in accordance with Section 23 05 53 - Identification for HVAC Piping and Equipment, identifying medium.

3.6 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

3.7 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by thermometer and gauge installation.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.1 Submit data for valves specified in this Section.

1.2 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 23 05 00 - Common Work Results for HVAC.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: One for every ten (10) valves each size, minimum one (1).

.2 Discs: One for every ten (10) valves, each size. Minimum one (1).

.3 Stem packing: One (1) for every ten (10) valves, each size. Minimum one (1).

.4 Valve handles: Two (2) of each size.

.5 Gaskets for flanges: One (1) for every ten (10) flanged joints.

.2 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

.2 Include following:

1.4 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MATERIALS

.4 Valves:

.1 Except for specialty valves, to be single manufacturer.

.2 Products to have CRN registration numbers.

.5 End Connections:

.1 Connection into adjacent piping/tubing:

.1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.

.2 Copper tube systems: solder ends or grooved ends to ANSI/ASME B16.18.

.6 Lockshield Keys:

.1 Where lockshield valves are specified, provide [10] keys of each size: malleable iron cadmium plated.

.7 Gate Valves:

.1 Requirements common to gate valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Connections: screwed with hexagonal shoulders.

.4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.

.5 Packing: non-asbestos.

.6 Handwheel: non-ferrous.

.7 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125

.1 Body: with long disc guides, screwed bonnet with stem retaining nut.

.2 Operator: Handwheel.

.3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:

.1 Body: with long disc guides, screwed bonnet with stem retaining nut.

.2 Operator: handwheel.

.4 NPS 2 and under, rising stem, split wedge disc, Class 125:

.1 Body: with long disc guides, screwed bonnet.

.2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem

.3 Operator: handwheel.

.5 NPS 2 and under, rising stem, solid wedge disc, Class 125:

.1 Body: with long disc guides, screwed bonnet.

.2 Operator: handwheel.

.6 NPS 2 and under, rising stem, solid wedge disc, Class 150:

.1 Body: with long disc guides, screwed bonnet.

.2 Operator: handwheel.

.8 Globe Valves:

.1 Requirements common to globe valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Bonnet: union with hexagonal shoulders.

.3 Connections: screwed with hexagonal shoulders.

.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.

.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.

.6 Handwheel: non-ferrous.

.7 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, composition disc, Class 125:

.1 Body and bonnet: screwed bonnet.

.2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, re-grindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: handwheel.

.3 NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, re-grindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: handwheel.

.4 NPS 2 and under, plug disc, Class 150, screwed ends:

.1 Body and bonnet: union bonnet.

.2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.

.3 Operator: handwheel.

.5 Angle valve, NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, re-grindable bronze seat, loosely secured to stem.

.3 Operator: [handwheel] [lockshield].

.9 Check Valves:

.1 Requirements common to check valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Connections: screwed with hexagonal shoulders.

.2 NPS 2 and under, swing type, bronze disc, Class 125:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: re-grindable.

.3 NPS 2 and under, swing type, bronze disc:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: re-grindable.

.4 NPS 2 and under, swing type, composition disc, Class 200:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc: renewable rotating disc of number [6] composition to suit service conditions, bronze two-piece hinge disc construction.

.5 NPS 2 and under, horizontal lift type, composition disc, Class 150:

.1 Body: with integral seat, union bonnet ring with hex shoulders, cap.

.2 Disc: renewable PTFE no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.

.6 NPS 2 and under, vertical lift type, bronze disc, Class 125:

.1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

.10 Silent Check Valves:

.1 NPS 2 and under:

.1 Body: cast high tensile bronze to ASTM B62 with integral seat

.2 Pressure rating: Class 125.

.3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders

.4 Disc and seat: renewable rotating disc.

.5 Stainless steel spring, heavy duty.

.6 Seat: re-grindable.

.11 Ball Valves:

.1 NPS 2 and under:

.1 Body and cap: cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class125, 2760-kPa CWP.

.3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders.

.4 Stem: tamperproof ball drive.

.5 Stem packing nut: external to body.

.6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.

.7 Stem seal: TFE with external packing nut.

.8 Operator: removable lever handle.

.12 Butterfly Valves:

.1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.

.1 Body: cast bronze, with copper-tube dimensioned grooved ends.

.2 Disc: elastomer coated ductile iron with integrally cast stem.

.3 Operator: handwheel.

Part 3 Execution

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Remove internal parts before soldering.

.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.2 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

1.2 CLOSEOUT SUBMITTALS

.1 Submit maintenance data for incorporation into manual specified in Section 23 05 00 - Common Work Results for HVAC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.4 Extra Materials/Spare Parts:

.5 Furnish following spare parts:

.1 Valve seats: One (1) for every then (10) valves each size, minimum one (1).

.2 Discs: One (1) for every ten (10) valves, each size, minimum one (1).

.3 Stem packing: One (1) for every ten (10) valves, each size, minimum one (1).

.4 Valve handles: Two (2) of each size.

.5 Gaskets for flanges: One (1) for every ten (10) flanged joints.

.6 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

.2 Include following:

.1 Lubricant gun for expansion joints.

Part 2 Products

2.1 MATERIAL

.7 Valves:

.1 Except for specialty valves, to be of single manufacturer.

.8 Standard specifications:

.1 Gate valves: MSS SP-70

.2 Globe valves: MSS SP-85

.3 Check valves: MSS SP-71

.9 Requirements common to valves, unless specified otherwise:

.1 Body, bonnet: cast iron to ASTM B209 Class B.

.2 Connections: flanged ends plain face with 2 mm raised face with serrated finish and grooved ends to ANSI B16.1.

.3 Inspection and pressure testing: to MSS SP-82.

.4 Bonnet gasket: non-asbestos.

.5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.

.6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.

.7 Gland packing: non-asbestos.

.8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.

.9 Identification tag: with catalogue number, size, other pertinent data.

.10 All products to have CRN registration numbers.

2.2 GATE VALVES

.11 NPS 2 1/2 - 8, non rising stem, inside screw, [bronze] [iron] trim, solid wedge disc:

.1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62.

.3 Seat rings: renewable bronze to ASTM B62, screwed into body.

.4 Stem: bronze to ASTM B62

.5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem

.6 Seat: integral with body.

.7 Stem: wrought steel.

.8 Operator: handwheel.

.9 Bypass: complete with union and gate as Section 23 05 23.01 - Valves – Bronze.

.12 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:

.1 Body and multiple-bolted bonnet: with [bosses in body and bonnet for taps and drains,] full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection

.3 Seat rings: renewable bronze screwed into body.

.4 Stem: [nickel-plated steel] [manganese-bronze].

.5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.

.6 Seat rings: integral with body.

.7 Stem: nickel-plated steel.

.8 Pressure-lubricated operating mechanism.

.9 Operator: handwheel.

.10 Bypass: complete with union and gate as Section 23 05 23.01 - Valves – Bronze.

2.3 UNDERWRITERS APPROVED GATE VALVE

.13 NPS 2 1/2 - 14, OS&Y:

.1 Approvals: UL and FM approved for fire service

.2 UL and FM Label: on valve yoke

.3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B), ductile iron to ASTM A536 Grade 65-45-12.

.4 Bonnet bushing, yoke sleeve: bronze, to FM requirements

.5 Packing gland: bronze.

.6 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass, ASTM B16.

.7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B)

.8 Bosses for bypass valve, drain on NPS 4 and over.

.9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.

.10 Disc seat ring: self-aligning, Millwood undercut on NPS 3 - 12.

.11 Pressure rating:

.1 NPS 2-1/2 - 12: 1.7 Ma CWP.

.2 NPS 14-1.2: 1.2 MPa CWP.

.12 Operator: handwheel.

.13 Bypass: complete with union and gate valve as Section 23 05 23.01 - Valves – Bronze.

2.4 GLOBE VALVES

.1 NPS 2 1/2 - 10, OSY:

.1 Body: with multiple-bolted bonnet.

.2 WP: 860 kPa steam, 1.4 MPa CWP.

.3 Bonnet-yoke gasket: non-asbestos.

.4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc

.5 Seat ring: renewable, re-grindable, screwed into body.

.6 Stem: bronze to ASTM B62

.7 Operator: handwheel.

.8 Bypass: complete with union and gate valve as Section 23 05 23.01 - Valves – Bronze.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

.1 Locations: on valves as indicated.

.2 Size of bypass valve:

.1 Main valve up to NPS 8: NPS 3/4.

.2 Main valve NPS 10 and over: NPS 1.

.3 Type of bypass valves:

.1 On gate valve: globe, with composition bronze] disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

.2 On globe valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze. Pressure rating to match main valve.

2.6 VALVE OPERATORS

.14 Install valve operators as follows:

.1 Handwheel: on valves except as specified.

.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

2.7 CHECK VALVES

.1 Swing check valves, Class 125:

.1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.

.1 Up to NPS 16: cast iron to ASTM A126 Class B.

.2 NPS 18 and over: cast iron to ASTM A126 Class C

.2 Ratings:

.1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.

.2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.

.3 NPS 18 and over: 1.03 MPa CWP.

.3 Disc: rotating for extended life.

.1 Up to NPS 6: bronze to ASTM B62.

.2 NPS 8 and over: bronze-faced cast iron.

.4 Seat rings: renewable bronze to ASTM B62 screwed into body.

.5 Hinge pin, bushings: renewable bronze to ASTM B62.

.6 Disc: A126 Class B, secured to stem, rotating for extended life.

.7 Seat: cast iron, integral with body.

.8 Hinge pin: exelloy; bushings: malleable iron.

.9 Identification tag: fastened to cover.

.10 Hinge: galvanized malleable iron.

.2 Swing check valves, NPS 2 1/2 - 8 Class 250:

.1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.

.2 Flanged ends: 2 mm raised face with serrated finish.

.3 Rating: 250 psi steam; 500 psi CWP.

.4 Disc: rotating for extended life.

.1 Up to NPS 3: bronze to ASTM B61

.2 NPS 4 - 8: iron faced with ASTM B61 bronze.

.5 Seat rings: renewable bronze to ASTM B61, screwed into body.

.6 Hinge pin, bushings: renewable, bronze to ASTM B61

.7 Hinge: galvanized malleable iron.

.8 Identification tag: fastened to cover.

2.8 SILENT CHECK VALVES

.1 Construction:

.1 Body: ductile iron with integral seat.

.2 Pressure rating: Class 125, WP = 860 kPa.

.3 Connections: grooved ends.

.4 Disc: bronze renewable rotating disc.

.5 Seat: renewable, EPDM.

.6 Stainless steel spring, heavy duty.

Part 3 Execution

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

3.2 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit data for valves specified in this section.

.1 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date and status.

1.2 CLOSEOUT SUBMITTALS

.1 Submit maintenance data for incorporation into manual specified in Section 23 05 00 - Common Work Results for HVAC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.3 Extra Materials/Spare Parts:

.4 Furnish following spare parts:

.1 Valve seats: One (1) for every ten (10) valves each size, minimum one (1).

.2 Discs: One (1) for every ten (10) valves, each size, minimum one (1).

.3 Stem packing: One (1) for every ten (10) valves, each size, minimum one (1).

.4 Valve handles: Two (2) of each size.

.5 Gaskets for flanges: One (1) for every ten (10) flanged joints.

.5 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

.2 Include following:

.1 Lubricant gun for expansion joints.

Part 2 Products

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSI2G

.1 Except to specialty valves, to be of single manufacturer.

.2 To be suitable for dead-end service.

.3 CRN registration number required for products.

.4 Sizes:

.1 Lug type: NPS 2 to 30.

.2 Grooved end type: NPS 2 to 12.

.5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.

.1 NPS 2 - 12: 200 psig.

.2 NPS 14 - 48: 200 psig.

.6 Minimum seat temperature ratings to 35] degrees C.

.7 Application: on-off operation.

.8 Full lug body (threaded) or grooved ends.

.9 Operators:

.1 NPS 2 - 6: handles which are capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black lacquer.

.10 Designed to comply with MSS SP-67 and API 609

.11 Compatible with ANSI Class 125/Class 150 flanges

.12 Construction:

.1 Body ductile iron.

.2 Disc: aluminum bronze.

.3 Seat: EPDM.

.4 Shaft: 316 stainless steel.

.5 Taper pin: 316 SS.

.6 Key: stainless].

.7 O-Ring: EPDM.

.8 Bushings: Teflon.

2.2 MOUNTING FLANGES

.1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges

2.3 PNEUMATIC ACTUATORS

.1 Operation: rack and pinion to provide linear torque-stroke proportion in compact package.

.1 Select torque to suit application. Refer to manufacturer's data sheets.

.2 Housing and end caps: hard anodized aluminum, complete with guide and Delrin wear pads for long service life.

.3 Actuators internally lubricated to ensure long service life.

.2 Operators:

.1 Double-acting pneumatic actuator using compressed air to energize actuator in both directions.

.2 Spring-return fail-safe pneumatic actuator using compressed air to energize actuator in one direction. Use compressed air to compress steel springs within actuator mechanism. Use energy stored in these compressed springs to return actuator to original position at which time air pressure is released.

.3 Pneumatic actuator to be convertible to spring return operation.

.4 Steel travel stop adjuster to allow for maximum turning angle of 95 degrees.

2.4 ELECTRIC ACTUATORS

.1 Operation: designed to provide precise quarter turn electric operation.

.1 Torque range: up to 1.130 N-m and speed ranges from 10 seconds to 30 seconds to move from fully open to fully closed.

.2 Gear train within actuator to provide smooth continuous rotary power stroke for accurate automatic valve positioning. Factory-set, field adjustable cam-actuated travel limit switches to provide precise control of shaft rotation.

.2 Construction:

.1 Castings: heavy duty industrial grade for rugged use.

.2 Actuators: continuous duty with high efficiency single phase reversing capacitor motor with thermal overload protection.

.3 Gears and pinions constructed from hardened steel.

.4 Gear train to be permanently lubricated.

.5 Mechanical brake to ensure that gear is locked in precise position.

.3 Electrical:

.1 Standard voltage: 120 VAC. 60 Hz.

.2 Control options: 4-20 Ma DC or 0-10 V DC.

.3 CSA approved.

.4 Electrical rating: NEMA IV

Part 3 Execution

3.1 PREPARATION

.1 Valve and mating flange preparation.

- .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
- .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
- .3 Install butterfly valves with disc in almost closed position.
- .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

.1 Install in accordance with manufacturer's instructions.

.2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.

.3 Verify suitability of valve for application by inspection of identification tag.

.4 Mount actuator on to valve prior to installation.

.5 Handle valve with care so as to prevent damage to disc and seat faces.

.6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.

.7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

.1 Air hoses or electrical connections to be made by actuator manufacturer.

.2 Cycle valve operation from fully closed to fully open then back to fully closed.

.3 At same time, check travel stop settings for proper disc alignment.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

1.2 CLOSEOUT SUBMITTALS

.6 Provide maintenance data for incorporation into manual in accordance with Section 23 05 00 - Common Work Results for HVAC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:

.1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts, and assemblies.

.2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1

.3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

.4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.

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

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP58 and ANSI B31.1.

.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: [galvanized] [painted with zinc-rich paint] after manufacture.

.2 Use [electro-plating galvanizing process] [hot dipped galvanizing process].

.3 Ensure steel hangers in contact with copper piping are [copper plated] [epoxy coated].

.2 Upper attachment structural: suspension from lower flange of I-Beam:

.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut, and carbon steel retaining clip.

.2 Rod: 9 mm UL listed.

.3 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed MSS-SP58 andMSS-SP69.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.

.2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete inserts: wedge shaped body with knockout protector plate UL listed MSS SP69.

.5 Shop and field-fabricated assemblies:

.1 Trapeze hanger assemblies:

.2 Steel brackets:

.6 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Do not use 22 mm or 28 mm rod.

.7 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel [black] [galvanized].

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.8 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivets, to insulation shields.

.9 Yoke style pipe roll: carbon steel yoke, rod, and nuts with cast iron roll, to MSS SP69.

.10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: black.

.2 Finishes for copper, glass, brass, or aluminum pipework: black.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height, and provided with Certified Mill Test Report (CMTR)

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with [2] springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. [Provide certificate of calibration for each hanger].

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height, and provided with CMTR

2.8 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Submit calculations with shop drawings.

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

2.11 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel.

.2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to industry standards.

.3 Steel pipes: install below coupling or shear lugs welded to pipe.

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

.1 Attach to concrete with four (4) minimum concrete inserts, one (1) at each corner.

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

.6 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 13 mm or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.7 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

.1 Plumbing piping: to the Ontario Building Code and the authority having jurisdiction.

.2 Fire protection: to applicable fire code.

.3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.6 Within 300 mm of each elbow.

.7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

.3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

.1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

.2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:

.1 Ensure that rod is vertical under operating conditions.

.2 Equalize loads.

.2 Adjustable clevis:

.1 Tighten hanger load nut securely to ensure proper hanger performance.

.2 Tighten upper nut after adjustment.

.3 C-clamps:

.1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:

.1 Hammer jaw firmly against underside of beam.

3.7 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work.

3.8 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-latest edition, Standard for the Installation of Sprinkler Systems.

.3 National Building Code of Canada (NBC) - latest edition

1.3 SUBMITTALS

.1 Submittals: in accordance with Section 23 05 00 - Common Work Results for HVAC.

.1 Submit manufacturer's printed product literature, specifications, and datasheet in accordance with Section 23 05 00 - Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01.

.2 Submit shop drawings in accordance with Section 23 05 00 - Common Work Results for HVAC.

.1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.2 Provide separate shop drawings for each isolated system complete with performance and product data.

.3 Provide detailed drawings of seismic control measures for equipment and piping.

.3 Quality assurance submittals: submit following in accordance with Section 23 05 00 - Common Work Results for HVAC.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Consultant will make available 1 copy of systems supplier's installation instructions.

.3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 23 05 00 - Common Work Results for HVAC.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic specialties from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MANUFACTURER

.1 Shock Response System analysis and system from one manufacturer regularly engaged in Vibration Isolation production.

.2 Coordinate with acoustic and vibration consultant for vibration isolation/seismic design and products.

.3 The supplier of the vibration isolators should provide shop drawings that include calculations showing compliance with the above specification. For equipment with variable frequency drives, the above requirements should be met based on the lowest anticipated operating speed of the equipment.

2.2 GENERAL

.1 All equipment isolation mounts shall be chosen on the basis of achieving at least 98% vibration isolation efficiency at the lowest operating speed. That is, the natural frequency of each vibration isolation system shall be no higher than 1/10 of the lowest excitation frequency of rotating machinery, whenever practicable, but in no case greater than 1/7. Where structural support (floor or roof, etc.) deflection will exceed 1/10 of the determined static deflection of the isolator, increase the isolator static deflection to maintain a minimum ratio of isolator deflection to floor deflection of 10:1. Static deflections shown on the drawings, specifications, or schedules are a guide only. Required natural frequencies and static deflections are to be determined, in accordance with the above relationships, based on actual excitation frequencies and other characteristics of final equipment selection. Selected vibration isolation mounts are to achieve the required static deflection under load,

with at least 50% reserve deflection. Submit shop drawings identifying equipment, lowest operating speed, weight, brand, type, and location of isolators prior to ordering or fabrication.

.2 Vibration isolation products are to be in accordance with the drawing schedule and details, and as specified below.

.3 Springs: All springs are to be stable, colour coded, selected to operate at no greater than ⅔ solid load, designed in accordance with the Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with the manufacturer's recommendations to suit the static deflection and maximum equipment load.

.4 Finishes: All steel components of isolation products not exposed to the weather or moisture are to be zinc plated. All steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and two coats of neoprene.

.5 Where the weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.

.6 Acceptable Products are:

.1 Vibro-Acoustics Ltd. Type FS

.2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type A

.3 Kinetics Noise Control Vibron Products Group Type FDS

.4 Mason Industries Inc. Type SLFH

.5 J. P. Environmental Products Inc. Type TSO

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 FLEXIBLE CONNECTORS

.1 Rubber Expansion Joints – Type EJN2-CR (c/w control rods):

.1 Temperature Range: -6°C to 148°C

.2 Safety Factor: 3 to 1

.3 Double sphere neoprene flexible connector with flanges.

.4 Synthetic rubber tube and cover construction, molded and cured in hydraulic presses. Rubber expansion joints shall be reinforced with multi-ply Nylon tire cord fabric. Internal reinforcing of metal wire or embedded rings are not acceptable.

.5 Rubber expansion joints shall either be double sphere c/w a factory installed steel body ring between the two spheres to control ballooning under high pressure/temperature situations.

.6 Rubber expansion joints for pipe sizes 1-1/2" and up will have floating steel flanges. The mating surface will be 100% rubber.

.7 For sizes 3/4" up to 3", threaded female union connectors are also accepted.

.8 Control rods shall be installed to prevent excessive elongation where required.

.1 Control rods shall utilize 1/4" thick neoprene grommets to limit vibration transfer.

.9 Install rubber expansion joints on inlet/outlets to the pumps and/or as indicated on drawings.

.10 Size to match line size.

.2 Braided Metal Flexible Connectors:

.1 Flexible connector with T-321 stainless steel hose and T-304 stainless steel braid with 150# carbon steel plate flanges.

.2 Corrugated 300 series stainless steel bellows or bronze bellows flexible connectors with stainless steel or bronze braiding connected to braid collars and pipe fittings at each end.

.3 Reducing sizes shall be available with combinations of all end fittings.

.4 Install braided metal flexible connectors on all connections to cooling tower, dry cooler unit and/or as indicated on drawings.

.1 Type FCB-SW – Flexible connector with bronze hose and bronze braid with copper female sweat ends

.2 Type FCB-CM – Flexible connector with bronze hose and bronze braid with copper hex male NPT ends

.3 Type FCSS-FL – Flexible connector with T-321 stainless steel hose and T-304 stainless steel braid with 150# carbon steel plate flanges

.4 Type FCSS-SM – Flexible connector with T-321 stainless steel hose and T-304 stainless steel braid with schedule 40 carbon steel male NPT ends

.5 Type FCSS-SW – Flexible connector with T-321 stainless steel hose and T-304 stainless steel braid with copper female sweat ends

.6 Type FCSS-GR – Flexible connector with T-321 stainless steel hose and T-304 stainless steel braid with schedule 40 carbon steel groove fittings

.7 Type FCSS-GRFL – Flexible connector with T-321 stainless steel hose and T-304 stainless steel braid with 150# carbon steel plate flange on one end, schedule 40 carbon steel groove fitting on other end.

.3 Thermal Expansion Compensators – Type TEC

.1 Thermal expansion compensators, constructed with two–ply series 300 stainless steel bellows and carbon steel shroud, internal liner and end fittings.

.2 Expansion compensators shall utilize anti-torque, anti-squirm device.

.3 The thermal expansion compensators shall be rated for a minimum of 1,378 kPa working pressure and axial movements of 1-3/4" compression and 1/4" extension.

In all applications, the compensator shall provide a minimum of 150% expected growth between anchors. Longer variations shall provide 3" compression and 1" extension.

.4 Expansion compensator ends shall match piping to allow for flanged, welded, grooved or copper sweat connections.

.4 Spider Pipe Guides - Type SPG

.1 Standard concentric spider type pipe alignment guides with heavy steel construction.

.2 Pipe guides shall be of sufficient strength to withstand lateral forces equal to 15% of pipe anchor loads.

.3 Spider pipe guides shall provide space for specified insulation thickness and are rated for a minimum of 4 inches of axial movement.

.4 For copper piping installations, dielectric spacers shall be furnished to prevent galvanic corrosion.

2.5 VIBRATION ISOLATION NEOPRENE PADS

.1 Minimum 7/8" (22 mm) thickness molded from high strength neoprene compound at minimum 2,750 psi (19 MPa) tensile strength.

.2 Pads shall be color coded for capacity and sized to deflect 20% of the overall height at 0.18" (4.5 mm). Maximum allowable deflection is 25% of the overall height at 0.22" (5.5 mm).

.3 Pads shall allow for up to 5/8" hex head nuts or anchor bolts when anchored through with a clamping nut and up to 1" anchor bolts when anchored through without a clamping nut, without having to make holes that alter published load vs. deflection performance.

.4 All pads shall be complete with steel load distribution plate and anchor cutouts.

2.6 ISOLATORS

.1 Type NSN - Vibration Isolation Neoprene Pads

.1 Minimum 7/8" (22 mm) thickness molded from high strength neoprene compound at minimum 2,750 psi (19 MPa) tensile strength.

.2 Pads shall be color coded for capacity and sized to deflect 20% of the overall height at 0.18" (4.5 mm). Maximum allowable deflection is 25% of the overall height at 0.22" (5.5 mm).

.3 Pads shall allow for up to 5/8" hex head nuts or anchor bolts when anchored through with a clamping nut and up to 1" anchor bolts when anchored through without a clamping nut, without having to make holes that alter published load vs. deflection performance.

.4 All pads shall be complete with steel load distribution plate and anchor cutouts.

.2 Type FS – Free Spring Floor Mounted Isolators

.1 Free-standing, laterally stable, unhoused spring isolators with components for leveling and securing equipment.

.2 Springs shall be supported with a neoprene cup with a steel insert.

.3 Type FST - Free Spring Floor Mounted Isolators

.1 Same as Type FS with the addition of an equipment support top plate with up to 4" static deflection where needed.

.4 Type CM - Closed Mount Spring Isolators

.1 Floor mounted spring isolators with telescoping housings and bolts for leveling and securing equipment.

.2 Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 1/4" (6 mm) thick, bonded to the base plate.

.3 Housings shall incorporate neoprene stabilizers to minimize short circuiting and provide vertical damping.

.5 Type SFS - Seismically Restrained Spring Floor Mounts

.1 Laterally stable, restrained spring type with vertical stud for bolting to the equipment. Springs shall be supported with a neoprene cup.

.2 Mount shall include an integral all-directional limit stop with an elastomeric grommet preventing metal-to-metal contact and with minimum 1/4" clearance under normal operation.

.6 Type SCR - Restrained Spring Floor Mounted Isolators

1. Laterally stable, vertically restrained spring isolators with welded steel housings and heavy top plates for supporting equipment. Springs shall be supported with a neoprene cup with a steel insert.
2. Housings shall include vertically restraining limit stops. The minimum clearance between metal components before metal to rubber contact is made shall be 1/4" (6 mm). The top plate and restraining bolts shall be out of contact with the housing during normal operation, and neoprene grommets shall be incorporated to eliminate metal to metal contact.

.7 Type SCSR - Seismic/Wind Restrained Spring Isolator

.1 Laterally stable, restrained spring type with housings and heavy top plates for supporting the equipment and resisting seismic and wind loading.

.2 Housings shall be of welded high grade steel construction and include all-directional high strength limit bolts.

.3 Maximum clearance around the restraining bolts shall be 1/4" (6 mm).

.4 The top plate and restraining bolts shall be out of contact with the housing during normal operation, and all directional snubbers shall be incorporated to minimize short-circuiting of restraining bolts.

.5 Isolators shall have a static deflection of up to 4" as needed. The isolator shall be furnished with factory installed oversized base plate for anchor load distribution purposes where required.

.6 Seismic allowable load capacities shall be determined through third party testing per ANSI/ASHRAE Standard 171, and test reports will be available by the manufacturer upon request.

.8 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

.9 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.10 Cadmium plate for outdoor 100% relative humidity installations.

.11 Colour code springs.

2.7 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.1 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

.2 Performance: as indicated.

2.8 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal-to-metal contact.

.2 Neoprene Hangers

.1 Type NH - Neoprene Hangers

.1 Double-deflection neoprene hanger isolators, each with an integral neoprene sleeve between hanger rod and housing.

.2 The neoprene element shall be color-coded to help identify load capacity and should include either an internal metal washer or external as a fail-safe to prevent pull-out failure.

.3 For the capacities above 300 lbs. (1.33 kN), the neoprene elements shall include 12 extrusions to be able to provide the desired deflection at the rated load.

.4 Hangers shall be furnished with vertical uplift stop washers for seismically restrained equipment and distribution systems.

.3 Spring Hangers

.1 Vibration isolator hanger supports steel with springs and welded steel housings. Hangers shall be designed for a minimum of 15-degree angular misalignment from vertical before support rod contacts housing; hangers serving lightweight loads 200 lbs. (0.90 kN) and less may be exempt from this requirement.

.2 Spring hangers shall be furnished with vertical uplift stop washers for seismically restrained equipment and distribution systems.

.1 Type SH – Spring hanger isolators complete with spring, compression cup, and neoprene acoustic washer.

.2 Type SHR – Combination spring and neoprene hanger isolators complete with spring, compression cup, and neoprene “double-deflection” element at top of hanger.

.3 Type SHB – Spring hanger isolators with elastomeric bottom cup complete with spring, compression cup, and neoprene cup under spring.

.4 Type SHRB – Combination spring and neoprene hanger isolators with elastomeric bottom cup complete with spring, compression cup, neoprene “double-deflection” element at top of hanger, and neoprene cup under the spring.

.5 Type PSH – Pre-compressed spring hanger isolators complete with spring, compression cup, and hardware to compress spring. Springs shall be pre-compressed to 2/3 rated load.

.6 Type PSHR – Pre-compressed combination spring and neoprene hanger isolators complete with spring, compression cup, neoprene “double-deflection” element at top of hanger, and hardware to compress spring. Springs shall be pre-compressed to 2/3 rated load.

.7 Type PSHB – Pre-compressed spring hanger isolators with elastomeric bottom cup complete with spring, compression cup, neoprene cup under spring, and hardware to compress spring. Springs shall be pre-compressed to 2/3 rated load.

.8 Type PSHRB – Pre-compressed combination spring and neoprene hanger isolators with elastomeric bottom cup complete with spring, compression cup, neoprene “double-deflection” element at top of hanger, neoprene cup under the spring, and hardware to compress spring. Springs shall be pre-compressed to 2/3 rated load.

2.9 SEISMIC INLINE PUMP STANDS

.1 Provide seismic stands for all vertical inline pumps mounted to slab.

.2 Stand shall be trapezoidal-shaped rigid support stands made of high strength, low alloy steel designed to be bolted to pipe flanges which support vertical inline pumps.

.3 Stands shall include neoprene grommet washers for anchor bolts, and shall be designed to provide adequate restraint for connected equipment to resist seismic loads.

.4 Stands shall be furnished under pump stands as a factory supplied package.

.5 All seismic allowable load capacities shall be determined through third party testing per ANSI/ASHRAE Standard 171, and test reports will be available by the manufacturer upon request.

.6 Seismic stand height shall accommodate variable height of the pump, provide custom stands as required.

2.10 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

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

2.11 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.12 STRUCTURAL BASES

.1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

.2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.

.3 Bases to clear housekeeping pads by 25 mm minimum.

2.13 INERTIA BASE

.1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gussetted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.

.2 Pump bases: "T" shaped, where applicable, to provide support for elbows.

.3 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.14 ROOF CURB ISOLATION RAILS

.1 General: complete factory assembled without need for sub-base.

.2 Lower member: continuous rectangular steel tube.

.3 Upper member: continuous rectangular steel tube to provide continuous support for equipment, complete with all-directional neoprene snubber bushings 6 mm thick to resist wind and seismic forces.

.4 Springs: steel, adjustable, removable, selected for 25 mm maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.

.5 High frequency isolation: 6 mm minimum thick continuous gasket on top and bottom of complete assembly or pads on top and bottom of each spring. Material: closed cell neoprene.

.6 Weatherproofing: continuous flexible counterflashing to curb and providing access to springs. Material: aluminum.

.7 Hardware: cadmium plated or galvanized.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

.1 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab.

.2 Coordinate locations and sizes of structural supports with locations of vibration isolators and seismic/wind restraints (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).

.3 Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint points that are not attached to the structure must be approved by the restraint manufacturer.

.4 All equipment isolation mounts shall be chosen on the basis of achieving at least 98% vibration isolation efficiency at the lowest operating speed. That is, the natural frequency of each vibration isolation system shall be no higher than 1/10 of the lowest excitation frequency of rotating machinery, whenever practicable, but in no case greater than 1/7.

Where structural support (floor or roof, etc.) deflection will exceed 1/10 of the determined static deflection of the isolator, increase the isolator static deflection to maintain a minimum ratio of isolator deflection to floor deflection of 10:1. Static deflections shown on the drawings, specifications, or schedules are a guide only. Required natural frequencies and static deflections are to be determined, in accordance with the above relationships, based on actual excitation frequencies and other characteristics of final equipment selection. Selected vibration isolation mounts are to achieve the required static deflection under load, with at least 50% reserve deflection. Submit shop drawings identifying equipment, lowest operating speed, weight, brand, type and location of isolators prior to ordering or fabrication.

3.3 VIBRATION ISOLATION

.1 Block and shim all bases level so that all ductwork, piping and electrical connections can be made to a rigid system at the proper operating level, before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.

.2 Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall be large enough to ensure adequate edge distance for isolator anchors.

.3 Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.

.4 Mount fans, as indicated on the drawings, on structural steel vibration bases common to both fan and motor. There shall be a minimum operating clearance of 1” (25 mm) between steel bases and the structure.

.5 Mount pumps and equipment, as indicated on the drawings, on concrete-filled inertia bases. Concrete in-fill shall be supplied by the installing contractor on site.

.6 Extent of Piping Isolation:

.1 Isolate all piping larger than 1” (25 mm) dia. rigidly connected to vibration isolated equipment with 1” (25 mm) static deflection spring hangers at spacing intervals in accordance with the following:

.2

Pipe Diameter	**Distance from Vibrating Equipment**
1-1/4” to 4"	50'
6" and 8"	60'
10" and larger	70'
Pipe Diameter	**Distance from Vibrating Equipment**
32 mm to 100 mm	15 m
150 mm and 200 mm	18 m
250 mm and larger	21 m

.3 Chilled, Condenser, and Domestic Cold and Hot Water Piping:

.1 Horizontal: Pipe stand floor supports shall be supported on Type CSR isolators. Suspended piping shall be supported with Type SHR isolators. The first 3 isolators shall have the same minimum static deflection as the equipment isolators, with a maximum of 2" (50 mm). The remaining isolators shall have a minimum 1" (25 mm) static deflection.

.2 Vertical: Piping shall be isolated from the supporting members or structure with Type FS, FST or SHR isolators with a minimum 1" (25 mm) static deflection.

.4 Spring hanger isolators shall be cut into the hanger rods and installed after the system is filled. Alternatively, provisions must be made to ensure piping does not change height during installation and start-up.

.5 Piping attached to isolated equipment with flexible connections or to air handling units with internal vibration isolators meeting the requirements of these specifications is exempt from these requirements.

.7 Extent of Ductwork Isolation:

.1 Isolate all ductwork that is rigidly connected to isolated equipment for a minimum distance of 50 feet from the equipment. Ductwork attached to isolated equipment with flexible connections or to air handling units with internal vibration isolators is exempt from these requirements.

.2 Suspended ductwork shall be supported with Type SHRB isolators with a minimum 1" (25 mm) static deflection.

.3 Floor-supported ductwork shall be isolated from the structure with Type FS or FST isolators with minimum 1" (25 mm) static deflection.

.8 Engine-generator set silencers and associated exhaust piping shall be supported with Type SHR isolators with a minimum 1-1/2" (40 mm) static deflection.

.9 Equipment Isolation as per table below:

Equipment Vibration Isolation Schedule

Equipment Type	Min. Quantity of Isolator	Connectors	Base Type	Isolator Type	Equipment Installation	Static Deflection	Notes
AHU/MUA	Full Extend of Base Supports	Flex-Connector	Direct Isolation	CM	Floor Mounted	4in	1,2
Fan Coil	Full Extend of Base Supports	S.S. Braided Line	Direct Isolation	NSN	Floor Mounted	0.1in	

Equipment Vibration Isolation Schedule							
Equipment Type	**Min. Quantity of Isolator**	**Connectors**	**Base Type**	**Isolator Type**	**Equipment Installation**	**Static Deflection**	**Notes**
Fan Coil (<2 ton)	4	S.S. Braided Line	Direct Isolation	NH	Ceiling Hung		
Fan Coil (>2.5ton)	4	S.S. Braided Line	Direct Isolation	SH	Ceiling Hung	1in	
Boiler	4	N/A	Direct Isolation	NSN	Floor Mounted	0.1 in	6
Air Cooled Chiller	4	EJN2-CR	Direct Isolation	SCR	Floor Mounted	2 in	1,5
Water/Refrigerant Cooled Chiller	6 to 8	EJN2-CR	Direct Isolation	SCR	Floor Mounted (inertia base required unless a floating floor is provided)	3 in	4
Air Cooled Condenser	4 to 6	FCFF-FL	Direct Isolation	SCR	Floor Mounted	2 in	1,5
Cooling Tower	4 to 6	FCFF-FL	Direct Isolation	SCR	Floor Mounted	4 in	1,5
Dry Cooler	8 to 10	FCFF-FL	Direct Isolation	SCR	Floor Mounted	2 in	1,5
Unit Heater	2 to 4	S.S. Braided Line	Direct Isolation	SH	Ceiling Hung	1in	
Heat Exchanger	4	N/A	Direct Isolation	NSN	Floor Mounted	0.2 in	6
Tanks	4	N/A	Direct Isolation	NSN	Floor Mounted	0.2 in	6
Inline Pump (2-10HP)	2 to 4	EJN2-CR	(Seismic) Inline Pump Stands	CM	Ceiling Hung	1 in	
Base Mounted Pump	2 to 4	EJN2-CR	Steel frame provided by manufacturer	CM	Floor Mounted	1 in	4
Inline Pump (>10HP)	2 to 4	EJN2-CR	(Seismic) Inline Pump Stands	CM	Ceiling Hung	2 in	

Equipment Vibration Isolation Schedule							
Equipment Type	**Min. Quantity of Isolator**	**Connectors**	**Base Type**	**Isolator Type**	**Equipment Installation**	**Static Deflection**	**Notes**
Pump Skid (DCW, non-potable, etc.)	6 to 8	EJN2-CR	(Seismic) Inline Pump Stands	CM	Floor Mounted	2 in	4
Vertical Inline Pump (>50Hp)	4	EJN2-CR	(Seismic) Inline Pump Stands	SCR	Floor Mounted	3 in	4
Vertical Inline Pump (10-49Hp)	4	EJN2-CR	(Seismic) Inline Pump Stands	CM	Floor Mounted	2 in	4
Vertical Inline Pump (2-8Hp)	4	EJN2-CR	Inline Pump Stands	CM	Floor Mounted	1 in	4
Vertical Inline Pump (<1Hp)	4	EJN2-CR	(Seismic) Inline Pump Stands	CM	Floor Mounted	1 in	
Energy Recovery Ventilator	4	Flex-Connector	Direct Isolation	SH	Ceiling Suspended	1 in	2
Fan (<1HP)	4	Flex-Connector	Direct Isolation	NH	Ceiling Suspended		3
Fan (>1 and <15HP)	4	Flex-Connector	Direct Isolation	SH	Ceiling Suspended	1 in	
Fan (15HP-50HP)	4	Flex-Connector	Direct Isolation	SH	Ceiling Suspended	2 in	
Fan (> 50HP)	4	Flex-Connector	Direct Isolation	SCSR	Base Mounted	3 in	4
Piping as per specifications	N/A	N/A	Direct Isolation	SH-1N/2N	Ceiling Suspended	1 or 2 in	

1. Provide structural base if equipment is not suitable for direct isolation
2. No additional isolation required if unit is internally isolated
3. No additional isolation required if unit comes with rubber-in-shear grommets
4. Equipment assembly to be supported on inertia bases (Type B3)
5. Wind load calculation/restraints should be included for outdoor located equipment
6. Multiple layers

3.4 INSTALLATION

.1 Seismic control measures to meet requirements of NBC.

.2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.

.3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first four (4) points of support. NPS10 and Over: first 6 points of support.

.2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.5 Where isolation is bolted to floor use vibration isolation rubber washers.

.6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.5 CONCRETE ANCHOR BOLTS

.1 Identify the position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre- or post-tensioned tendons, electrical and telecommunications conduit, and gas lines.

.2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

.3 Install neoprene grommet washers on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 1/8" (3.2 mm).

.4 Mechanical Anchors: Protect threads from damage during anchor installation.

.1 Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

.5 Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

.6 Set anchors to manufacturer's recommended torque, using a torque wrench.

3.6 PIPING SYSTEMS

.1 Exemptions: Follow exemptions on applicable building codes.

.2 Restraint spacing:

.1 For ductile piping, space lateral supports a maximum of 40' (12 m) o.c., and longitudinal supports a maximum of 80' (24 m) o.c.

.2 For non-ductile piping (e.g., cast iron, PVC) space lateral supports a maximum of 20' (6 m) o.c., and longitudinal supports a maximum of 40' (12 m) o.c.

.3 For piping with hazardous material inside (e.g., natural gas, medical gas) space lateral supports a maximum of 20' (6 m) o.c., and longitudinal supports a maximum of 40' (12 m) o.c.

.4 For pipe risers, restrain the piping at floor penetrations using the same spacing requirements as above.

.3 Brace a change of direction longer than 12' (3.7 m).

.4 Longitudinal restraints for single pipe supports shall be attached directly to the pipe, not to the pipe hanger.

.5 For supports with multiple pipes (trapezes), secure pipes to trapeze member with clamps approved for application.

.6 Piping on roller supports shall include a second roller support located on top of the pipe at each restraint location to provide vertical restraint.

.7 Install restraint cables so they do not bend across edges of adjacent equipment or building structure.

.8 Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

.9 Install flexible piping connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

.10 Coordinate seismic restraints with thermal expansion compensators, guides, and anchor points. Thermal expansion anchor points shall be designed to accommodate seismic forces.

3.7 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Arrange with the manufacturer’s representative to review the work of this Section and submit written reports to verify compliance with Contract Documents.

.1 After installation, arrange and pay for the vibration isolation product manufacturer, or representative, to visit the site to verify that the vibration isolation systems are installed and operating properly, and shall submit a

certificate so stating. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

.2 After installation, arrange and pay for the seismic restraint product manufacturer, or representative, to visit the site to verify that the seismic and wind restraint systems are installed properly, and shall submit a certificate so stating.

.2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

.1 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Engineer within 3 days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with the written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.2 Take vibration measurements for equipment as indicated.

.3 Provide Engineer with minimum 5 business days' notice in advance of commencement of tests.

.4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.5 Submit complete report of test results including sound curves.

.3 Verification requirements in accordance with Division 01, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.8 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheets. Include product characteristics, performance criteria, and limitations.

.2 Submittals: in accordance with Section 23 05 00 Common Work Results for HVAC.

.2 Product data to include paint colour chips, other products specified in this section.

.3 Samples:

.1 Submit samples for approval.

.2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling, and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Waste Management and Disposal: separate waste materials for reuse and recycling.

.2 Dispose of unused paint and coating material at official hazardous material collections site approved by the authority having jurisdiction.

.3 Do not dispose of unused paint and coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

.1 3 mm thick [laminated plastic] [or] [white anodized aluminum], matte finish, with square corners, letters accurately aligned, and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of twenty-five (25) letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size # 5.

.2 Equipment in Mechanical Rooms: use size # 9.

.5 Identification for PSPC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

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

.3 Before starting work, obtain written approval of identification system from consultant.

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1 and authority having jurisdiction.

.2 Propane gas: to CSA/CGA B149.1 and authority having jurisdiction.

.3 Sprinklers: to NFPA 13.

.4 Standpipe and hose systems: to NFPA 14.

2.5 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3except where specified otherwise

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

.2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.

.3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:

.1 To full circumference of pipe or insulation.

.2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:

.1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.

.2 Other pipes: pressure sensitive [plastic-coated cloth] [vinyl] with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from the Consultant.

.2 Colours for legends, arrows: to following table:

Background colour	Legend, arrows
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Raw water	Green	RAW WATER
River water	Green	RIVER WATER
Sea water	Green	SEA WATER
City water	Green	CITY WATER
Treated water	Green	TREATED WATER
Brine	Green	BRINE

Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
High temp HW Heating supply	Yellow	HTHW HTG. SUPPLY++
High temp HW Heating return	Yellow	HTHW HTG. RETURN++
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR
Steam [_____] kPa	Yellow	[_____] kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Continuous blow-off	Yellow	CONT. BLOW-OFF
Chilled drinking water	Green	CH. DRINK WTR
Drinking water return	Green	CH. DRINK WTR. CIRC
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold-water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Contaminated lab waste	Yellow	CONT. LAB WASTE
Acid waste	Yellow	ACID WASTE (add source)
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
No. [_____] fuel oil suction	Yellow	# [_____] FUEL OIL
No. [_____] fuel oil return	Yellow	# [_____] FUEL OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Lubricating oil	Yellow	LUB. OIL
Hydraulic oil	Yellow	HYDRAULIC OIL
Gasoline	Yellow	GASOLINE
Natural gas	to Codes	
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Demineralized water	Green	DEMIN. WATER
Chlorine	Yellow	CHLORINE
Nitrogen	Yellow	NITROGEN
Oxygen	Yellow	OXYGEN
Compressed air (<700kPa)	Green	COMP. AIR [_____] kPa
Compressed air (>700kPa)	Yellow	COMP. AIR [_____] kPa
Vacuum	Green	VACUUM

Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS
Carbon dioxide	Red	CO2
Instrument air	Green	INSTRUMENT AIR

2.6 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure stark contrast.

2.7 VALVES, CONTROLLERS

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.8 CONTROLS COMPONENTS IDENTIFICATION

.1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.

.2 Inscriptions to include function and (where appropriate) fail-safe position.

2.9 LANGUAGE

.1 Identification in English.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

.1 Provide identification only after painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

.3 Identify systems, equipment to conform to Consutlant.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate, or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping, or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass, where directed by consultant. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section [01 33 29 - Sustainable Design Reporting], include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.8 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Engineer within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC National Standards for Total System Balance, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB) TABES Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA, HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.2 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.3 EXCEPTIONS

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

1.4 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.5 PRE-TAB REVIEW

.1 Review Contract Documents before project construction is started and confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.6 START-UP

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

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.7 OPERATION OF SYSTEMS DURING TAB

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

1.8 START OF TAB

.1 Notify Engineer 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal, and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place and clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed and 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.

1.9 APPLICATION TOLERANCES

.1 Complete the TAB to the following tolerances of design values:

.1 Other HVAC systems: plus 5 %, minus 5 %.

.2 Hydronic systems: plus or minus 10 %.

1.10 ACCURACY TOLERANCES

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

1.11 INSTRUMENTS

.1 Prior to TAB, submit to Engineer list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Engineer.

1.12 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.13 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Engineer, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.14 TAB REPORT

.1 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.2 Submit an electronic copy of TAB Report to Engineer for verification and approval.

1.15 VERIFICATION

.1 Reported results subject to verification by Engineer.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Pay costs to repeat TAB as required to satisfaction of Engineer.

1.16 SETTINGS

.1 After TAB is completed to satisfaction of Engineer, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.17 COMPLETION OF TAB

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

1.18 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section, TAB standards of AABC, NEBB, SMACNA, and ASHRAE.

.2 Do TAB of systems, equipment, components, controls specified Division 23.

.3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB, qualified to standards of AABC or NEBB.

.4 Quality assurance: perform TAB under direction of supervisor qualified by the standards of AABC or NEBB.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish, and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year, and capacity.

.2 Details of operation, servicing, and maintenance.

.3 Recommended spare parts list.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.4 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, and cleaning procedures.

1.2 QUALITY ASSURANCE

.1 Qualifications:

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC/CSA markings.

.2 Waste Management and Disposal:

.1 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612>, with factory applied vapour retarder jacket to CGSB 51-GP-52 Ma (as scheduled in PART 3 of this section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 without factory applied vapour retarder jacket to CGSB 51-GP-52 Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553

.2 Jacket: to CGSB 51-GP-52 Ma

.3 Maximum "k" factor: to ASTM C553

2.3 JACKETS

.1 Aluminum:

.1 To ASTM B209 with and without moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Stucco embossed.

.4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

.2 Stainless steel:

.1 Type: 304 for indoor installation and 316 for outdoor installation.

.2 Thickness: 0.40 mm sheet.

.3 Finish: Stucco embossed.

.4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 ULC Listed Canvas Jacket:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.

.5 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

.6 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.

.7 Contact adhesive: quick-setting.

.8 Canvas adhesive: washable.

.9 Tie wire: .5] mm stainless steel.

.10 Banding: 12 mm wide, 0.5 mm thick stainless steel.

.11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on both faces of insulation.

.12 Fasteners: 4 mm diameter pins with35 mm diameter square clips, length to suit thickness of insulation.

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.2 Apply materials in accordance with manufacturers instructions and as indicated.

.3 Use [2] layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers and supports are outside vapour retarder jacket.

.5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

Location	TIAC Code		Insulation Thickness
	Rectangular	Round	
Indoor, concealed	none	none	-
Indoor, exposed within mechanical room	CRF/1	CRD/2	25mm (1”)
Indoor, exposed elsewhere	CRF/2	CRD/3	25mm (1”)
Outdoor, exposed to precipitation	CRF/3	CRD/4	75mm (3”)
Outdoor, elsewhere	CRF/4	CRD/5	75mm (3”)

.3 All outdoor air intake ductwork from outside louvres to mixing plenum of air handling unit or to motorized damper in other systems in 50mm (2") thickness.

.4 All exhaust and relief ductwork from outside louvres back 1.5m (5 ft) upstream of motorized dampers or where there are no motorized dampers, from louvre to fan discharge in 50mm (2") thickness.

.5 Mixed air plenums in 50mm (2") thickness.

.6 Behind unused portion of louvers in 50mm (2") thickness.

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheet in in accordance with Section 23 05 00 - Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.2 Quality assurance submittals: submit manufacturer's installation instructions.

1.1 QUALITY ASSURANCE

.1 Qualifications:

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

1.2 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Place excess or unused insulation and insulation accessory materials in designated containers.

.2 Dispose of unused adhesive material at official hazardous material collections site as per municipal standards.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Maximum "k" factor: ASTM C547.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C547.

.5 TIAC Code C-1: rigid mineral fibre board, unfaced

.1 Mineral fibre: ASTM C612.

.2 Maximum "k" factor: ASTM C612.

.6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket

.1 Mineral fibre: ASTM C612.

.2 Jacket: to CGSB 51-GP-52 MA.

.3 Maximum "k" factor: ASTM C612.

.7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section)

.1 Mineral fibre: ASTM C553.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C553.

.8 TIAC Code A.6: flexible unicellular tubular elastomer

.1 Insulation:

.2 Maximum "k" factor.

.3 Certified by manufacturer free of potential stress corrosion cracking corrodents.

.9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: ASTM C533.

.2 Maximum "k" factor: ASTM C533.

.3 Design to permit periodic removal and re-installation.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C449/C449M.

.2 Hydraulic setting or Air drying on mineral wool, to ASTM C449.

2.4 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type to CAN/CGSB 51.53 with pre-formed shapes as required

.2 Colours: to match adjacent finish paint.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Pressure sensitive vinyl tape of matching colour.

.7 Covering adhesive: compatible with insulation.

.2 ABS Plastic:

.1 One-piece moulded type with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint.

.3 Minimum service temperatures: -40 degrees C.

.4 Maximum service temperature: 82 degrees C.

.5 Moisture vapour transmission: 0.012 perm.

.6 Thickness: 0.75 mm.

.7 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints

.8 Locations:

.1 For outdoor use ONLY.

.3 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.4 Stainless steel:

.1 Type: 316.

.2 Thickness: 0.25 mm.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on both faces.

.7 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

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

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed, and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Hot equipment: To TIAC code 1503-H.

.2 Cold equipment: to TIAC code 1503-C.

.2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.

.2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges, and fittings unless otherwise specified.

.2 Hot Equipment:

.1 TIAC code A-1 or C-1 with mechanical fastenings, wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC code C-2 unfaced with wire or bands and 13 mm cement precede by one layer of reinforcing mesh.

.3 Thicknesses:

Equipment	Thickness
Domestic hot water storage tanks	25 mm
Heat exchangers	50 mm

.3 Cold equipment:

.1 TIAC A-3 or C-4 with mechanical fastenings, wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC C-2 faced with vapour retardant jacket and with wire or bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 TIAC A-6 or C-4 with mechanical fastenings, wire or bands.

.4 Thicknesses: chillers (except factory insulated) 50 mm.

.4 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with jacket.

.2 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheet in in accordance with Section 23 05 00 - Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.1 Quality assurance submittals: submit manufacturer's installation instructions.

1.2 QUALITY ASSURANCE

.3 Qualifications:

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling, and unloading:

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Place excess or unused insulation and insulation accessory materials in designated containers.

.2 Dispose of unused adhesive material at official hazardous material collections site as per municipal standards.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.4 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.5 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.6 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

.2 Maximum "k" factor: to CAN/ULC-S702.

.7 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

.2 Jacket: to CGSB 51-GP-52 Ma

.3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

.8 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702 and ASTM C547.

.2 Jacket: to CGSB 51-GP-52 Ma.

.3 Maximum "k" factor: to CAN/ULC-S702 and ASTM C547.

.9 TIAC Code A-6: flexible unicellular tubular elastomer

.1 Insulation: with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52 Ma

.3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

.10 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Hydraulic setting or Air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Indoor: standard.

.2 Outdoor: UV rated material at least 0.5 mm thick.

.8 Locations:

.1 Indoor exposed installations; not required for concealed installation including return air plenums and ceiling spaces.

.2 ABS Plastic:

.1 One-piece moulded type and sheet with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint where applicable.

.3 Minimum service temperatures: -40 degrees C.

.4 Maximum service temperature: 82 degrees C.

.5 Moisture vapour transmission: 0.012 perm.

.6 Thickness: [0.75] mm.

.7 Fastenings:

.1 Solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.8 Locations:

.1 For outdoor use ONLY.

.3 Canvas:

.1 220 and 120 gm/m^2 cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.4 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 9] mm wide, 0.5mm thick at 300 mm spacing.

.5 Stainless steel:

.1 Type: 316.

.2 Thickness: 0.25 mm.

.3 Finish: stucco embossed.

.4 Joining: longitudinal and circumferential slip joints with [50] mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed, and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.2 Apply materials in accordance with manufacturer’s instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valve, primary flow measuring elements, flanges and unions at equipment.

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges, and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: Tape at 300 mm on centre.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

.1 Seals: lap seal adhesive, lagging adhesive.

.5 TIAC Code: C-2 with vapour retarder jacket.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

.1 Seals: lap seal adhesive, lagging adhesive.

.2 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp °C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over
Steam	up to 175	[A-1]	38	50	65	75	90	90
Steam, Saturated and Super heated	over 175	[A-1]	38	65	65	75	90	90
Condensate Return	60 - 94	[A-1]	25	38	38	38	38	38
Pumped Condensate return	up to 94	[A-1]	25	38	38	38	38	38
Boiler Feed Water		[A-1]	25	25	25	25	25	25
Hot Water Heating	60 - 94	[A-1]	25	38	38	38	38	38
Hot Water Heating	up to 59	[A-1]	25	25	25	25	38	38
Glycol Heating	60 - 94	[A-1]	25	38	38	38	38	38
Glycol Heating	up to 59	[A-1]	25	25	25	25	38	38
Domestic HWS		[A-1]	25	25	25	38	38	38
Chilled Water	4 - 13	[A-3]	25	25	25	25	25	25
Chilled Water or Glycol	below 4	[A-3]	25	25	38	38	38	38
Chilled Water Pump Casing		[A-3]	25	25	25	25	25	25
Condenser Water Outdoors			25	25	25	25	25	38
Condenser Water Indoors			-	-	-	-	-	-
Refrigerated Drinking Water		[A-3]	25	25	25	25	25	25
Domestic CWS		[A-3]	25	25	25	25	25	25
Domestic CWS with vapour retarder		[C-2]	25	25	25	25	25	25
Refrigerant [hot gas] [liquid] [suction]	4 - 13	[A-6]	25	25	25	25	25	25
Refrigerant [hot gas] [liquid] [suction]	below 4	[A-6]	25	25	38	38	38	38
RWL and RWP		[C-2]	25	25	25	25	25	25
Cooling Coil cond. drain		[C-2]	25	25	25	25	25	25
Diesel generator exhaust system		[A-2]	38	65	65	75	90	90

.8 Finishes:

.1 Exposed indoors: PVC jacket.

.2 Exposed in mechanical rooms: PVC jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum jacket.

.6 Finish attachments: SS bands, at 50 mm on centre. Seals: closed.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5

3.7 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

1.2 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Pump operation.

.2 Boiler and/or chiller operation.

.3 Pressure bypass open/closed.

.4 Control pressure failure.

.5 Maximum heating demand.

.6 Maximum cooling demand.

.7 Boiler and/or chiller failure.

.8 Cooling tower (and/or industrial fluid cooler) fan failure.

.9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.3 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed.

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.4 CONDENSER WATER AND HUMIDIFICATION SYSTEMS

.1 In addition to procedures specified above, perform following:

.1 Add chemicals once per week as required.

.2 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.3 Set up and adjust drip feeders, timer controls, pump strokes as required to maintain required chemical feed rates.

.4 Inject inhibitor into cooling tower sump.

1.5 GLYCOL SYSTEMS

.1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.6 STEAM SYSTEMS

.1 Performance verification:

.1 When systems are operational, perform relevant tests of steam and condensate return piping systems as specified under hydronic systems.

.2 Verify operation of components of steam system including:

.1 Steam traps by:

.2 Flash tanks.

.3 Thermostatic vents.

.3 Verify performance of condensation units, including:

.1 Pump capacity at design temperature.

.2 Controls.

.4 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.

.5 Adjust piping system as required to eliminate water hammer.

.2 Monitor system continuously until acceptance for proper operation of components including steam traps, thermostatic vents, flash tanks and condensate pumping units.

1.7 GASEOUS FUEL SYSTEMS

.1 Operation tests:

.1 Measure gas pressure at gas metre outlet and at burner manifold.

.2 Verify details of temperature and pressure compensation at meter.

.3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.

.4 Check terminals of vents for gas pressure regulators.

1.8 FUEL OIL SYSTEMS

.1 Environmental protection systems:

.1 Test oil storage tank leakage detection system using manufacturer's recommended procedures.

.2 Test spill protection and over-fill protection systems using manufacturer's recommended procedures.

.2 Fuel oil pumps:

.1 Check strainers on pump inlet, relief valve on pump outlet with discharge to oil return piping, pressure gauge on strainer inlet, pump inlet and pump discharge.

.2 Verify pump performance.

.3 Pump performance within plus 20% and minus 0% of design.

.3 Operational Tests:

.1 Timing: perform at same time as 100% and 105% boiler PV tests.

.2 Charge system and verify operation.

.3 Verify adequacy of flow rates and pressure from storage facilities to burners.

.4 Verify accurate metering of fuel to burners.

.5 For further details refer to relevant sections of Division 23.

.4 Heavy oil systems:

.1 Verify temperature of stored oil and of oil adjacent to suction pipe.

.2 Verify steam pressure at storage tank inlet.

.3 Verify complete heat tracing system for completeness, controls, operation.

.4 Verify that steam condensate is discharged to sewer after being suitably cooled.

.5 Heavy oil pumping and heating set:

.1 For test purposes and where suction lift is involved, level of oil in tank should be near empty.

.2 Measure oil pressure at strainer inlet and outlet, inlet and discharge of pumps, inlet, and outlet of heaters.

.3 Measure oil temperature at inlet and outlet of heaters.

.4 Measure steam pressure at inlet of control valve and at inlet of heaters.

.5 Verify heat exchanger performance using procedures specified Section 23 57 00 - Heat Exchangers for HVAC.

.5 Notify authorities having jurisdiction to enable witnessing of tests as required.

1.9 POTABLE WATER SYSTEMS

.1 When cleaning is completed, and system filled:

.1 Verify performance of equipment and systems as specified elsewhere in Division 23.

.2 Check for proper operation of water hammer arrestors. Run [one] outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

.3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.10 INDUSTRIAL QUALITY COMPRESSED AIR SYSTEMS

.1 Commissioning Agency: installing Contractor.

.2 Design Criteria, Design Intents: refer to Performance Verification (PV) Report Forms.

.3 Commissioning Procedures.

.1 Check operation of automatic drain valves.

.2 Bleed off measured flow rate of compressed air from receiver.

.3 Measure cumulative length of time that air compressor operates to recover pressure. Carry out test over extended period of time.

.4 Test compressor unloading systems at stages of operation. This may be performed by repeating above test at several bleed-off rates.

.5 Refrigerated air drier: perform similar checks and tests as specified for air compressor. Measure cooling air flow rate, pressure, entering and leaving ambient and compressed air temperatures.

.6 Water-cooled after-coolers: measure water flow rate, EWT, LWT, compressed air temperature, pressure drops.

1.11 MEDICAL AND/OR LABORATORY GASES SYSTEMS

.1 Refer to Section 01 91 13 - General Commissioning Requirements: Medical and Laboratory Services and Equipment.

1.12 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.

.4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.13 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank, and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 05 15 - Plumbing Specialities and Accessories.

.6 Roof drains:

.1 Refer to Section 22 05 15 - Plumbing Specialities and Accessories.

.2 Remove caps as required.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheet in accordance with Section 23 05 00 - Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling, and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Waste Management and Disposal: separate waste materials for reuse and recycling.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete [by water treatment specialist].

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least [4] weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt, and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to [maximum design] [82 degrees C minimum]. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 hours at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.8 Glycol Systems:

.1 In addition to procedures specified above perform specified procedures.

.2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202 standard.

.9 Steam Systems: in addition to general requirements as specified above, perform following:

.1 Remove internal components of steam traps until flushing and warm-up have been completed.

.2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.

.3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.

.4 Water hammer: determine source and eliminate cause.

.10 Steam boilers:

.1 Isolate boilers from piping system.

.2 Fill to normal operating level. Add cleaner. Fire to 50% of design operating steam pressure. Maintain for 24 h, during which blow down boiler every 4 hours including water columns, controls, skimmer lines and valves, test cocks, blowdown valves. Add water to return to operating level.

.3 Allow boiler to cool, then drain, flush, and inspect.

.4 Reconnect to piping system.

.5 Refill boiler with clean softened water and immediately add chemical inhibitors.

.6 Apply heat slowly and raise to normal design operating steam pressure. Maintain for 4 h.

.7 Discharge condensate from steam system to sewer for 96 hours after initial operation. During this period continue chemical treatment of boilers with inhibitors to ensure complete removal of oils, grease and millscale from steam and condensate return piping steam.

.8 Drain steam condensate until it is clean and free from suspended matter. Ensure proper operation of steam traps.

.9 Allow boiler to cool, drain, open inspection ports and wash out with clean water.

.10 If boiler is not used immediately, refill with softened water, add sodium sulphite, bring up to pressure. Test for residual sulphite.

.11 After cleaning is completed and system is filled, perform relevant start-up procedures as specified for hydronic systems:

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment.

.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.8 Repeat with water at design temperature.

.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.10 Bring system up to design temperature and pressure slowly.

.11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.12 Adjust pipe supports, hangers, springs as necessary.

.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.16 Check operation of drain valves.

.17 Adjust valve stem packings as systems settle down.

.18 Fully open balancing valves (except those that are factory-set).

.19 Check operation of over-temperature protection devices on circulating pumps.

.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for electric and electronic control system for HVAC and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground, indoors and in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect electric and electronic control systems from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 THERMOSTAT (LINE VOLTAGE-HEATING AND COOLING)

.3 Line voltage, wall-mounted thermostat with:

.1 Full load rating: 16 A at 120 V.

.2 Temperature setting range: 5 degrees C to 30 degrees C.

.3 Thermometer range: 5 degrees C to 30 degrees C.

.4 Markings in 5-degree increments.

.5 Differential temperature fixed at 1.1 degrees C.

2.2 THERMOSTAT (HEAVY-DUTY, LINE VOLTAGE, HEATING AND COOLING)

.1 Heavy-duty line voltage thermostat with:

.1 Full load rating: 16 A at 120 V.

.2 Temperature setting range: 5 degrees C to 30 degrees C.

.3 Thermometer range: 5 degrees C to 30 degrees C.

.4 Markings in 5-degree increments.

.5 Differential temperature fixed at 1.1 degrees C.

2.3 THERMOSTAT (LINE VOLTAGE, HEATING)

.1 Line voltage electric heating thermostat with:

.1 Full load rating: 22 A at 120 V.

.2 Temperature setting range: 5 degrees C to 30 degrees C.

.3 Thermometer range: 5 degrees C to 30 degrees C.

.4 Scale markings: off-5-10-15-20-25 degrees C.

2.4 THERMOSTAT (LOW VOLTAGE)

.1 Low voltage wall thermostat:

.1 For use on 24 V circuit at 1.5 A capacity.

.2 With heat anticipator adjustable 0.1 to 1.2 A.

.3 Temperature setting range: 10 degrees C to 25 degrees C.

2.5 THERMOSTAT (REMOTE BULB)

.1 Line voltage remote bulb type thermostat with:

.1 8 A rating on 120 V.

.2 3 m copper capillary tube nylon coated.

.3 Moisture and dust-resistant enclosure.

2.6 THERMOSTAT (FAN COIL)

.1 Line voltage fan coil heating-cooling thermostat with:

.1 Full load rating: 6 A at 120 V.

.2 Two rocker switches for "Heat-Off-Cool" and "Low-Medium-High" fan switching. Isolate heating and cooling circuits. "Off" switch to break power to fan and thermostat.

2.7 THERMOSTAT GUARDS

.1 Thermostat guards: lockable, clear plastic. Slots for air circulation to thermostat.

2.8 LOW LIMIT TEMPERATURE ALARM

.1 Low limit temperature alarm with:

.1 Rating: 10.2 A at 120 V, 6.5 A at 240 V.

.2 Sensing bulb and 1.5 m long capillary tube.

.3 Switching action: manual.

.4 Temperature setting range: 0 degrees C to 15 degrees C.

2.9 HIGH LIMIT TEMPERATURE ALARM

.1 High limit temperature alarm with:

.1 Rating 10 A at 120 V, 6 A at 240 V.

.2 Positive lock-out.

.3 Manual reset only after 14 degrees C drop-in temperature.

.4 Cut-out setting: 50 degrees C.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electric and electronic control systems installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Install control devices.

.2 On outside wall, mount thermostats on bracket or insulated pad [25] mm from exterior wall.

.3 Install remote sensing device and capillary tube in metallic conduit. Conduit enclosing capillary tube must not touch heater or heating cable.

3.3 CLEANING

.1 Progress Cleaning: Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.].

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Co-ordinate submittal requirements and provide submittals required by Section 23 05 00 - Common Work Results for HVAC.

.3 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
- .2 Indicate the following on manufacturers catalogue literature: valves.

.4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Instructions: submit manufacturer's installation instructions.

.7 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 23 05 00 - Common Work Results for HVAC.

1.2 DELIVERY, STORAGE AND HANDLING

.8 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal of paper, plastic, polystyrene, corrugated cardboard for recycling.
- .4 Separate for reuse and recycling and place in designated containers for steel, metal, and plastic waste.
- .5 Divert unused metal materials from landfill to metal recycling facility.

Part 2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:

- .1 NPS 1/2 to 2, screwed.
- .2 NPS2 1/2 and over, plain end.

2.2 JOINTING MATERIAL

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: non-metallic flat.

2.3 FITTINGS

.1 Steel pipe fittings, screwed, flanged, or welded:

.1 Malleable iron: screwed, banded, Class 150.

.2 Steel pipe flanges and flanged fittings: to ASME B16.5.

.3 Welding: butt-welding fittings.

.4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.

.5 Bolts and nuts: to ASME B18.2.1.

.6 Nipples: schedule 40, to ASTM A53/A53M.

2.4 VALVES

.1 Provincial Code approved, lubricated plug or ball type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

.1 Install in accordance with Section 23 05 05 - Installation of Pipework, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.

.2 Install drip points:

.1 At low points in piping system.

.2 At connections to equipment.

3.3 VALVES

.1 Install valves with stems upright or horizontal unless otherwise approved by Engineer.

.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Test system in accordance with CAN/CSA B149.1, CAN/CSA B149.2, and requirements of authorities having jurisdiction.

.2 Manufacturer's Field Services:

.1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection, and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.

.2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.

.3 Schedule site visits to review work at stages listed:

.1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.

.2 Twice during progress of work at 25% and 60% complete.

.3 Upon completion of work, after cleaning is carried out.

.3 Obtain reports within 3 days of review and submit immediately to the Engineer.

.4 Performance Verification:

.1 Refer to Section 23 08 13 - Performance Verification HVAC Systems.

3.5 ADJUSTING

.1 Purging: purge after pressure test in accordance with CAN/CSA B149.1 and/or CAN/CSA B149.2.

.2 Pre-Start-Up Inspections:

.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

.2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 CLEANING

.1 Cleaning: in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metal ducts and include product characteristics, performance criteria, physical size, finish, and limitations.

.1 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.3 Test and Evaluation Reports:

.1 Certification of Ratings:

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

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	[C]
250	[C]
125	[C]
125	[Unsealed]

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape, or combination thereof.

.3 Class C: transverse joints and connections made air tight with gaskets, sealant, tape, or combination thereof. Longitudinal seams unsealed.

.4 Unsealed seams and joints.

2.2 SEALANT

.1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

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

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows:

.1 Rectangular: standard radius: 1.5 times width of duct.

.2 Round: smooth radius, five-piece, centerline radius: 1.5 times diameter.

.3 Mitered elbows, rectangular:

.1 To 407 mm: with single thickness turning vanes.

.2 Over 407 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with [radius on branch 1.5 times width of duct, 45 degrees entry on branch.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 Full-radiused elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with NFPA and the authorities having jurisdiction.

.2 Coordinate to ensure fire stopping materials and installation does not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication, and reinforcement: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint shall be a class A seal.

2.8 STAINLESS STEEL

.1 To ASTM A480/A480M, Type 304.

.2 Finish: number 4.

.3 Thickness, fabrication, and reinforcement: to ASHRAE and SMACNA.

.4 Joints: to ASHRAE and SMACNA.

2.9 ALUMINUM

.1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication, and reinforcement: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA.

2.10 BLACK STEEL

.1 To ASTM A635/A635M.

.2 Thickness: 1.2 mm or as indicated.

.3 Fabrication: ducts and fittings to ASHRAE and SMACNA.

.4 Reinforcement: as indicated.

.5 Joints: continuous weld.

2.11 KITCHEN EXHAUST SYSTEMS

.1 Construct in accordance with NFPA 96.

.2 Material: stainless steel.

.3 Thickness: to ASHRAE and SMACNA

.4 Fabrication: to ASHRAE and SMACNA

.5 Reinforcement: to ASHRAE and SMACNA

.6 Grease filters: to Section 23 38 13 - Commercial Kitchen Hoods.

2.12 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to ASHRAE and SMACNA.

.3 Hangers: black galvanized steel angle with black galvanized steel rods to ASHRAE and SMACNA following table:

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

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp with steel plate washer.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC fan installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 GENERAL

.1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA as indicated.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct] [Ensure diffuser is fully seated.

.3 Support risers in accordance with ASHRAE, SMACNA as indicated.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing in accordance with ASHRAE and SMACNA as follows:

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

3.4 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Dishwasher exhaust.

.2 Fresh air intake.

.3 Minimum 3000 mm from duct mounted humidifier in all directions.

.4 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder or weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards hoods served.

.1 Slope header ducts down toward risers.

.4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and discharging to open funnel drain or as indicated.

3.5 KITCHEN EXHAUST SYSTEMS

.1 Install to NFPA 96 and as indicated.

3.6 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.7 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 GENERAL

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

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.

.2 Material:

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

2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks complete with safety chain.

.2 301 to 450 mm: four sash locks complete with safety chain.

.3 451 to 1000 mm: piano hinge and minimum two sash locks.

.4 Doors over 1000 mm: piano hinge and two handles operable from both sides.

.5 Hold open devices.

2.4 TURNING VANES

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

2.5 INSTRUMENT TEST

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

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

.4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

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

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

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic specialties installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

.1 Inlets and outlets to supply air units and fans.

.2 Inlets and outlets of exhaust and return air fans.

.3 As indicated.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Size:

.1 Provide in accordance with best practices.

.2 Locations:

.1 Fire and smoke dampers.

.2 Control dampers.

.3 Devices requiring maintenance.

.4 Required by code.

.5 Reheat coils.

.6 Elsewhere as indicated.

.3 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.2 For temperature readings:

.4 Turning Vanes:

.1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards

2.2 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Single thickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

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

.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside nylon end bearings.

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

2.4 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: 100 mm.

.4 Bearings: self-lubricating nylon.

.5 Linkage: shaft extension with locking quadrant.

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

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish, and limitations.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Operation and Maintenance Data: submit operation and maintenance data for [dampers] for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 MULTI-LEAF DAMPERS

.1 Opposed or parallel blade type as indicated.

.2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.

.3 Pressure fit self-lubricated bronze bearings.

.4 Linkage: plated steel tie rods, brass pivots, and plated steel brackets, complete with plated steel control rod.

.5 Performance:

.1 Leakage: in closed position less than 2% of rated air flow.

.6 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

.2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.2 DISC TYPE DAMPERS

.1 Frame: brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

.2 Disc: spin formed, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

.3 Gasket: extruded neoprene, field replaceable, with 10-year warranty.

.4 Bearings: roller self lubricated and sealed.

.5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.

.6 Performance:

.1 Leakage: in closed position less than 0.001% of rated air flow.

2.3 BACK DRAFT DAMPERS

.1 Automatic gravity operated, single] leaf, extruded aluminum construction with nylon bearings, vinyl blade seals, mill aluminum finish, with heavy gauge aluminum brackets with aluminum linkage bar.

2.4 RELIEF DAMPERS

.1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 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 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers are observable and accessible.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for fire and smoke dampers and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate the following:

.1 Fire dampers.

.2 Smoke dampers.

.3 Firestop flaps.

.4 Operators.

.5 Fusible links.

.6 Design details of break-away joints.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Operation and Maintenance Data: submit operation and maintenance data for fire and smoke dampers for incorporation into manual.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit maintenance materials in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Provide:

.1 6 fusible links of each type.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 FIRE DAMPERS

.1 Fire dampers: arrangement Type A listed and bear label of ULC, meet requirements of the Ontario Building Code, NFPA 90A, and the authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Fire dampers: provide in accordance with fire ratings as listed on architectural drawings.

.2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.

.3 Top hinged: offset single damper, round or square; interlocking guillotine type, sized to maintain full duct cross section.

.4 Fusible link actuated, weighted to close, and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.

.7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA, and install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 SMOKE DAMPERS

.1 Smoke Dampers: to be ULC or UL listed and labelled.

.2 Normally closed reverse action smoke vent (S/D-RASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link as indicated. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.

.3 Normally open smoke/seal (S/D-SSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel to provide required constant sealing pressure. Provide stainless steel negator springs with locking devices to ensure positive closure for units mounted horizontally in vertical ducts.

.4 Motorized (S/D-M): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled

.5 Electro thermal link (S/D-ETL): dual responsive fusible link which melts when subjected to local heat of 74 degrees C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

.1 Damper: similar to smoke dampers specified above.

.2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

2.4 FIRE STOP FLAPS

.1 Fire smoke flaps: ULC listed and labelled, and fire tested in accordance with CAN/ULC-S112.2.

.2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.

.3 Flaps held open with fusible link conforming to ULC-S505 and close at [74] degrees C [or as indicated].

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for fire damper installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Coordinate installation of fire stopping with general contractor.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for flexible ducts and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate:

.1 Thermal properties.

.2 Friction loss.

.3 Acoustical loss.

.4 Leakage.

.5 Fire rating.

.3 Test and Evaluation Reports:

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

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 GENERAL

.1 Factory fabricated to CAN/ULC-S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

.1 Type 1: spiral wound flexible aluminum, equal to Flexmaster Triple Lock aluminum ductwork.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

.1 Type 2: spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Thermal loss/gain: Refer to Section 23 07 13 – Duct Insulation.

2.4 NON-METALLIC - UNINSULATED

.1 Type 3: non-collapsible, coated [mineral base fabric] [aluminum foil mylar] type, mechanically bonded to, and helically supported by, external [steel] wire, as indicated.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.5 NON-METALLIC - INSULATED

.1 Type 4: non-collapsible, coated [mineral base fabric] [aluminum foil/mylar] type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Thermal loss/gain: Refer to Section 23 07 13 – Duct Insulation.

2.6 METALLIC ACOUSTIC INSULATED - MEDIUM PRESSURE

.1 Type 5: spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate and Type M vapour barrier, as indicated.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Acoustical performance: Minimum attenuation (dB/m) to following table:

	Frequency (Hz)				
Duct Diam:	**125**	**250**	**500**	**1000**	**2000**

100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

2.7 METALLIC - ACOUSTIC INSULATED - HIGH PRESSURE

.1 Type 6: spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible mineral fibre thermal insulation and encased in spiral wound flexible aluminum jacket.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Acoustical performance: minimum attenuation (dB/m) to following table:

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

2.8 NON-METALLIC - ACOUSTIC INSULATED

.1 Type 7: non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible mineral fibre acoustic insulation and encased in aluminum foil/mylar laminate and Type M vapour barrier.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

.3 Acoustical performance: Minimum attenuation (dB/m) to following table:

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

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for flexible ducts installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 DUCT INSTALLATION

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

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for [duct liners] and include product characteristics, performance criteria, physical size, finish, and limitations.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Operation and Maintenance Data: submit operation and maintenance data for duct liners for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 DUCT LINER

.1 General:

.1 Mineral Fibre duct liner: air surface coated mat facing.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A, and NFPA 90B.

.3 Fungi resistance: to ASTM C1338 and ASTM G21.

.2 Rigid:

.1 Use on flat surfaces, or where indicated.

.2 25 mm thick, to ASTM C107, Type 2, fibrous glass rigid board duct liner.

.3 Density: 48 kg/m^3minimum.

.4 Thermal resistance to be minimum:

.1 0.76 (m^2. degrees C)/W for 25 mm thickness

.2 1.15 (m^2. degrees C)/W for 38 mm thickness

.3 1.53 (m^2. degrees C)/W for 50 mm thickness

.4 For all options above: when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

.5 Maximum velocity on faced air side: 20.3] m/s.

.6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.

.3 Flexible:

.1 Use on round or oval surfaces, unless otherwise noted.

.2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.

.3 Density: 24 kg/m^3 minimum.

.4 Thermal resistance to be minimum:

.1 0.37 (m^2. degrees C)/W for 12 mm thickness

.2 0.74 (m^2. degrees C)/W for 25 mm thickness

.3 1.11 (m^2. degrees C)/W for 38 mm thickness

.4 1.41 (m^2. degrees C)/W to 50 mm thickness

.5 For all options above: when tested in accordance with ASTM C177, at 24 degrees C mean temperature

.5 Maximum velocity on coated air side: 25.4 m/s.

.6 Minimum NRC of0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

2.2 ADHESIVE

.1 Adhesive: to NFPA 90A, NFPA 90B and ASTM C916.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.

.3 Water-based fire-retardant type.

2.3 FASTENERS

.1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal] retaining clips, 32 mm square.

2.4 JOINT TAPE

.1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

.1 Meet requirements of NFPA 90A and NFPA 90B.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for duct liner installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 GENERAL

.1 Do work in accordance with SMACNA HVAC Duct Construction Standard, except as specified otherwise.

.2 Line inside of ducts where indicated.

.3 Duct dimensions, as indicated, are clear inside duct lining.

3.3 DUCT LINER

.1 Install in accordance with manufacturer's recommendations, and as follows:

.1 Fasten to interior sheet metal surface with 90% coverage of adhesive ASTM C916.

.1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.

.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres, impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.

.1 Spacing of mechanical fasteners in accordance with SMACNA HVAC Duct Construction Standard.

.2 In systems, where air velocities exceed 20.3 m/s, install galvanized sheet metal noising to leading edges of duct liner.

3.4 JOINTS

.1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:

.1 Bed tape in sealer.

.2 Apply 2 coats of sealer over tape.

.2 Replace damaged areas of liner at discretion of the Engineer.

.3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC fans and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.2 Provide:

.1 Fan performance curves showing point of operation, bhp/kW, and efficiency.

.2 Sound rating data at point of operation.

.3 Provide:

.1 Motors, sheaves, bearings, shaft details.

.2 Minimum performance achievable.

1.2 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

.2 Capacity: flow rate, static pressure, bhp/W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.

.4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

2.2 FANS GENERAL

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 For use with variable speed controllers.

.3 Sizes as indicated.

.2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment, inlet and outlet dampers and vanes and as indicated.

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

.7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.3 CENTRIFUGAL FANS

.1 Fan wheels:

.1 Welded aluminum construction.

.2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.

.3 Backward inclined] blades, as indicated.

.2 Bearings: re-greaseable bearings in a cast iron pillow block housing, rated at 200,000 hours average life.

.3 Housings:

.1 All aluminum.

2.4 CABINET FANS - GENERAL PURPOSE

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single or multiple wheels with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, direct drive with variable speed controls where indicated.

.3 Fabricate casing of corrosion resistant galvanized steel fan housing.

2.5 UTILITY SETS

.1 Characteristics and construction: for centrifugal fans.

.2 Preassemble single width centrifugal fan with removable protective hood with vents, back draft dampers, and 12 mm mesh bird screens.

.3 Provide belt driven sets with adjustable motor bed plate [and variable pitch driver sheave].

2.6 AXIAL FLOW FANS (TUBE-AXIAL OR VANE-AXIAL)

.1 Casings: welded steel with welded motor support, hinged access plates, streamlined inlet cone and discharge bell sections and integral silencer casing.

.2 Blade material: steel. Hub material: steel.

.3 Supports:

.1 Floor mounted units: reinforced legs.

.2 Ceiling suspended units: support brackets welded to side of casing. Extend grease lubrication facilities to outside of casing.

.4 Bearings: ball or roller with extension tubes to outside of casing.

.5 Direct drive:

.1 Fixed blade wheels: totally-enclosed, air over motors.

.2 Diameter of wheel hub: at least equal to that of motor frame.

.6 Belt drive:

.1 Drive fixed blades by externally mounted motors through V-belt drive. Provide internal belt fairing, external belt guards and adjustable motor mounts.

.2 Adjust blades for varying range of volume and pressure. Hubs to facilitate indexing of blade angle. Provide manual adjustment stops to avoid overloading motor.

2.7 IN-LINE CENTRIFUGAL FANS

.1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct drive].

.2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

2.8 PROPELLER FANS

.1 Fabricate multibladed propellers of steel or aluminum of airfoil shape within bell mouth entrance on integral mounts, with grease lubricated ball bearings, with extended lubrication fittings, suited for operating in any position, direct or belt driven, complete with motor as indicated.

.2 Provide blade guards, bird screen and back draft dampers on discharge.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC fan installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads, and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for heat pumps and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date and status.

.2 Indicate the following:

.1 Capacity.

.2 Pressure drop.

.3 Noise rating.

.4 Leakage.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Operation and Maintenance Data: submit operation and maintenance data for heat pumps for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 VARIABLE VOLUME BOXES

.1 Pressure independent, reset to air flow between minimum and maximum air volume.

.2 Sizes and capacities: as indicated on schedule.

.3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s.

.4 Complete with:

.1 Operator and controller.

.2 Sound attenuator.

.3 Reheat coil: as indicated.

.5 Minimum 35 kPa reset span.

.6 Adjustable reset start point.

.7 Adjustable reset span to maximum 70 kPa when supplied with minimum 140 kPa main control air.

.8 No control air bleed off through inlet sensor.

.9 Operator to be factory mounted and calibrated:

.1 Gauge taps for balancing with standard pressure gauge.

.2 Controller to have adjustable flow settings.

2.2 CONSTANT VOLUME BYPASS BOXES

.1 Maintains space condition by bypassing supply air to return air.

.2 Sizes and capacities: as indicated on schedule.

.3 Complete with:

.1 Bypass collar.

.2 Minimum air volume stop.

.3 Controller and operator.

.4 Reheat coil as indicated.

.5 Manual balancing damper.

2.3 FAN POWERED BOXES

.1 General:

.1 Primary air assembly, pressure independent with reset to any air flow between minimum and maximum air volume as indicated.

.2 Sizes and capacities: as indicated on schedule.

.3 Field calibration and readjustment of air volume as follows:

.1 Gauge tops for balancing with standard pressure gauge.

.2 Adjustable flow settings.

.4 Complete with:

.1 Sound attenuator.

.2 Reheat coil as indicated.

.2 Fan section:

.1 CSA certified.

.2 Forward curved, centrifugal, direct drive, internally suspended and isolated from casing on rubber-in-shear isolators complete with access panel.

.3 Fan controls sealed from primary air flow.

.4 Electrical characteristics: as indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air terminal units installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 INSTALLATION

.1 Install in accordance with manufacturers recommendations.

.2 Support independently of ductwork.

.3 Install with at least 1000 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.

.4 Locate controls, dampers, and access panels for easy access.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles, and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate following:

.1 Capacity.

.2 Throw and terminal velocity.

.3 Noise criteria.

.4 Pressure drop.

.5 Neck velocity.

1.2 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.2 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

2.2 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Frames:

.1 Full perimeter gaskets.

.2 Plaster frames where set into plaster or gypsum board and as specified.

.3 Concealed fasteners.

.3 Concealed manual volume control damper operators.

.4 Colour: confirm with architect/interior designer.

2.3 MANUFACTURED UNITS

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

2.4 SUPPLY GRILLES AND REGISTERS

.1 General: as indicated on Diffuser Schedule.

2.5 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 General: as indicated on Diffuser Schedule.

2.6 DIFFUSERS

.1 General: as indicated on Diffuser Schedule.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register and grille installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Install in accordance with manufacturer’s instructions.

.2 Install with flat head screws in countersunk holes where fastenings are visible.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish, and limitations.

.2 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

.3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.2 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

2.2 GRAVITY ROOF OUTSIDE AIR INTAKES AND RELIEF VENTS

.1 Factory manufactured galvanized steel.

.1 Complete with integral bird screen of 2.7 mm diameter aluminum wire.

.2 Maximum throat velocity: 3.3 m/s intake.

.3 Maximum loss through unit: 15 Pa exhaust static pressure.

.4 Maximum velocity through damper area: 1.5 m/s.

.2 Bird screens:

.1 Complete with integral bird screen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and 19 mm mesh on intake.

2.3 GOOSENECK HOODS

.1 Thickness: to ASHRAE and SMACNA.

.1 Kitchen: to NFPA 96.

.2 Elsewhere: to ASHRAE and SMACNA.

.2 Fabrication: to ASHRAE and SMACNA.

.1 Kitchen: to NFPA 96.

.2 Elsewhere: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA.

.4 Supports: as indicated.

.5 Complete with integral bird screen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and 19 mm mesh on intake.

2.4 FIXED LOUVRES

.1 Manufacturer: Ventex Inc., Bolton, ON.

.2 Model, size, etc. as indicated on mechanical drawings.

.3 Equal to Ventex model no. 2455 4” deep high-performance louver complete with flange frame for flange mount installation.

.4 Construction: welded with exposed joints ground flush and smooth.

.5 Material: extruded aluminum alloy 6063-T5.

.6 Mullions: as recommended by manufacturer.

.7 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body

.8 Screen: 19 GA. galvanized, 12 mm x 12 mm mesh, 2 mm diameter wire aluminum bird screen on inside face of louvres in formed U-frame.

.9 Finish: clear anodized finish unless otherwise instructed by Architect.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louvres, intakes, and vents installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for outdoor HVAC equipment and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.2 Drawings to indicate project layout and dimensions; indicate:

.1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired, and piped ready for final connection to building system, its size and recommended bypass connections.

.2 Piping, valves, fitting shipped loose showing final location in assembly.

.3 Control equipment shipped loose, showing final location in assembly.

.4 Complete internal panel pneumatic tube piping and wiring and external panel pneumatic tube piping and wiring, both as schematics and as actually assembled.

.5 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes, and location of mounting bolt holes; include mass distribution drawings showing point loads.

.6 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.

.7 Pump and fan performance curves.

.8 Details of vibration isolation.

.9 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.

.10 Type of refrigerant used.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.6 Manufacturer's Field Reports:

.1 Submit manufacturer's field reports specified.

.7 Sustainable Design Submittals:

.1 LEED Canada submittals: in accordance with Section 01 35 21 - LEED Requirements (where required).

.2 Construction Waste Management:

.1 Submit project Waste Management Plan and/or Waste Reduction Workplan, highlighting recycling and salvage requirements.

.2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.

.3 Recycled Content:

.1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer and post-industrial content, and total cost of materials for project.

.4 Regional Materials: submit evidence that project incorporates the required percentage of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for outdoor HVAC equipment, for incorporation into manual.

.1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.

.2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground or indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect outdoor HVAC equipment from any nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan and/or Waste Reduction Workplan (where required) related to Work of this Section and in accordance with Section 01 35 21 - LEED Requirements.

.5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials, as specified in the Construction Waste Management Plan and/or Waste Reduction Workplan, in accordance with Section 01 74 19 - Waste Management and Disposal and Section 01 35 21 - LEED Requirements.

1.4 WARRANTY

.1 For Work of this Section 23 74 00 - Packaged Outdoor HVAC Equipment, 12 months warranty period is extended to 60 months.

.2 Contractor hereby warrants that packaged rooftop HVAC units and refrigeration compressors will function and operate in accordance with CCDC 2 GC 24, but for 60 months.

Part 2 Products

2.1 GENERAL

.1 Roof mounted, self-contained unit with gas burner and DX refrigeration and bear label of CSA, CGA, FM, UL and ULC.

.2 Units to consist of cabinet and frame, supply fan, return fan (where applicable) heat exchanger, burner (with integral induced draft fan), heater control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, return damper, motorized or gravity exhaust damper (refer to schedules).

.3 Prefabricated roof curb to conform to requirements of National Roofing Contractors Association (NRCA), minimum height 450 mm.

.4 Conform to ANSI/AHRI 210/240, rating for unit larger than 40 kW nominal.

2.2 CABINET

.1 Cabinets: weatherproofing tested and certified to AGA rain test standards and soundproofing tested to AHRI 270, dbA at 5m free field.

.2 Framing and supports: 2 mm thick welded steel, galvanized after manufacture, with lifting lugs.

.3 Outer casing: weathertight 1.2 mm thick galvanized steel with baked enamel finish, complete with flashing.

.4 Access: removable, gasketed hinged doors or panels with locking door handle type and screwdriver operated flush cam type fasteners.

.5 Insulation: neoprene coated glass fibre on surfaces where conditioned air is handled, 50 mm thick, 32 kg/m^3 density.

.6 Provide a factory installed, internal sloped condensate drain pan, constructed of a non-corrosive material, complete with a minimum, 20mm (3/4”) drain connection.

2.3 FANS

.1 Centrifugal, forward curved impellers, statically and dynamically balanced. Multi V-belt drive with adjustable variable pitch motor pulley, rubber or spring isolated hinge mounted motor, fan and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators. Vibration isolators: 95% efficiency.

2.4 AIR FILTERS

.1 50 mm thick, efficient, metal framed, replaceable media standard to unit manufacturer.

.2 To meet NFPA 90A, air filter requirements type Class 1 or 2 (where required).

2.5 ELECTRIC HEATERS

.1 Nickel chromium electric resistant type, Finned tube, helical coil or expanded strip heating elements.

.2 Controls:

.1 Panel board with multi-stage modulating or full SCR controller.

.2 Indicating light centre.

.3 Remote thermostat as indicated.

.4 Fuse blocks (one per step unless otherwise specified).

.5 Built-in control transformer.

.6 Thermal cut outs: [[9] manual reset disc types, one per circuit;] [one linear bulb type manual reset] [one linear bulb type automatic reset.]

.7 Built-in fused disconnect switch.

.8 Elements control: accessible with protection against no air flow, short and grounds, and of self checking type.

.9 High limit temperature control: de-energize heating elements to protect against over heating.

.10 Supply fan: start before electric elements are energized and continue operating until bonnet temperature reaches minimum setting. Include switch for continuous fan operation.

.11 Conform to CSA C22.1, Canadian Electrical Code

2.6 HEAT EXCHANGERS AND BURNERS

.1 Gas fired, multiple flue passes, with primary heating surface of aluminized type or stainless steel (where specified), secondary heating surface, stainless steel, aluminized tubes.

.1 Gas burner: factory mounted, wired and fire tested complete with operating and safety controls.

.2 Provide an induced draft combustion section with direct spark ignition system, redundant main gas valve and two-stage heating (minimum).

.3 Spark ignited pilot with pilot flame safety shut-off.

.4 The heat exchanger shall be a tubular section type, constructed of 20 gauge steel and coated with a 1.2mm aluminum-silicone alloy for corrosion resistance.

.5 Provide an Integrated Control Unit (IGC) board to provide timed control of the evaporator fan and burner ignition. An LED shall provide diagnostic information. The LED shall be visible without removing the control box access panel. The IGC panel shall include anti-cycle protection for gas heat operation.

2.7 HOT WATER COIL

.1 Aluminum or Copper fins (refer to schedules), mechanically bonded to copper tubes.

.2 Piping: complete with shut off valves, drain valves, unions, or flanges.

.3 Hydrostatically tested to 1.7 MPa.

2.8 REFRIGERATION

.1 Conform to CSA B52 standard and UL 1995 requirements.

.2 Compressor/Condenser Section:

.1 Semi-Hermetic (or fully hermetic) compressor(s), vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and automatic pump down system with control to liquid line solenoid valve.

.2 Fan(s): propeller type with single piece spun venturi outlets and zinc plated guards. Motor[s]: sequenced for head pressure control.

.3 Electrical system: complete with operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof, rain tight disconnect.

.4 Include refrigerant piping with automatic hot gas bypass, sight glass, filter, and valves.

.5 Condenser: staggered copper tube aluminum fin coil assembly with sub-cooling rows to provide sub-cooling.

.6 Capacity reduction: hot gas bypass and/or cylinder unloading. Hot gas side port distribution. Provide fan control flooding for head control for low ambient operation down to -23.3 degrees C ambient temperature.

.7 Refrigerant: As per latest codes, by-laws, and applicable standards.

.3 Evaporator:

.1 Rated to ANSI/AHRI 210/240 standard.

.2 Thermostatic expansion valve, with adjustable super heat and external equalizer.

.3 Coil: NPS 1/2, NPS 5/8, od staggered seamless copper tubes expanded into aluminum fins, and insulated condensation pan.

.4 Cooling coil condensate drain pans: designed to avoid standing water, easily cleaned or removable for cleaning. Drain connection: deep seal trap complete with trap seal primer.

2.9 CONTROLS

.1 In addition to combustion safety controls, provide smoke sensors in return to applicable NFPA standards, low limit on supply and freeze protection on steam and water coils.

.2 Single Zone Cooling Control:

.1 Zone sensor/Room thermostat to activate cooling relay in control circuit cycling compressor. Provide safeties and pressure controls. Condenser fans to operate in sequence.

.2 As back pressure is reduced, hot gas bypass opens to maintain set back pressure.

.3 When call for cooling is satisfied, relay is de-energized closing liquid line solenoid valve and pumps down. On two compressor units provide separate circuits to evaporator and condenser and manual double pole double throw switch for lead-lag unit choice.

.3 Multi-Zone Heat-Cool Unit:

.1 Remote solid state electronic control panel containing "on-off" "summer-winter" selector switches "heat", "cool", and "fan" indicating lights.

.2 Hot deck temperature: maintained by modulating, outdoor reset [[_____] ratio] controller such that hot deck temperature increases [_____]degrees C for each [_____] degrees C increment of outside temperature below 21 degrees C set point (adjustable). [Hot] deck control operation: occurs with selector switch positioning re: Winter-Summer, whenever any [zone] dampers are open past [_____]% position on heating side.

.3 Cold deck temperature: at "summer" position, maintained by [cold] deck thermostat operating liquid line solenoid valve(s) as required, with compressor lockout at (14) degrees C, restart (17) degrees C.

.4 Freeze protection control: wired in cold deck control circuit to guard against coil frosting and low air flow, with shut off by differential pressure switch or low temperature.

.5 Cooling capacity control: provided by hot gas bypass valve modulating to maintain constant suction temperature.

.6 Modulating zone thermostats controlling modulating zone damper operators shall maintain zone temperatures.

.4 Mixed Air Single Zone Unit:

.1 Manual or Automatic outside and return air dampers for fixed outside air quantity.

.2 Remote controlled outside and return air dampers with damper operator and remote rheostat package for adjusting outside air quantity.

.3 Motorized outside, return and (automatic, power exhaust, gravity) relief dampers with spring return damper operator and control package to automatically vary outside air quantity. Outside air and exhaust air dampers, normally closed.

.4 Tight fitting opposed blade dampers with neoprene or suitable gaskets, bronze, or synthetic bushings and 1% maximum leakage.

.5 Damper operation: 24 V, spring return motor with gear train sealed in oil, [and heater for operation under -18 degrees C.

.6 Mixed air controls: maintain [[_____] degrees C] [indicated] mixed air temperature, lock out compressor below [14] degrees C ambient, restart [17] degrees C, revert dampers to provide [_____] % fresh air above [21] degrees C adjustable.

.5 Single Zone Heat-Cool Unit:

.1 Low voltage, adjustable room thermostat controls burner operation, heater stages in sequence with delay between stages, compressor and supply fan to maintain room temperature setting.

.2 Thermostat: include system selector switch day-night/heat-cool-off and fan control switch (on-auto).

.3 Automatic changeover thermostat: with multi-stage heating and multi-stage cooling. Electronic programmable with battery back up.

.4 Provide remote mounted fan control switch on remote panel (where indicated on plan and/or schedules).

.6 Night mode: unit cycles as unit heater with 100% recirculation on winter or summer cycles unit off.

.7 Night set-back: As described and shown.

2.10 REMOTE PANEL

.1 Provide remote readout panel [for each unit] containing:

.1 Signal lights indicating system status, heating system failure, cooling system failure, and dirty filters.

.2 Check switches proving signal light operation.

.3 System on-off switch cooling system on-off switch.

.4 Fan on-off switch.

.5 Manual 12 hours timer to override night-set back control, remote damper control on outside air damper.

.2 Provide gauges in remote panel indicating outside air, mixed air, return air and discharge air temperatures for each deck before heat exchangers.

2.11 FIRE ALARM SHUTDOWN

.1 Extend control wiring to terminal blocks for connection by Division 26 for fire alarm shutdown.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for outdoor HVAC equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of the Consultant .

.2 Inform the Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Consultant.

3.2 INSTALLATION

.1 Install as per manufacturers' instructions on roof curbs provided by manufacturer as indicated.

.2 Manufacturer to certify installation, supervise start-up and commission unit.

.3 Run drain line from cooling coil condensate drain pan to discharge over roof drain.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection, and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.

.2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.

.3 Schedule site visits to review work at stages listed:

.1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.

.2 Twice during progress of work at 25% and 60% complete.

.3 Upon completion of work, after cleaning is carried out.

.2 Obtain reports within 3 days of review and submit immediately to the Consultant .

.3 Performance Verification:

.1 General:

.1 In accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems, supplemented as specified herein.

.2 Rooftop Air Handling Units:

.1 Set zone mixing dampers for full cooling, except that where diversity factor forms part of design set that percentage of zone dampers to full heating.

.2 Set outside air and return air dampers for minimum outside air.

.3 Set face and bypass dampers so face dampers are fully open and bypass dampers are fully closed.

.4 Check for smooth, vibration less correct rotation of supply fan impeller.

.5 Measure supply fan capacity.

.6 Adjust impeller speed as necessary and repeat measurement of fan capacity.

.7 Measure pressure drop each component of air handling unit.

.8 Set outside air and return air dampers for the percentage of outside air required by design and repeat measurements of fan capacity.

.9 Reduce differences between fan capacity at minimum and maximum outside air less than 5%.

.10 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.

.11 Reduce difference between fan capacity with BPD fully closed to bypass and fully open to bypass to less than 5%.

.12 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than 5%.

.13 OAD: verify for proper stroking, interlock with RAD.

.14 Measure DBT, WBT of SA, RA, EA.

.15 Measure air cooled condenser discharge DBT.

.16 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.

.17 Simulate maximum cooling load and measure refrigerant hot gas and suction temperatures and pressures.

.18 Use smoke test to verify no short-circuiting of EA, relief air to outside air intake or to condenser intake.

.19 Simulate maximum heating load and:

.20 Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.

.21 Verify operating control strategies, including:

.22 Set zone mixing dampers for full heating and repeat measurements.

.23 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5%.

.24 Measure return fan capacity.

.25 Adjust impeller speed as necessary and repeat measurement of return fan capacity.

.26 Check capacity of heating unit.

.27 Measure DX refrigeration system performance as per specified Section.

.28 Refer to other sections of these specifications for PV procedures for other components.

.3 Start-Up:

.1 General: in accordance with Section 23 08 16 - Cleaning and Start-Up of HVAC Piping Systems.

.4 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.

.5 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

.4 Commissioning Reports:

.1 In accordance with Section 01 91 13 - General Commissioning Requirements: reports supplemented as specified herein. Include:

.1 Report forms as specified Section 01 91 13 - General Commissioning Requirements: Report Forms and Schematics.

3.4 DEMONSTRATION

.1 Training: in accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel, supplemented as specified.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

.3 Perform cleaning operations in accordance with manufacturer's recommendations.

.4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal and 01 35 21 - LEED Requirements (where applicable).

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for fan coil units and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Product data to include:

.1 Filters, fan accessibility.

.2 Suspension and/or anchoring of cabinet.

.3 Thermostat, transformer, controls where integral.

.4 kW rating, voltage, phase.

.5 Cabinet material thicknesses.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date, and status.

.2 Indicate the following:

.1 Capacity.

.2 Pressure drop.

.3 Noise rating.

.4 Leakage.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.’

Part 2 Products

2.1 FAN COIL UNITS

.1 Provide fan coil units as specified.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for fan coil unit(s) installation, in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Mount or hang units as applicable.

.2 Make electrical and control connections.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 23 05 00 - Common Work Results for HVAC.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for finned tube radiation heaters and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by the contractor including initials, date and status.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.2 CLOSEOUT SUBMITTALS

.5 Submit in accordance with 23 05 00 - Common Work Results for HVAC.

.6 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.2 Storage and Handling Requirements:

.1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials.

Part 2 Products

2.1 UNIT HEATERS

.1 Provide as indicated on mechanical drawings.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for finned tube radiation heater installation in accordance with manufacturer's written instructions.

.1 Inform Engineer of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Engineer.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Include double swing pipe joints as indicated.

.3 Check final location with Engineer if different from that indicated prior to installation.

.1 Should deviations beyond allowable clearances arise, request, and follow Engineer’s directive.

.4 Hot water units: for each unit, install gate valve on inlet and lockshield globe calibrated balancing valve on outlet of each unit. Install drain valve at low point.

.1 Install manual air vent at high point.

.5 Clean finned tubes and comb straight.

.6 Provide supplementary suspension steel as required.

.7 Install thermostats in locations indicated.

.8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

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

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by unit heaters installation.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for radiant heating units and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for radiant heating units, for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground and/or indoors in a dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect radiant heating units from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 Provide CSA approved, packaged factory assembled components consisting of heat exchangers, burners, controls, air filters, vacuum generators, reflectors, fans.

2.2 BURNERS

.1 Burners to include following features:

.1 Manufactured to ANSI Z83.19/CSA 2.35 standard, vented infrared heater standards.

.2 CSA certified for use with natural gas.

.3 Air-fuel mixture-controlled combustion system designed for compatibility with remote-generated and controlled vacuum.

.4 Fail-safe design to shut off supply of fuel in following situations:
  .1 Power failure.
  .2 Inadequate pilot flame.
  .3 Inadequate vacuum in combustion chamber.
  .4 Failure of main fuel valve in open position.
.5 Combustion air terminal compatible with connect of filter and outside air duct.
.6 Electrical control system isolated from combustion air system.
.7 Combustion process operational status indicator lights or observation windows.
.8 Pre-wired burner control system with electric ignition.
.9 Suitable for operation with 115 V AC, single phase, 60 Hz electrical service.
.10 Enamel-finished steel enclosure complete with removable access panels.
.11 Heating output capacity compatible with associated downstream radiant tube.

.2 Burners to include following features:
.1 Manufactured to ANSI Z83.19/CSA 2.35 standard, vented infrared heater standards.
.2 CSA certified for use with natural gas.
.3 Air-fuel mixture-controlled combustion system designed for compatibility with combustion supply air blower.
.4 Fail-safe design to shut off supply of fuel in following situations:
  .1 Blower motor failure.
  .2 Main flame failure.
  .3 Inadequate inlet air.
  .4 Excessive flue back pressure.
.5 Combustion air terminal suitable for connection of outside air duct.
.6 Electrical control system isolated from combustion air system.
.7 Combustion process operational status indicator lights and/or observation windows.
.8 Pre-wired burner control system with electric ignition.
.9 Suitable for operation with 120 V AC, single phase, 60 Hz electrical service.
.10 Enamel-finished steel enclosure complete with removable access panels.
.11 Heating output capacity compatible with associated downstream radiant tube.
.12 Centrifugal, direct-drive blower with adequate air flow capacity to accommodate ducted inlet and exhaust air requirements.

2.3 VACUUM GENERATORS

.1 Vacuum generators to include following features:
.1 Corrosion-resistant construction with capacity to accommodate total upstream output of burners.
.2 Direct-drive via 115/230 V, 60 Hz, totally-enclosed, thermally protected, ball-bearing motor.
.3 Dynamically-balanced impeller.
.4 Flexible inlet connection.
.5 Temperature and pressure rated for maximum conditions which could be encountered.
.6 Common support bracket for vacuum generator and motor.

.7 Exhaust duct terminal complete with exhaust duct and exterior terminal with bird screen.

.8 Removable acoustic enclosure.

.9 Condensate terminal complete with trap and drain line connection.

2.4 HEAT EXCHANGER

.1 Heat exchanger to consist of radiant piping with following features:

.1 Nominal (102 mm O.D., 1.519 mm thick, steel tubing) or (89 mm O.D., 0.607 mm thick, aluminized steel spiral pipe).

.2 Removable, heat and corrosion-resistant joint connections designed to accommodate system expansion/contraction.

.3 Length compatible with upstream burner output capacity.

2.5 REFLECTORS

.1 Reflectors to include following features:

.1 Polished aluminum construction complete with corrugations and configuration to maximize radiant heat directed toward floor.

.2 Standard lengths to facilitate installation complete with overlaps at joints to accommodate expansion and contraction.

.3 Hangers/supports at spacing recommended by system manufacturer to maintain maximum reflector efficiency.

.4 Side extension reflector complete with supports, retainers, and brackets, to prevent radiant heat from striking adjacent surfaces.

.5 Barrier reflector shield complete with supports, retainers, and brackets, to prevent radiant heat from striking objects beneath radiant piping.

.6 Factory fabricated corners, joints, tees, end caps, and related accessories.

.7 Egg-crate style aluminum grille beneath reflectors complete with supports, shields, as required, to improve aesthetics of radiant heating system and complement reflector design efficiency.

2.6 OUTSIDE AIR SUPPLY

.1 Outside air supply to include following features:

.1 Ducted outside air supply to each burner to provide sealed-combustion system.

.2 Insulation and vapour retarder on duct to prevent condensation.

.3 Duct size to ensure adequate air supply to each burner.

.4 Exterior air inlet terminal complete with bird screen and weatherproof hood.

.5 Flexible duct connector adjacent to burner complete with removable joint clamp at burner.

2.7 CONTROLS

.1 System controls to include following features:

.1 Pre-wired control panel complete with transformers, relays, terminal blocks, wiring, circuits, hinged door, visible door-mounted system status lights, steel cabinet complete with baked enamel finish and keyed access.

.2 24 V heating thermostat control of burners complete with radiant heat shields where shown.

.3 Integral pre-purge and post purge cycles for combustion chambers and heat exchanger pipes.

.4 Thermostat radiant heat reflector shields, if exposed to radiant heat.

.5 Vacuum switch interlock with vacuum generator.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for radiant heating unit installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant .

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant .

3.2 INSTALLATION

.1 Install infrared radiant system in accordance with CSA B149.1 standard, as recommended by manufacturer and as indicated.

.2 Provide grading of radiant pipe as required.

.3 Make provision for pipe movement caused by normal operation and expansion.

.4 Maintain required clearances from combustibles.

.5 Follow manufacturer's detailed installation, testing, operation, and maintenance instructions.

.6 Install thermostats where indicated. Supply heat shields, where recommended by the manufacturer.

.7 Test radiant system as recommended by manufacturer and required by authorities having jurisdiction. Air test piping for leaks. Check burner safety controls.

.8 Arrange equipment, including burners, vacuum generators, to facilitate removal without dismantling pipe, reflectors, or associated apparatus.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal Requirements.

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

END OF SECTION

Part 1 General

1.1 DESIGN REQUIREMENTS

.1 Confirm with the Consultant, that the Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Final Report: submit report to the Consultant:

.1 Include measurements, final settings, and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by the Consultant before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments, and modifications to EMCS as set during commissioning and submit to the Consultant in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable to improve performance, environmental conditions, or energy consumption.

1.3 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of by either the Consultant, before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.4 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - GENERAL COMMISSIONING REQUIREMENTS.

.2 Carry out commissioning under direction of the Consultant and in presence of the Consultant.

.3 Inform, and obtain approval from, the Consultant in writing at least fourteen (14) days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

.4 Correct deficiencies, re-test in presence of the Consultant , until satisfactory performance is obtained.

.5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.6 Load system with project software.

.7 Perform tests as required.

1.5 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by the Consultant .

1.6 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 Products

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than two (2) months prior to tests.

.4 Locations to be approved, readily accessible and readable.

.5 Application: to conform to normal industry standards.

Part 3 Execution

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Consultant.

.3 Commission integrated systems using procedures prescribed by Consultant.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor 's premises as approved by the Consultant.

.3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU 's, and TCU 's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 VAV supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp metre at source and to BECC.

.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.

.8 The Consultant to mark instruments tracking within 0.5 % in both directions as "approved for installation".

.9 Transmitters above 0.5 % error will be rejected.

.10 DP switches to open and close within 2% of setpoint.

.2 Completion Testing.

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits, and engineering units. Include space on commissioning technician and Consultant .

This document will be used in final startup testing.

.3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of the Consultant to provide:

.1 Two (2) technical personnel capable of re-calibrating field hardware and modifying software.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 The Consultant acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final startup testing.

.5 O&M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel and the Consultant .

.7 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.8 Operate systems as long as necessary to commission entire project.

.9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of the 30-day test, demonstrate that the operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL 's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.2 Test to last at least 30 consecutive 24-hour days.

.3 Tests to include:

.4 System will be accepted when:

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 The Consultant shall verify reported results.

3.3 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by the Consultant, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

.1 Demonstrate to the Consultant , that the operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks, and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

Part 1 General

1.1 SYSTEM DESCRIPTION

.1 Refer to control schematics and all relevant details, for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

- .1 Building Controllers.
- .2 Control devices as listed in I/O point summary tables.
- .3 OWS(s).
- .4 Data communications equipment necessary to effect EMCS data transmission system.
- .5 Field control devices.
- .6 Software/Hardware complete with full documentation.
- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:

- .1 Design and provide conduit and wiring linking elements of system.
- .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by the Consultant , prior to installation.
- .3 Location of controllers as reviewed by the Consultant , prior to installation.
- .4 Provide utility power to EMCS and emergency power to EMCS as indicated.
- .5 Metric references: in accordance with Standard CAN/CSA Z234.1.

.4 Language Operating Requirements:

- .1 Provide English operator selectable access codes.
- .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
- .3 Operating system executive: provide primary hardware-to-software interface, specified as part of hardware purchase, with associated documentation to be in English.
- .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high-level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
- .5 Include, in English:

.1 Input and output commands and messages from operator-initiated functions, field related changes and alarms, as defined in CDL's or assigned limits (i.e., commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French (optional). Point name expansions in both languages.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Submit for review:

.1 Equipment list and systems manufacturers, at time of bid/tender, within 48 hours within 10 days after award of contract.

.2 List existing field control devices to be re-used included in bid/tender, along with unit price.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certification, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by the Consultant, certifying
that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to the Consultant .

.8 Existing devices intended for re-use: submit test report.

1.3 QUALITY ASSURANCE

.1 Have local office within 50km of project, staffed by trained personnel capable of providing instruction, routine maintenance, and emergency service on systems,

.2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

.3 Have access to local supplies of essential parts and provide a 7-year guarantee of availability of spare parts after obsolescence.

.4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.5 Health and Safety:

.1 Perform construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide the Consultant , with schedule within 2 weeks after award of Contract.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling, in accordance with Section 01 74 19 - Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins, for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers (either Steel, Metal or Plastic) waste in accordance with Waste Management Plan.

.5 Place materials defined as hazardous or toxic in designated containers.

.6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal, regulations.

.7 Label location of salvaged material's storage areas and provide barriers and security devices.

.8 Ensure emptied containers are sealed and stored safely.

.9 Divert unused [metal]materials from landfill to metal recycling facility as approved by the Consultant.

.10 Fold up metal and plastic banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

2.2 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 and ASHRAE STD 135.

.2 Complete list of equipment and materials to be used on project and forming part of bid/tender documents, by adding manufacturer's name, model number and details of materials, and submit for approval.

2.3 ADAPTORS

.1 Provide adaptors between metric and imperial components.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 PAINTING

.1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

3.3 FIELD QUALITY CONTROL

.1 Verification requirements in accordance with Section 01 33 29 - Sustainable Design Reporting, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified Wood.

.8 Low-emitting materials.

END OF SECTION

Part 1 General

1.1 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.

- .1 Location of a local office.
- .2 Description and location of installing and servicing technical staff.
- .3 Location and qualifications of programming design and programming support staff.
- .4 List of spare parts.
- .5 Location of spare parts stock.
- .6 Names of sub-contractors and site-specific key personnel.
- .7 Sketch of site-specific system architecture.
- .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
- .9 Descriptive brochures.
- .10 Sample CDL and graphics (systems schematics).
- .11 Response time for each type of command and report.
- .12 Item-by-item statement of compliance.
- .13 Proof of demonstrated ability of system to communicate utilizing one of the following: (Proprietary Communications Protocol, BACnet, Lontalk, etc.).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within five (5) working days after tender closing and before contract award, for review by the Consultant .

.3 Shop Drawings to consist of three (3) hard copies and one (1) soft copy of design documents, shop drawings, product data and software.

.4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.5 Soft copy to be in AutoCAD - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.3 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within thirty (30) working days of award of contract and include following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model, and range of velocity transmitter.

.10 Compressor schematic and sizing data.

1.4 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within sixty (60) working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels [for equipment to be supplied by others].

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point, including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules, and terminations.

.4 [Pneumatic schematics and schedules].

.5 Complete Point Name Lists.

.6 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

.7 Software and programming details associated with each point.

.8 Manufacturer's recommended installation instructions and procedures.

.9 Input and output signal levels or pressures, where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.7 Graphic system schematic displays of [air] [and] [water] systems with point identifiers and textual description of system, [and typical floor plans] as specified.

.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.

.9 Listing and example of specified reports.

.10 Listing of time-of-day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section [25 01 11 - EMCS: Start-up, Verification and Commissioning].

1.5 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within forty-five (45) working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between Contract Document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 The Consultant, retains right to
revise sequence or subsequent CDL prior to software finalization without cost to the Consultant .

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit detailed preventative maintenance schedule for system components to the Consultant.

.3 Submit detailed inspection reports the Consultant.

.4 Submit dated, maintenance task lists to the Consultant. Include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.

.2 Device type and range.

.3 Measured value.

.4 System displayed value.

.5 Calibration detail

.6 Indication if adjustment required,

.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to the Consultant, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to the Consultant, in accordance with Section 01 78 00 - Closeout Submittals, the “As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.2 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish the Consultant , with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.

.5 Perform Work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.

.2 Location, date, and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of the Consultant.

1.3 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to the Consultant , in preparation and implementation of service contracts and in-house preventive maintenance procedures.

.2 Service Contracts to include but not limited to:

.1 Annual verification of field points for operation and calibration.

.2 Complete inventory of installed system.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to the Consultant, as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204 standard.

.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

.4 Review system performance with the Consultant, to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface, and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.

.1 Submit samples at random from equipment shipped, as requested by the Consultant, for testing
before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

1.2 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 Turn over to the Consultant,
existing materials removed from Work not identified for re-use.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 - 32 degrees C with 10 - 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

.8 Devices installed in user occupied space shall not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

.1 General: (except for room sensors) shall be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200 degrees C and over.

.2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored lead wires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.

.6 Immersion wells: NPS (3/4), stainless-steel, spring-loaded construction, with heat transfer compound compatible with sensor. Insertion length 100-150 mm (or as indicated).

.2 Room temperature sensors and display wall modules.

.1 Temperature sensing and display wall module.

.1 LCD display to show space temperature ed and temperature setpoint.

.2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.

.3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit and/or contractor supplied palm compatible handheld device, for access to zone bus.

.4 Integral thermistor sensing element 10,000 ohm at 24 degrees.

.5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.

.6 Stability 0.02 degrees C drift per year.

.7 Separate mounting base for ease of installation.

.2 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed aluminum or brushed stainless steel finish, with guard (as indicated).

.2 Element 10-50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000-ohm, accuracy of plus or minus 0.2 degrees C.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460mm or as indicated.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6096 mm. Bend probe at field installation time to 100mm radius at point along probe without degradation of performance.

.4 Outdoor air temperature sensors:

.1 Outside air type: complete with probe length 100 - 150mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.

.2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.

.3 Output signal: 4 - 20 mA into 500-ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10%.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full-scale output.

.7 Maximum current to 100 or 1000-ohm RTD sensor: not to exceed 25mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0% of full scale/50 degrees C.

.10 Long term output drift: not to exceed 0.25% of full scale/6 months.

.11 Transmitter ranges: select narrowest range to suit application from following:

.1 Minus 50 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.

.2 0-100 degrees C, plus or minus 0.5 degrees C.

.3 0-50 degrees C, plus or minus 0.25 degrees C.

.4 0-25 degrees C, plus or minus 0.1 degrees C.

.5 10-35 degrees C, plus or minus 0.25 degrees C.

2.4 HUMIDITY SENSORS

.1 Room and Duct Requirements:

.1 Range: 5-90% RH minimum.

.2 Operating temperature range: 0-60 degrees C.

.3 Absolute accuracy:

.1 Duct sensors: plus or minus 3%.

.2 Room sensors: plus or minus 2%.

.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.

.5 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.

.6 Room sensors: locate in air stream near RA grille or wall mounted as indicated.

.7 Duct mounted sensors: locate so that sensing element is in air flow in duct.

.2 Outdoor Humidity Requirements:

.1 Range: 0 - 100 % RH minimum.

.2 Operating temperature range: -40 - 50 degrees C.

.3 Absolute accuracy: plus or minus 2%.

.4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.

.5 Must be unaffected by condensation or 100% saturation.

.6 No routine maintenance or calibration is required.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

.1 Input signal: from RH sensor.

.2 Output signal: 4-20 mA onto 500-ohm maximum load.

.3 Input and output short circuit and open circuit protection.

.4 Output variations: not to exceed 0.2 % of full-scale output for supply voltage variations of plus or minus 10%.

.5 Output linearity error: plus or minus 1.0% maximum of full-scale output.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 1.0% full scale/6 months.

.8 Long term output drift: not to exceed 0.25% of full-scale output/6 months.

2.6 PRESSURE TRANSDUCERS

.1 Requirements:

.1 Combined sensor and transmitter measuring pressure.

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4-20mA into 500-ohm maximum load.

.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full-scale output over entire range.

.5 Temperature effects: not to exceed plus or minus 1.5% full scale/50 degrees C.

.6 Over-pressure input protection to at least twice rated input pressure.

.7 Output short circuit and open circuit protection.

.8 Accuracy: plus or minus 1% of Full Scale.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20mA into 500-ohm maximum load.

.3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full-scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5% full scale/50 degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160Pa at 10m/s. Air stream manifold.

.2 Accuracy: plus or minus 1% of actual duct static pressure.

2.9 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20mA linear into 500-ohm maximum load.

.2 Calibrated span: not to exceed 150% of duct static pressure at maximum flow.

.3 Accuracy: 0.4% of span.

.4 Repeatability: within 0.5% of output.

.5 Linearity: within 1.5% of span.

.6 Dead-band or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.10 VELOCITY PRESSURE SENSORS

.1 Requirements:

.1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.

.2 Maximum pressure loss: 37Pa at 1000m/s.

.3 Accuracy: plus or minus 1% of actual duct velocity.

2.11 VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20mA linear into 500-ohm maximum load.

.2 Calibrated span: not to exceed 125% of duct velocity pressure at maximum flow.

.3 Accuracy: 0.4% of span.

.4 Repeatability: within 0.1% of output.

.5 Linearity: within 0.5% of span.

.6 Dead-band or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.12 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.

.2 Adjustable setpoint and differential.

.3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.

.4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.

.5 Accuracy: within 2% repetitive switching.

.6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.

.7 Switches on steam and high temperature hot water service: provide pigtail syphon.

2.13 TEMPERATURE SWITCHES

.1 Requirements:

.1 Operate automatically. Reset automatically, except as follows:

.1 Low temperature detection: manual reset.

.2 High temperature detection: manual reset.

.2 Adjustable setpoint and differential.

.3 Accuracy: plus or minus 1 degree Celsius.

.4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.

.5 Type as follows:

.1 Room: for wall mounting on standard electrical box with protective guard as indicated.

.2 Duct, general purpose: insertion length = 460mm.

.3 Thermowell: stainless steel, with compression fitting for NPS 3/4. thermowell. Immersion length: 100mm.

.4 Low temperature detection: continuous element with 6096mm insertion length, duct mounting, to detect coldest temperature in any 30mm length.

.5 Strap-on: with helical screw stainless steel clamp.

2.14 CURRENT / PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:

.1 Input range: 4 to 20mA.

.2 Output range: proportional 20-104kPa or 20-186kPa as applicable.

.3 Housing: dustproof or panel mounted.

.4 Internal materials: suitable for continuous contact with industrial standard instrument air.

.5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2% of full scale over entire range.

.6 Integral zero and span adjustment.

.7 Temperature effect: plus or minus 2.0% of full scale/50 degrees Celsius or less.

.8 Regulated supply pressure: 206kPa maximum.

.9 Air consumption: 16.5ml/s maximum.

.10 Integral gauge manifold c/w gauge (0-206 kPa).

2.15 SOLENOID CONTROL AIR VALVES

.1 Coil: 120V AC or 24V DC, as indicated.

.2 Capacity: to pass a minimum of 0.15 l/s air at 140 kPa differential.

2.16 AIR PRESSURE GAUGES

.1 Diameter: 38mm minimum.

.2 Range: zero to two times operating pressure of measured pressure media or nearest standard range.

2.17 ELECTROMECHANICAL RELAYS

.1 Requirements:

.1 Double voltage, DPDT, plug-in type with termination base.

.2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.

.3 Contacts: rated at 5 amps at 120V AC.

.4 Relay to have visual status indication.

2.18 SOLID STATE RELAYS

.1 General:

.1 Relays to be socket or rail mounted.

.2 Relays to have LED Indicator

.3 Input and output Barrier Strips to accept 14 to 28 AWG wire.

.4 Operating temperature range to be -20 degrees C to 70 degrees C.

.5 Relays to be CSA Certified.

.6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.

.7 Operational frequency range, 45 to 65 HZ.

.2 Input:

.1 Control voltage, 3 to 32 VDC.

.2 Drop out voltage, 1.2 VDC.

.3 Maximum input current to match AO (Analog Output) board.

.3 Output.

.1 AC or DC Output Model to suit application.

2.19 CURRENT TRANSDUCERS

.1 Requirements:

.2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.

.2 0-1 volt DC.

.3 0-10 volts DC.

.4 0-20 volts DC.

.3 Frequency insensitive from 10 - 80 hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

2.20 CURRENT SENSING RELAYS

.1 Requirements:

.1 Suitable to detect belt loss or motor failure.

.2 Trip point adjustment, output status LED.

.3 Split core for easy mounting.

.4 Induced sensor power.

.5 Relay contacts: capable of handling 0.5amps at 30 VAC / DC. Output to be NO solid state.

.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.

.7 Adjustable latch level.

2.21 CONTROL DAMPERS

.1 Construction: blades, 152mm wide, 1219mm long, maximum. Modular maximum size, 1219mm wide x 1219mm high. Three or more sections to be operated by jack shafts.

.2 Materials:

.1 Frame: 2.03mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.

.2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.

.3 Bearings: maintenance free, synthetic type of material.

.4 Linkage and shafts: aluminum, zinc, and nickel-plated steel.

.5 Seals: synthetic type, mechanically locked into blade edges.

.1 Frame seals: synthetic type, mechanically locked into frame sides.

.3 Performance: minimum damper leakage meet or exceed AMCA Standard 500 ratings.

.1 Size/Capacity: refer to damper schedule.

.2 25 L/s/m^2 maximum allowable leakage against 1000Pa static pressure for outdoor air and exhaust air applications.

.3 Temperature range: -40 degrees C to +100 degrees C.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 Jack shafts:

.1 25mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.

.2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.

.3 Install using manufacturers installation guidelines.

.4 Use same manufacturer as damper sections.

2.22 PNEUMATIC CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Piston type with spring return for "fail-safe" in Normally Open or Normally Closed position, as indicated.

.2 Operator: size to control dampers against maximum pressure and dynamic opening/closing pressure, whichever is greater.

.3 Adjustable spring and stroke external stops to limit strokes in either direction.

.4 For modulating applications provide with full relay type positioner with interconnecting linkage for mechanical feedback. Adjust to operate between range of 20-90 kPa unless otherwise indicated in control sequence of operation or input/output summary sheet.

.5 Positioners not required on single damper sections with less than 1m^2 face area.

2.23 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Direct mount proportional type as indicated.

.2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.

.3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.4 Power requirements: 5VA maximum at 24 V AC.

.5 Operating range: 0 - 10V DC or 4 - 20mA DC.

.6 For VAV box applications floating control type actuators may be used.

.7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.24 CONTROL VALVES

.1 Body: globe style, characterized ball.

.1 Flow characteristic as indicated on control valve schedule: linear, equal percentage, quick opening.

.2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.3 Normally open/Normally closed, as indicated.

.4 Two or Three-port, as indicated.

.5 Leakage rate ANSI class IV, 0.01% of full open valve capacity

.6 Packing easily replaceable.

.7 Stem, stainless steel.

.8 Plug and seat, stainless steel, brass, or bronze.

.9 Disc, replaceable, material to suit application.

.10 NPS 2 and under:

.1 Screwed National Pipe Thread (NPT) tapered female connections.

.2 Valves to ANSI Class 250, valves to bear ANSI mark.

.3 Rangeability 50:1 minimum.

.11 NPS 2½ and larger:

.1 Flanged connections.

.2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.

.3 Rangeability 100:1 minimum.

.2 Butterfly Valves NPS 2 and larger:

.1 Body: for chilled water ANSI Class 150 cast iron lugged body and wafer body installed in locations as indicated. For steam and heating water ANSI Class 150 carbon steel lugged body and wafer body.

.2 End connections to suit flanges that are ANSI Class 150.

.3 Extended stem neck to provide adequate clearance for flanges and insulation.

.4 Pressure limit: bubble tight sealing to 170 kilopascals.

.5 Disc/vane: 316 stainless steel, aluminum bronze to ASTM B148.

.6 Seat: for service on chilled water PTFE (polytetrafluoroethylene), EPDM (ethylene propylene diene monomer). For service on steam and heating water PTFE, RTFE (reinforced PTFE).

.7 Stem: 316 stainless-steel.

.8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.9 Flow characteristic linear.

.10 Maximum flow requirement as indicated on control valve schedule.

.11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.

.12 Normally open or normally closed, as indicated.

.13 Valves are to be provided complete with mounting plate for installation of actuators.

2.25 PNEUMATIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Diaphragm: moulded Buna-N rubber, nylon reinforced.

.3 Spring return to normal position.

.4 Spring range adjustment and position indicator.

.5 Provide pilot positioners on modulating control valves over 50 mm and where indicated on drawings and I/O summary. Positioners to operate between 20 to 90 kPa unless otherwise noted or required by sequence.

.6 Minimum shut-off pressure: refer to control valve schedule.

2.26 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:

.1 Construction: steel, cast iron, aluminum.

.2 Control signal: 0-10V DC or 4-20mA DC.

.3 Positioning time: to suit application. 90 second maximum.

.4 Fail to normal position as indicated.

.5 Scale or dial indication of actual control valve position.

.6 Size actuator to meet requirements and performance of control valve specifications.

.7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

.8 Minimum shut-off pressure: refer to control valve schedule.

2.27 WATTHOUR METERS AND CURRENT TRANSFORMERS

.1 Requirements:

.1 Include three phases, test and terminal blocks for watthour metre connections and connections for monitoring of current. Provide two (2) transformers for 600 V 3-wire systems for watthour metre use. Accuracy: plus or minus 0.25 % of full scale. For chiller applications: to have instantaneous indicator with analog or digital display.

.2 Watthour metre sockets: to ANSI C12.7.

.3 Potential and current transformers: to ANSI/IEEE C57.13.

.4 Potential transformers: provide two primary fuses.

.5 Demand meters: configure to measure demand at 15-minute intervals.

2.28 SURFACE WATER DETECTORS

.1 Requirements:

.1 Provide alarm on presence of water on floor.

.2 Expendable cartridge sensor.

.3 Internal waterproof switch.

.4 One set of dry contacts 2 amps at 24 V.

.5 Unaffected by moisture in air.

.6 Self-powered.

2.29 PANELS

.1 Free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required, indicated to handle requirements with additional space to accommodate 25% additional capacity as required by the Consultant without adding additional cabinets.

.3 Panels to be lockable with same key.

2.30 CONTROL AIR COMPRESSOR STATIONS

.1 Requirements: provide two (2) high pressure, base mounted, each complete with belts, guards, intake muffler, replaceable cartridge intake cleaner, starter, pressure switches, alternator.

.2 Capacity: size to maintain air pressure, meet control air requirements on 25% maximum running time.

.3 Receiver: size to suit running time. Complete with electronic automatic drain with strainer, pressure relief valve, pressure gauge ASME code rated for 1400 kPa.

.4 Vibration isolation: 5% transmissibility.

.5 Refrigerated air drier:

.1 Two (2) continuous operating type, complete with refrigerant evaporator, mechanical condensate separator, installed with two (2) isolating valves. Designed for 1400kPa maximum operating pressure.

.2 Capacity: sized for full capacity of compressors, to reduce dewpoint to minus 10 degrees C when dehydrating at 700kPa. Maximum pressure drop 19kPa at rated capacity.

.3 Provide two (2) filter and PRV assemblies, with isolating valves and filter element, having 99% efficiency in removal of 0.5-micron diameter solid particles and oil aerosols and with indication of degree of saturation. Piping: ensure one dryer is always in circuit and active.

2.31 WIRING

.1 In accordance with Section 26 27 10 - Modular Wiring System and 26 27 26 - Wiring Devices.

.2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.

.3 Wiring must be continuous without joints.

.4 Sizes:

.1 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.

.2 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment, components so that manufacturers and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures, and instructions.

.3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.5 Fire-stopping: provide space for fire stopping in accordance with Section 07 84 00 - Fire stopping. Maintain the fire-resistance rating integrity of the fire separation.

.6 Electrical:

.1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by the Consultant , before beginning Work.

.4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.5 Install communication wiring in conduit.

.1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill, not to exceed 40%.

.4 Design drawings do not show conduit layout.

.6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. The Consultant to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

.7 Pneumatic: provide Pneumatic tubing, valves, and fittings for field control devices in accordance with Section 23 09 43 - Pneumatic Control System for HVAC.

.8 Mechanical: supply and install in accordance with Section 23 09 43 - Pneumatic Control System for HVAC.

.1 Pipe Taps.

.2 Wells and Control Valves.

.3 Air flow stations, dampers, and other devices.

.9 VAV Terminal Units: supply, install and adjust as required.

.1 Air probe, actuator and associated vav controls.

.2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.

.3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE AND HUMIDITY SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

.1 Protect from solar radiation and wind effects by non-corroding shields.

.2 Install in NEMA 4 enclosures.

.4 Duct installations:

.1 Do not mount in dead air space.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.

.1 Install averaging element horizontally across the ductwork starting 305 mm from top of ductwork. Each additional horizontal run to be no more than 305 mm from one above it. Continue until complete cross-sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

.2 Wire multiple sensors in series for low temperature protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations.

.1 Locate well in elbow where pipe diameter is less than well insertion length.

.2 Thermowell to restrict flow by less than 30%.

.3 Use thermal conducting paste inside wells.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

3.4 MAGNEHELIC PRESSURE INDICATORS

.1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensor as reviewed by the Consultant.

.2 Locations: as indicated or as specified.

3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.

.1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.6 I/P TRANSDUCERS

.1 Install air pressure gauge on outlet.

3.7 AIR PRESSURE GAUGES

.1 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.

.2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.8 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.9 AIR FLOW MEASURING STATIONS

.1 Protect air flow measuring assembly until cleaning of ducts is completed.

3.10 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION