

PART 1 GENERAL

1.1 GENERAL SUMMARY OF WORK

- .1 The plans and specifications are performance based documents and are not installation shop drawings. The Controls Contractor shall study the intent of the performance based plans and specifications to produce a set of installation Controls Shop Drawings that represents complete and fully functional controls systems which meets the intent of the performance based plans and specifications complete with all required appurtenances (wiring, sensors, actuators, control panels, etc.), programming, etc.
- .2 Comply with the requirements set out for the General Contractor.
- .3 The Mechanical work shall include all labour, materials, equipment, and tools required to install, test and place into operation a complete and fully operational Mechanical System consisting of the various sub-systems as described in, but not necessarily limited to, the following Specification Sections and Drawings:
 - .1 Specification Section 210720 – Thermal Insulation for Piping.
 - .2 Specification Section 230501 – Common Work Results Mechanical
 - .3 Specification Section 230505 – Installation of Pipework.
 - .4 Specification Section 230516 – Expansion Fittings and Loops for HVAC Piping.
 - .5 Specification Section 230529 – Hangers and Supports for HVAC Piping and Equipment.
 - .6 Specification Section 230554 – Mechanical Identification.
 - .7 Specification Section 230593 – Testing, Adjusting and Balancing for HVAC.
 - .8 Specification Section 230801 – Performance Verification of Mechanical Piping Systems.
 - .9 Specification Section 230802 – Cleaning and Start-up of Mechanical Piping Systems.
 - .10 Specification Section 232115 – Hydronic Systems - Copper.
 - .11 Specification Section 232116 – Hydronic Systems - Steel.
 - .12 Specification Section 232500 – HVAC Water Treatment Systems
 - .13 Specification Section 250111 – EMCS – Start-up, Verification and Commissioning.
 - .14 Specification Section 250112 – EMCS - Training.
 - .15 Specification Section 250501 – EMCS – General Requirements.
 - .16 Specification Section 250502 – EMCS – Submittals and Review Process.
 - .17 Specification Section 250503 – EMCS – Project Record Documents.
 - .18 Specification Section 250554 – EMCS - Identification.
 - .19 Specification Section 250560 – EMCS – Field Installation.
 - .20 Specification Section 250820 – EMCS – Warranty and Maintenance.
 - .21 Specification Section 251001 – EMCS – Local Area Network (LAN).
 - .22 Specification Section 251002 – EMCS – Operator's Work Station (OWS).
 - .23 Specification Section 253001 – EMCS – Building Controllers.
 - .24 Specification Section 253002 – EMCS – Field Control Devices.
 - .25 Specification Section 259001 – EMCS – Site Requirements, Applications and System Sequences of Operation.
 - .26 Specification Section Appendix "A" – Controls
 - .27 Specification Section Appendix "B" – Low Pressure By-pass VAV Box Controls
 - .28 Specification Section Appendix "C" – Electric Boiler
 - .29 Specification Section Appendix "D" – Propane Boiler
 - .30 Specification Section Appendix "E" – Original 2002 Balance Report
 - .31 Drawing M-1.0 Mechanical – Title Sheet and Legend
 - .32 Drawing M-2.1 Mechanical – Basement Floor Existing Ventilation & Heating Piping Layout
 - .33 Drawing M-2.2 Mechanical – Main Floor Existing Ventilation & Heating Piping Layout
 - .34 Drawing M-2.3 Mechanical – Second Floor Existing Ventilation & Heating Piping Layout
 - .35 Drawing M-2.4 Mechanical – Details & Controls Schematics
 - .36 Drawing M-2.5 Mechanical – Controls Schematics & System Architecture

- .4 The existing systems must remain operational while the existing control systems and the existing control valves are being upgraded and replaced. The proposed phasing is:
 - .1 Install the new Caleffi Discall magnetic air and dirt separator in the main glycol heating supply line downstream of the boilers next to the existing air separator.
 - .1 Limit system downtime to about 2-4 hours depending on outside air temperature to prevent the room temperatures from dropping below about 65°F (18.3°C).
 - .2 Provide temporary heating to protect property from damage (freezing) and to prevent the occurrence of uncomfortable occupant space temperatures below about 65°F (18.3°C).
 - .2 Clean and flush the existing hydronic heating system before replacing any of the existing control valves.
 - .1 Limit system downtime to about 2-4 hours depending on outside air temperature to prevent the room temperatures from dropping below about 65°F (18.3°C).
 - .2 Provide temporary heating to protect property from damage (freezing) and to prevent the occurrence of uncomfortable occupant space temperatures below about 65°F (18.3°C).
 - .3 Replace the Controls on the existing Main Systems (AH-1, Boilers, Pumps, etc.) and commission the controls to ensure that they are fully operational:
 - .1 Replace existing actuators and sensors with new actuators and sensors while temporarily reusing the existing control panel control components to control them. Install additional new actuators, sensors etc. that the new controls system requires which the old control system did not require.
 - .2 Install the new control system control panel beside the existing control panel and transfer the control of the new actuators, sensors etc. to the new control panel. Label the existing control wiring and the new control wiring to ensure that the transfer of control goes smoothly (i.e. without components being incorrectly wired to the new controller).
 - .3 Commission the controls to ensure that they are fully operational.
 - .4 Limit system downtime to about 2-4 hours depending on outside air temperature to prevent the room temperatures from dropping below about 65°F (18.3°C).
 - .5 Provide temporary heating to protect property from damage (freezing) and to prevent the occurrence of uncomfortable occupant space temperatures below about 65°F (18.3°C).
 - .4 Replace the Controls on the VAV Boxes (and similar systems) on a room by room basis:
 - .1 Replace the existing controls on the existing VAV Low Pressure Bypass Boxes (and similar systems) with the new controls. Label control wiring to ensure that components are not being incorrectly wired to the new controller.
 - .2 Replace the associated existing hydronic heating control valves with new modulating hydronic heating system control valves,
 - .3 Replace the existing thermostats with new communicating thermostats.
 - .4 Commission the controls to ensure that they are fully operational.
 - .5 Limit system downtime to about 2-4 hours depending on outside air temperature to prevent the room temperatures from dropping below about 65°F (18.3°C).
 - .6 Provide temporary heating to protect property from damage (freezing) and to prevent the occurrence of uncomfortable occupant space temperatures below about 65°F (18.3°C).
 - .5 After all of the existing control valves have been replaced and the controls are fully functional:
 - .1 Clean and flush the existing hydronic heating system

- .2 Limit system downtime to about 2-4 hours depending on outside air temperature to prevent the room temperatures from dropping below about 65°F (18.3°C).
- .3 Provide temporary heating to protect property from damage (freezing) and to prevent the occurrence of uncomfortable occupant space temperatures below about 65°F (18.3°C).

1.2 HYDRONIC HEATING SYSTEM WORKING FLUID:

- .1 Dowfrost HD inhibited propylene glycol-based heat transfer fluid with an operating range of -50°F to 325°F (-46°C to 163°C) and low toxicity premixed to a solution of 50%/50% Dowfrost HD/distilled or deionized water. Mixing on site is not acceptable.

1.3 DEFINITIONS

- .1 Notwithstanding any definition elsewhere in the contract documents, wherever the term "Contractor" is used in the Mechanical Specifications, it means the firm having a contract with the "Departmental Representative" to perform, supervise and coordinate all work.
- .2 Notwithstanding any definition elsewhere in the contract documents, wherever the term "Sub-Contractor" is used in the Mechanical Specifications, it means the firm having a contract with the "Contractor" to perform, supervise and coordinate all work of that particular Division. This Sub-contractor shall be wholly responsible to the "Contractor" for all work of that Division.
- .3 Notwithstanding any definition elsewhere in the contract documents, the term "Departmental Representative" means the person designated in the Contract, or by written notice to the Contractor, to act as the Departmental Representative for the purposes of the Contract, and includes a person, designated and authorized in writing by the Departmental Representative to the Contractor.
- .4 Notwithstanding any definition elsewhere in the contract documents, wherever the term "Provide" is used in relationship to equipment, piping etc., in this Division, it means "Supply, Install and Connect".
- .5 Whenever "Drawings and Specifications" are referred to in these documents, it means "the Contract Drawings and Specifications" (including all addenda and post contract revisions) of all Disciplines (Architectural, Structural, Mechanical and Electrical).

1.4 MECHANICAL DRAWINGS

- .1 The Drawings for the Mechanical work are performance drawings, diagrammatic and approximately to scale, intended to convey the scope of work and indicate the general arrangement and approximate location of apparatus, fixtures and pipe/duct runs. These Drawings do not intend to show Architectural and Structural details.
- .2 Do not scale the Drawings. Obtain information involving accurate dimensions from dimensions shown on the Architectural and Structural drawings, and by site measurement.
- .3 Even though some piping and/or ductwork is not completely shown or is shown schematically, and all details are not shown or specified, it is expected that the contractors be familiar enough with their fields of work to complete the project to the standards generally adhered to by the local industry, including good workmanship and common sense. The Departmental Representative reserves the right to furnish any additional detail drawings, which, in the judgement of the Departmental Representative, may be necessary to clarify the work, and such drawings shall

- form a part of this contract. The work for such Clarifications shall be at no cost to the Departmental Representative.
- .4 Make, at no additional cost, any changes or additions to materials, and/or equipment necessary to accommodate structural conditions (pipes or ducts around beams, columns etc.), and to provide complete and adequate service clearance.
 - .5 The exact location of the Mechanical components may be changed by the contractors to suit site conditions, provided the changes are reviewed with the Departmental Representative, the changes are duly noted on the 'Record' drawings, and the changes do not affect the operation or code-compliance of the system(s). Any such changes shall be at no cost to the Departmental Representative.

1.5 CHANGES TO THE SCOPE OF WORK

- .1 From time to time during construction, changes to the scope of work may be proposed by the Departmental Representative. These Proposed Changes are to be priced by the contractors in a timely manner. Only after the Departmental Representative has reviewed and accepted the pricing, will these Proposed Changes be added to the contract.
- .2 Pricing for the Mechanical portions of these Proposed Changes shall be submitted by the Sub-contractor to the Contractor complete with price breakdowns as follows:
 - .1 Sub-sub-contractors' prices c/w labor, material and overhead prices broken out.
 - .2 Sub-contractor's price c/w labor, material and overhead prices broken out.
 - .3 Pricing shall be submitted on an item-by-item basis. Each Proposed Change may contain more than one item.

1.6 TRADE DEFINITIONS

- .1 All work called for in the Contract Documents shall be considered to be within the scope of the Contract, and shall be the responsibility of the Contractor.
- .2 The arrangement of the Drawings and Specifications into Divisions, Sections, and Trades is purely arbitrary, with the sole intention of clarifying the scope and content of the work required to complete the project. The actual division of the work amongst the sub-contractors shall be the responsibility of the Contractor, and the actual division of the work between the sub-sub-contractors shall be the responsibility of the sub-contractors.
- .3 The Contractor, at his option and as per his contracts with the Sub-Contractors, may delegate responsibility to the Sub-contractors for the division of the work.
- .4 The Sub-contractors, at their option and as per their contracts with the sub-sub-contractors, may delegate responsibility to the sub-sub-contractors for the division of the work.
- .5 Sections of the Mechanical specifications, and specific but arbitrary responsibility divisions noted in the Mechanical Specifications, are not intended to delegate functions nor to delegate work to any specific trade, but may be useful to the Contractor or Sub-contractor when dividing the work amongst the Trades and Sub-trades.
- .6 In the event of a dispute regarding the responsibilities of the various trades and sub-trades, the Contractor and Sub-contractors may request information or a recommendation from the

Departmental Representative. However, the Contractor and Sub-contractor shall be responsible for determining the final division of work.

1.7 CONSTRUCTION TECHNIQUES AND METHODS OF INSTALLATION

- .1 Conform to the requirements of Section 017300 – Execution Requirements.
- .2 The selected techniques, methods of fabrication and installation, and the size of the labor force shall be suitable to meet the completion schedule.
- .3 The contractors shall be responsible for determining the most appropriate construction techniques and methods of installation for their portions of the work.
- .4 The contractors shall be responsible for laying out the systems, equipment, and components for their portions of the work.
- .5 The contractors shall consult with the manufacturers to obtain their installation recommendations, and shall comply with such recommendations and/or with local code requirements, whichever is the most stringent.
- .6 Patents
 - .1 Pay all royalties and license fees, and defend all suits or claims, for infringement of any patent rights, and save the Departmental Representative harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Contractor or anyone directly or indirectly employed by him, or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement on such letters patent or rights.
- .7 Construction Drawings
 - .1 Where requested, prepare drawings in conjunction with all trades concerned, showing sleeves and openings for passage through structures, and all inserts, equipment bases, sumps and pits, supports, etc.

1.8 CODES, PERMITS, FEES AND INSPECTIONS

- .1 Comply with the most stringent requirements of the latest editions of the applicable C.S.A. standards; the requirements of the Authorities Having Jurisdiction; Federal, Provincial and Municipal Codes; and the applicable standards of the Underwriters' Association. These codes and regulations constitute an integral part of these specifications.
- .2 Not all pertinent codes and standards have been referenced in this Specification. Conform to the requirements of all applicable codes and standards whether specified or not.
- .3 In case of conflict, the codes take precedence over the drawings and specifications. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.
- .4 Before starting any work, submit the required number of copies of Drawings and Specifications to the Authorities for their approval and comments. Comply with any changes requested as part of the contract, but notify the Departmental Representative immediately of such changes, for proper processing of these requirements. Prepare and furnish any additional drawings, details or information as may be required. Information such as heat loss calculations, and other data that may be required can be obtained from the Departmental Representative. Should the authorities require the information on specific forms fill in these forms by transcribing the information provided by the Departmental Representative.

- .5 Apply for, obtain, and pay for all required permits, licenses, inspections, examinations, and fees.
- .6 Arrange for the inspection of all the work by the Authorities Having Jurisdiction over the work. On completion of the work, present to the Departmental Representative the final unconditional certificate of approval of the inspecting authorities. When the Authorities Having Jurisdiction do not normally issue certificates, provide a declaration confirming that the Authorities have inspected and accepted the work.

1.9 LIABILITY

- .1 Maintain all necessary insurance coverage to save and indemnify the Departmental Representative.
- .2 Protect and maintain the work until the project has been completed and turned over to the Departmental Representative. Protect the building and contents from damage during the construction period. Repair all damages without additional cost to the Departmental Representative.
- .3 Special care shall be taken to insure that any existing equipment, structures, components and property are not damaged during the construction period. Repair all damages without additional cost to the Departmental Representative.

1.10 HEALTH AND SAFETY

- .1 Conform to the requirements of Section 013529.6 - Health and Safety Requirements.
- .2 Conform to the requirements of Section 028101 – Hazardous Materials.
- .3 Submit WHMIS MSDS in accordance with Section 028101 - Hazardous Materials.
 - .1 Indicate VOC's for adhesive and solvents during application and curing.
- .4 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting prior to beginning work of this Section and on-site installations in accordance with Section 013216.07 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review installation instructions and warranty requirements.

1.11 SUPERVISION

- .1 Maintain at this job site qualified personnel and supporting staff with proven experience in erecting, supervising, testing and adjusting projects of comparable nature and complexity.

- .2 Supervision personnel and their qualifications are subject to the approval of the Departmental Representative.

1.12 WORK SCHEDULE

- .1 Unless otherwise noted, the work shall be scheduled for normal hours. The contractors shall be aware that off-hour work may be necessary for certain locations or types of work, and shall include the extra costs in the tender price.
- .2 It shall be the responsibility of the Contractor to schedule the work to meet the Departmental Representative's completion date. The Contractor shall coordinate the sub-trades and adjust the workforce as required to meet the schedule.
 - .1 Conform to the requirements of Section 013216.07 - Construction Progress Schedule - Bar (GANTT) Chart.
- .3 Expediting
 - .1 Continuously check and expedite delivery of equipment and materials. If necessary, inspect at the source of manufacture.
 - .2 Continuously check and expedite the flow of necessary information to and from all parties involved.
 - .3 Immediately inform the General Contractor if information is required from him.

1.13 COORDINATION

- .1 The Contractor shall be responsible for the complete coordination amongst all trades, including timing, completion, deliveries, interference of building components and sequencing of the trades.
- .2 The Contractor shall coordinate the Mechanical and Electrical sub-contractors to ensure compatibility of the system components.
- .3 The Contractor shall coordinate the Mechanical and Electrical sub-contractors to ensure access to control panels on mechanical equipment for the purpose of completing fire alarm panel connections.
- .4 The Contractor shall coordinate all trades to ensure that access doors and panels are of the same manufacturer, and of a style appropriate for the intended use.
- .5 Provide in good time, all inserts, sleeves, sump frames, anchors etc., for mechanical services, required to be built into forming.

1.14 WASTE MANAGEMENT AND DISPOSAL

- .1 Hazardous Materials
 - .1 Place materials defined as hazardous or toxic in designated containers.

- .2 Dispose of hazardous materials in accordance with all Regional and Municipal regulations.
- .3 Adhesives, Sealants and Paints
 - .1 Divert unused adhesives, sealants and paints from landfill to official hazardous material collections site.
 - .2 Do not dispose of unused adhesives, sealants and paints into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.
- .4 Water Treatment Chemicals
 - .1 Dispose of unused water treatment chemicals at official hazardous material collections site.
 - .2 Do not dispose of unused water treatment chemicals into sewer system, into streams, lakes, onto ground or in any locations where it will pose health or environmental hazard.
- .2 Conform to the requirements of Section 017421 - Construction/Demolition Waste Management and Disposal.
- .3 Ensure emptied containers are sealed, labelled and stored safely for disposal away from children.
- .4 Place excess or unused insulation and insulation accessory materials in designated containers.

1.15 DELIVERY, STORAGE, HANDLING AND UNLOADING

- .1 Hazardous Materials
 - .1 Conform to the requirements of Section 028101 – Hazardous Materials.
 - .2 Place materials defined as hazardous or toxic in designated containers.
 - .3 Handle hazardous materials in accordance with Regional and Municipal regulations.
- .2 Conform to the requirements of Section 016100 – Common Product Requirements.
- .3 Deliver, store, handle and unload materials in accordance with Manufacturer's Instructions.
- .4 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .5 Protection
 - .1 Protect from weather and construction traffic.
 - .2 Protect against damage from any source.
 - .3 Store at temperatures and conditions required by manufacturer.
 - .4 Protect stored or installed absorptive material from moisture damage.

1.16 CLEANING

- .1 Conform to the requirements of Section 017411 – Cleaning
- .2 Perform cleaning operations as specified and in accordance with manufacturer's recommendations.
- .3 General Clean-up:
 - .1 The worksite shall be maintained in a condition of general cleanliness and tidiness.
 - .2 Provide, erect, maintain and remove temporary protective barriers and shelters. Use drop sheets, temporary walls or other means necessary to limit the spread of construction dirt and debris. Barriers shall be used to minimize the spread of dust, smoke, fumes and noise to other portions of the building.
 - .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .4 Mechanical Systems Clean-up:
 - .1 At the completion of the project, leave all systems in full operation, the exterior of all new and renovated systems clean, and the work areas cleaned to the satisfaction of the Departmental Representative and Occupants.
 - .2 Clean exposed surfaces of new and renovated mechanical equipment, ductwork, piping, etc.
 - .3 The level of cleaning shall be consistent with the intended use of the building and the mechanical systems.
 - .4 The Departmental Representative reserves the right to inspect the Mechanical Systems to determine the effectiveness of the cleaning. Where cleaning is deemed to be unacceptable, the cleaning shall be re-done at no extra charge to the Departmental Representative.
- .5 Special Cleaning:
 - .1 Polish plated work.
 - .2 Vacuum clean and remove debris from the inside of air handling systems, fans, ducts, coils, terminal units, etc.

1.17 CUTTING AND PATCHING

- .1 Conform to the Requirements of section 017300 – Execution Requirements.
- .2 The cutting of openings not requiring lintels or other structural support will be the responsibility of the trade requiring the opening. The opening size shall be the minimum required. Patching will be the responsibility of the trades normally engaged in working with the finishing materials required to restore the opening to the original or specified conditions.
- .3 Where openings require lintels or other structural support, or roofing work, such openings will be specified under other divisions of this specification.

1.18 FIRE STOPPING

- .1 Fire Stop Materials shall be provided at all penetrations through fire and smoke separations. Refer to the Architectural Drawings for the locations of all separations.
- .2 Fire Stop Materials shall be as approved by the Authorities Having Jurisdiction.
- .3 Fire Stop Material installation shall be as per Manufacturer's recommendations.

1.19 DESIGN NOISE LEVELS

- .1 The maximum design noise levels for this project shall be as per ASHRAE Standards.
- .2 All equipment, components and systems shall be selected and installed with the intent of not exceeding these noise levels.
- .3 Where the equipment, components and systems fail to meet the noise level criteria, modifications shall be made as required, at no additional cost to the Departmental Representative.

1.20 QUALITY ASSURANCE

- .1 Conform to the requirements of Section 014500 - Quality Control.
- .2 Conform to the requirements of Section 016100 – Common Product Requirements.
- .3 Quality Assurance submittals:
 - .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .4 Welding
 - .1 Only persons who have passed welding tests to the satisfaction of the Authorities Having Jurisdiction and who are certified by them to be qualified welders, shall be permitted to do any welding on this contract.
- .5 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 product(s), 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 Obtain reports and submit immediately to Departmental Representative.
- .6 Standard Of Equipment, Materials And Components
 - .1 All equipment, materials and components shall be new and of first class quality.
 - .2 All equipment, materials and components shall be of proven design, and of current models with published ratings, for which replacement parts are available.
 - .3 All equipment, materials and components shall be tested, certified and labeled by ULC and/or CSA for use in Canada. The certification and labeling shall be appropriate for the

- intended function of the item being supplied, as dictated by the relevant codes and standards.
- .4 Where items are not adequately certified and labeled by the manufacturer, the contractor supplying the item shall be responsible for obtaining approval for the use of the item from the local Authority Having Jurisdiction, and shall bear all associated costs.
- .5 Where a manufacturer's name, make or model is specified, it is for the sole purpose of setting a standard of quality, performance, capacity, appearance, size and/or serviceability
- .6 Use only Copper, Bronze, Brass and Stainless Steel (no iron) for materials coming in contact with Domestic Water Systems.
- .7 Approved 'Substitutes' And 'Alternates'
- .1 Where a Manufacturer's name, make, model, and/or size is specified, it is for the purpose of setting a standard of quality, performance, capacity, appearance and/or serviceability, and is acceptable without qualification. Manufacturers listed as acceptable 'Substitutes' have been deemed by the Departmental Representative as capable of producing equipment and/or material of comparable quality, performance and approximate dimensions, and can be used in the preparation of the tender. Where no substitutes are indicated, provide the exact make specified.
- .2 'Substitute' equipment and material is deemed to be interchangeable with that specified, with little or no revisions required to the design intent and/or other items, equipment or connections.
- .3 'Alternate' equipment and material is deemed to be an acceptable 'Substitute' which will require major revisions to the design intent and/or other items, equipment or connections.
- .4 Requests for approval of additional 'Substitutes' or 'Alternates' must be submitted not less than ten days prior to closing date of the tender, and submissions must bear proof of acceptance by the Departmental Representative if used in the tender. Requests shall include all performance, capacity, appearance, weight, connections, power and wiring requirements, etc required for the Departmental Representative to make a complete evaluation.
- .5 Assume full responsibility for ensuring that, when providing accepted 'Substitutes' and 'Alternates', all space, weight, connections, power and wiring requirements, etc. are considered and adjusted costs are included in the tender. The Mechanical systems have been designed based on the equipment/materials of the specified manufacturer(s). The onus shall be on the Subcontractor (along with his sub-sub-contractor and the supplier) to ensure that 'Substitute' or 'Alternate' equipment/materials will meet the required performance and electrical characteristics, as well as fit properly into the allotted space, including allowance for required access and servicing. Any additional costs incurred as a result of modifications to the system(s) or the room layout, or modifications required by other trades, shall be borne by the Subcontractor (along with his sub-sub-contractor and the supplier) and shall be deemed to be included in the tender price.
- .6 Bidders must base their price on specified manufacturers or approved 'Substitutes'. 'Alternates', when allowed, must be listed separately, with the amount to be added or subtracted for each substitution. If in the preparation of the tender, this Subcontractor neglects to name the manufacturer of an accepted 'Alternate', it will be understood that specified or 'Substitute' equipment will be provided.
- .7 If, in the opinion of the Departmental Representative, 'Substitute' equipment/material submitted for review as Shop Drawings is not satisfactory, satisfactory equipment/material of the specified or an accepted 'Substitute' manufacturer must be re-submitted.

- .8 If, in the opinion of the Departmental Representative, 'Alternate' equipment/material submitted for review as Shop Drawings is not satisfactory, satisfactory equipment/material of the specified or an accepted 'Substitute' manufacturer must be re-submitted.
- .9 APPROVED 'SUBSTITUTES'
- .1 The following is the list of pre-approved 'Substitutes':
- | | | | | | |
|-----|-----------------------------------|------------------------------------|---------------|---------------------|--------------|
| .1 | Access Doors: | Lehage; | Milcor; | Acudor; | Mifab; |
| .2 | Actuators for Valves and Dampers: | | | Belimo | |
| .3 | Air Filters: | Farr; | AAF; | Continental; | |
| .4 | Air Vents: | Armstrong; | Braukman; | Bell and Gossett; | |
| | | Maid-O-Mist; | Dole; | Hamlet and Garneau; | |
| .5 | Back Flow Preventors: | Conbraco; | Beeco; Febco; | Watts; | |
| | | Kunkle; | Taylor; | Consolidated; | |
| | | Fisher; | Singer; | Crosby-Ashton; | |
| | | Boylston; | Lonergan; | Masoneilan; | Wilkins |
| .6 | Chemical Treatment: | Bird Archer; | Calgon; | | |
| | | Dearborne; | Mogul; | Drew Chemical; | |
| .7 | Controls : | Landis and Steafa (Siemens); | Johnson; | | |
| | | Barber Coleman (Siebbe); | Honeywell; | | |
| | | Mikkelson Coward (Andover); | CSE/Delta; | | |
| | | BSD (Building Systems Design Ltd.) | | | |
| .8 | Hydronic System Accessories: | Caleffi; | Bell Gosset; | Taco; | Spirax/Sarco |
| | | | | Flexhose | |
| .9 | Insulation (General): | Fibreglas; | Manson; | Knauf; | |
| .10 | Level and Flow Switches: | | Magnetrol; | | |
| .11 | Mechanical Grooved Pipe Joints: | | Gruv-Lok; | Victaulic | |

1.21 WARRANTIES

- .1 No certificate issued, payment made, or partial or entire use of the system(s) by the Departmental Representative, shall be construed as acceptance of defective work or material.
- .2 Include copies of all warranty and guaranty certificates and declarations in the Operating and Maintenance Manuals, in the appropriate sections.
- .3 Provide a certificate or declaration indicating the warranty and conditions.
- .4 Warranty satisfactory operation of all work and equipment installed under this contract. Repair or replace at no charge to the Departmental Representative, all items which fail or prove to be defective within the Warranty period, provided that the failure is not due to improper usage by the Departmental Representative. Make good all damages incurred as a result of the failure and of the repair of the system(s).
- .5 The warranty shall be for all parts and labour. Do not expect any participation from the Departmental Representative's personnel in the correction of warranty related work.

- .6 For systems, equipment and components which are used continuously throughout the year, the normal warranty period shall be one calendar year from the date of Substantial Completion. For seasonal equipment, components and systems which are not normally used continuously throughout the year, the warranty period shall include at least one full season of satisfactory operation.
- .7 When equipment or systems are put into use subsequent to the acceptance of the building, or a portion of the building, the warranty period for seasonally used equipment and systems shall be deemed to commence from the date of satisfactory operation, not from the date of final acceptance by the Departmental Representative.
- .8 The Departmental Representative retains the right to demand, and to receive, an extension of the original construction warranty for any equipment, component or system which consistently fails to perform, or which requires repeated repair or adjustment.
- .9 Wherever manufacturer's warranties in excess of the Contractor's warranty are provided, furnish the Departmental Representative with copies of the Certificates, dated and acknowledged, and inserted in the O and M Manuals. The Contractors Warranty shall include a list of the Manufacturer's extended warranties.
- .10 Warranty work shall be carried out within a reasonable time period following the reporting of the problem. Should the repair time for any failed component be unreasonably long, as determined by the Departmental Representative, make alternate arrangements to have a temporary replacement component made available until such time that the original component is repaired and re-installed. There shall be no additional cost to the Departmental Representative for any temporary replacement component or for any labour required to implement the work.

1.22 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 - Closeout Submittals.
- .3 Shop drawings:
 - .1 Submit for approval after award of contract.
 - .2 Product Information may contain standard manufacturer's brochures, catalogue sheets, schematics, diagrams performance charts, illustrations, etc., but must have:
 - .1 Information which is not applicable crossed off
 - .2 Available listed options which are being provided clearly marked
 - .3 Shop Drawings submitted by the Contractor shall contain:
 - .1 Project Information such as Name and Address
 - .2 Contractor Information such as Name, Address, Phone Numbers
 - .3 Supplier Information such as Name, Address, Phone Numbers
 - .4 Equipment Identification using the same System Name and Identification Number as the Contract Documents.

- .5 Manufacturer's printed product literature, specifications and datasheets including product characteristics, performance criteria, and limitations
- .6 All Equipment Information required for Departmental Representative to assess suitability such as:
 - .1 Mounting arrangements and Operating and Maintenance clearances.
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Make, Model, Size
 - .1 including schedules where numerous similar items are provided
 - .3 Physical Data such as:
 - .1 Dimensions
 - .2 Materials
 - .3 Weights
 - .4 Installation Requirements
 - .5 Installation Clearances
 - .4 Performance Data such as:
 - .1 Volume
 - .2 Pressure
 - .3 Capacity
 - .4 Performance Curves (with specified performance clearly marked)
 - .5 Acoustical sound power data, where applicable.
 - .5 Motor Data such as:
 - .1 Horse Power
 - .2 Voltage/Phases
 - .3 Efficiency
 - .6 Specialty Items such as:
 - .1 Bearings
 - .2 Filters
 - .3 Internal Controls including safety lockouts

- .4 Safety Items such as relief valves and regulators
 - .5 Options
 - .7 Wiring and Control Diagrams
 - .8 Manufacturer to certify current model production.
 - .9 Certification of compliance to applicable codes.
- .4 Shop Drawing Review:
 - .1 In addition to project identification, date, etc., the form of stamp used in shop drawing review shall contain the following format:
 - .1 Reviewed
 - .2 Reviewed As Noted
 - .3 Revise and Re-Submit
 - .4 Not Reviewed
 - .2 This review by the Departmental Representative is for the sole purpose of ascertaining conformance with the general design concept.
 - .3 This review shall not mean that the Departmental Representative approved the detail design inherent in the shop drawings, the responsibility for which shall remain with the Sub-contractor submitting same, and such review shall not relieve the Sub-contractor of his responsibility for errors or omissions in the shop drawings, or of his responsibility for meeting all the requirements of the contract documents. The contractors are responsible for confirming and correlating dimensions at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all sub-trades, as well as compliance with codes and inspection authorities such as C.S.A., etc.
- .5 Closeout Submittals:
 - .1 Conform to the requirements of Section 017800 - Closeout Submittals.
 - .2 Approvals:
 - .1 Operation and maintenance manual and Record Drawings approved by Departmental Representative, and final copies deposited with Departmental Representative before final inspection.
 - .2 Submit copies of draft Operation and Maintenance Manual and Record Drawings to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

- .3 Present all copies of the Operation and Maintenance Manuals and Record drawings to the Departmental Representative for review. The Departmental Representative will review the submittals and return them with comments. The Sub-contractor shall make all requested changes. This process shall continue until the Manuals and Record Drawings are deemed complete by the Departmental Representative. The Sub-contractor shall turn over the completed manuals to the Departmental Representative.
- .3 Provide:
 - .1 Product data and related information.
 - .2 Operation and maintenance data and related information.
 - .3 Record and As-built Drawings
 - .4 Spare parts, special tools and maintenance materials.
 - .5 Warranties and bonds.
- .4 Product Data shall include copies of approved shop drawings.
- .5 Performance data to include:
 - .1 Manufacturer's Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Manufacturer's Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .4 Equipment performance verification test results.
 - .5 Special performance data as specified.
 - .6 Testing, adjusting and balancing reports as specified in Section 230593 - Testing, Adjusting and Balancing for HVAC.
- .6 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.
- .7 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.
- .8 Maintenance material:
 - .1 Furnish spare parts in accordance with Section 017800 - Closeout Submittals
 - .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 017800 - Closeout Submittals.
- .9 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .10 Record Drawings
 - .1 Obtain two sets of white prints and, as the job progresses, mark these prints to accurately indicate the installed work. Have the white prints available for inspection at the site at all times, and present for scrutiny at each job meeting.
 - .1 G.C. will provide mechanical construction drawings for the Mechanical Contractor to mark-up as 'Record Drawings'.
 - .2 Mark changes as work progresses and as changes occur
 - .3 Make available for reference purposes and inspection.
 - .4 Provide marked-up sets of prints as required for each phase of work.
 - .2 At the completion of the work, submit these sets of "Record" drawings to the Departmental Representative for review. Make changes as requested by the Departmental Representative and resubmit. This process will continue until the "Record" drawings are deemed complete by the Departmental Representative.
 - .3 These 'Record' drawings will be copied to become the 'As-built' Drawings
 - .4 Submit completed 'Record' drawings with Operating and Maintenance Manuals.
- .11 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

- .1 Arrange and pay for three copies of the final 'Record' Drawings to be produced and labeled 'As-built'.
- .2 Transfer information from 'Record' Drawings to 3 additional copies, revising these copies to show work as actually installed.
- .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).
 - .1 Submit to Departmental Representative for approval and make corrections as directed.
- .3 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .4 Submit completed 'As-built' drawings with Operating and Maintenance Manuals.
- .6 Quality Assurance Submittals:
 - .1 Conform to the requirements of Section 013529.06 – Health and Safety Requirements.
 - .2 Conform to the requirements of Section 014500 – Quality Control.
 - .3 Conform to the requirements of Section 016100 – Common Product Requirements.
 - .4 Conform to the requirements of Section 017421 – Construction/Demolition Waste Management and Disposal.

1.23 COMMISSIONING

- .1 General
 - .1 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
 - .2 Systems Commissioning will be conducted prior to turnover to the Departmental Representative. The purpose of the Commissioning is to ensure all systems are functioning as designed prior to building turnover to the Departmental Representative.
 - .3 Commissioning will require the presence of knowledgeable representatives of the necessary Mechanical Sub-sub-contractors, Major Equipment Suppliers and Facility Maintenance Staff. Include all necessary costs for systems commissioning. The Departmental Representative will participate to the extent deemed necessary.
 - .4 All aspects of the mechanical systems operations will be operated, checked and verified. If any portion of the work fails to meet the design requirements, the Commissioning procedure will be halted and only resumed when all necessary repairs are completed.
 - .1 All extra costs resulting from this postponement, including costs for the Departmental Representative to revisit the site, will be borne by the Sub-Contractor.

- .5 Provide and pay for all required testing and repairs where, in the opinion of the Departmental Representative, Manufacturer's ratings or specified performance is not being achieved.
- .2 Intent
 - .1 The intent of the Commissioning Process is to provide assurance that the system(s) are:
 - .1 Installed and complete as designed and specified.
 - .2 Functioning as intended.
 - .3 Optimized to meet the performance criteria specified and implied in the Contract Documents.
 - .2 The Departmental Representative will not take over the Systems without complete acceptable Verification and Certification.
- .3 The Commissioning Agent:
 - .1 May be in the direct employ of the Mechanical Contractor, and may be the Project Coordinator or Foreman.
 - .2 May be an individual or agency hired on a Contract Basis to undertake the Commissioning Process.
- .4 Commissioning Process
 - .1 The Commissioning Process will consist of the following:
 - .1 Periodic Inspections by the Departmental Representative.
 - .2 Start-up of the Systems and Equipment by the Mechanical Contractor.
 - .3 Testing and Balancing of the System Components by the Mechanical Contractor and his Sub-sub-contractors.
 - .4 Verification and Certification of System Components by the Commissioning Agent
 - .5 Performance Testing by the Departmental Representative and/or his Representatives.
- .5 Site Review
 - .1 Periodic site review by the Departmental Representative and/or their Representatives of the Mechanical Systems during Installation will be made to ensure General Compliance with the Contract Documents
 - .2 The Sub-Contractor's work will be reviewed periodically by the Departmental Representative, or their representatives, solely for the purpose of determining the general quality of the work. Guidance will be offered to the contractors in regard to interpretation of plans and specifications, to assist them in carrying out the work. Site reviews, and directives given to the contractors, do not relieve the Contractor, and his agents, servants and employees, of his responsibility to provide the work in all of its parts, in a safe and workmanlike manner, and in accordance with the plans and specifications, nor impose

upon the Departmental Representative or their representatives, any responsibility to supervise or oversee the erection or installation of any work.

- .3 The Departmental Representative will issue site observation reports and deficiency lists from time to time. All deficiencies shall be cleared up to the satisfaction of the Departmental Representative within a reasonably short time.

.6 Start-Up

- .1 Conform to the requirements of Section 230802 – Cleaning and Start-up of Mechanical Piping Systems
- .2 Start-up shall only be undertaken after a complete review of the Equipment and Systems
 - .1 All Systems must be clean and ready for use.
 - .2 All System Safeties must be in place.
- .3 Start-up of the Systems and Equipment is the responsibility of the Mechanical Contractor
 - .1 The presence of knowledgeable representatives of the necessary Mechanical Sub-sub-contractors and Major Equipment Suppliers may be required.
 - .2 In some instances, especially where existing Equipment and Systems are being used, the presence of the Facility Maintenance Staff will be required.
 - .3 The Mechanical Contractor will be responsible for Coordinating all necessary personnel, equipment and materials.
- .4 All System Start-up Check Sheets must be completed at the time of Start-up.
- .5 Copies of the Start-up Check Sheets are to be submitted to the Commissioning Agent immediately after Start-up.

.7 Testing And Balancing

- .1 Conform to the requirements of Section 014500 - Quality Control.
- .2 Conform to the requirements of Section 017700 – Closeout Procedures
- .3 Conform to the requirements of Section 230593 – Testing, Adjusting and Balancing for HVAC.
- .4 Conform to the requirements of Section 230801 – Performance Verification of Mechanical Piping Systems.
- .5 Testing and Balancing of the System Components is the responsibility of the Mechanical Contractor and his Sub-sub-contractors.
- .6 Testing and Balancing shall only be undertaken after the Systems and Equipment have been started-up and run-in to the extent that the Systems are relatively stable and there are no obvious deficiencies or problems.
- .7 Preliminary Copies of the Testing and Balancing Report are to be submitted to the Commissioning Agent immediately after Testing and Balancing.
- .8 Safety Device Testing

- .1 Make complete inspections of all safety devices such as: back flow preventers, fire extinguishers, hose cabinets; freeze protection devices; fire dampers, smoke dampers, fire stops, and the like to ensure:
 - .1 That safety devices are complete in accordance with the specifications and Manufacturer's recommendations.
 - .2 That the safety devices are connected and operating according to all local regulations, and appropriate access is provided.
- .9 On completion of the inspections and tests, provide letters and/or certificates, confirming that inspections and tests have been completed. Insert in each O & M Manual.
- .8 Verification And Certification
 - .1 Verification and Certification shall be undertaken in stages:
 - .1 After Start-up, for review of the installed systems.
 - .2 After Testing and Balancing, for review of system operation.
 - .2 Outline of Work:
 - .1 The Commissioning Agent shall perform the following tasks:
 - .1 Review all system documentation including:
 - .1 The Contract Documents.
 - .2 The Operation and Maintenance Manuals.
 - .3 The 'As-Built' and 'Record' Drawings.
 - .4 The Air and Water Balance Reports.
 - .5 All Test Results.
 - .2 Ensure all documentation is complete.
 - .1 Notify the Contractors of any deficiencies.
 - 1. Review corrected documentation.
 - .2 Review, Notification and re-review shall continue until all documentation is complete.
 - .3 Review the installed systems to ensure that they are complete and correct.
 - .1 Notify the Contractors of any deficiencies.
 - 1. Review corrected installations.
 - .2 Review, Notification and re-review shall continue until all installations are complete.
 - .4 Operate the systems to ensure they are functioning properly.
 - .1 Function Review shall include:
 - 1. All setpoints are properly set.

2. All balance points are properly set.
 3. Sequences of Operation are correct.
 - .2 Notify the Contractors of any deficiencies.
 1. Review corrected installations.
 - .3 Review, Notification and re-review shall continue until all systems are functioning properly.
 - .5 Provide a Preliminary Report to the Departmental Representative.
 - .6 Provide a copy of the final Report in each Operation and Maintenance Manual.
- .9 Performance Verification
 - .1 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
- .10 Report
 - .1 The Report shall contain a detailed sequence of the Verification Procedure, with the appropriate system responses, and a Letter of Certification of Operation.
 - .2 The Report shall contain a completed copy of all Start-up and Verification Check Sheets.
 - .3 Provide a preliminary copy of the Report to the Departmental Representative.
 - .1 The Departmental Representative will review the Report and request Clarifications and Revisions.
 - .1 After all Clarifications and Revisions have been completed, the Report will be deemed Final.
 - .4 Provide a copy of the Final Report in each Maintenance Manual.
- .11 Performance Testing
 - .1 Performance Testing by the Departmental Representative and/or his Representatives will commence after the Systems have been turned over to the Departmental Representative.
 - .2 The Departmental Representative reserves the right to call in Third Party Individuals or Companies to verify that the Systems and Equipment are operating as specified.
- 1.24 INSTRUCTIONS TO DEPARTMENTAL REPRESENTATIVE
 - .1 Prepare a suitable list/sign-off sheet to indicate the instructions and materials have been provided
 - .1 List shall Include all Systems.
 - .2 List shall Include all Materials.
 - .3 List shall include spaces for Sign-off Names and Dates for the Departmental Representative's Representative.

- .2 Instruct the Departmental Representative's representatives in all aspects of the operation of the systems and equipment.
- .3 Demonstration
 - .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
 - .2 Manufacturers representatives to provide demonstrations and instructions where required
 - .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Arrange and pay for the services of Manufacturers' representatives required for the instruction on specialized portions of the installation.
- .5 Present all copies of the Final Operation and Maintenance Manuals to the Departmental Representative.
- .6 Present all copies of the Final Record Drawings to the Departmental Representative.

1.25 OPERATION REQUIREMENTS

- .1 Include:
 - .1 Cleaning materials and schedules.
 - .2 Repair and maintenance materials and instructions.
- .2 Special Tools And Spare Parts
 - .1 Prepare a Suitable List/Sign-off Sheet to indicate the Materials provided.
 - .1 List shall Include all Materials.
 - .2 List shall include spaces for Sign-off Names and Dates for the Departmental Representative's Representative.
 - .2 Identify spare parts containers as to contents and replacement parts number.
 - .3 Provide one set of all specialized tools required to service equipment as recommended by the Manufacturers.

1.26 DOCUMENTATION AND SYSTEM(S) ACCEPTANCE

- .1 The Contractor shall prepare a suitable document to be signed by the Departmental Representative, confirming:
 - .1 The Departmental Representative has received satisfactory instruction in the operation and maintenance of all equipment and systems.
 - .2 The Operation and maintenance manuals have been received and reviewed by the Departmental Representative.

- .3 The "Record" and "As-built" drawings have been received and reviewed by the Departmental Representative.
- .4 Specified spare parts, components, keys, removable handles, tools and the like, have been accepted by the Departmental Representative.

1.27 TEMPORARY AND TRIAL USAGE

- .1 The Departmental Representative has the privilege of trial usage of mechanical systems, or parts thereof, for the purpose of testing and learning the operational procedures.
- .2 Assist in the trial usage over a length of time, as deemed reasonable by the Departmental Representative, at no extra cost, and do not waive any responsibility because of trial usage.
- .3 Trial usage shall not be construed as acceptance by the Departmental Representative.
- .4 Provide and pay for all testing required on the system components where, in the opinion of the Departmental Representative, Manufacturer's ratings or specified performance is not being achieved.

1.28 TEMPORARY SERVICES

- .1 Do not use any of the permanent mechanical systems during construction unless specific written approval is obtained from the Departmental Representative.
- .2 The use of permanent facilities for temporary construction service shall not affect, in any way, the commencement date of the warranty period.
- .3 If the permanent mechanical systems are used during construction, the equipment and systems shall be cleaned and refurbished as required to bring them back to a new/unused condition.

1.29 CHANGING OF EQUIPMENT DRIVES

- .1 If required, as determined from the review of the preliminary balancing report, changes to the equipment drives shall be carried out as follows:
 - .1 The Balancing Contractor shall be responsible for calculating the new drive requirements.
 - .2 For new equipment, the Contractor who supplied the equipment shall be responsible for obtaining and installing the new drive components.
- .2 This contract shall include one drive change for each New Fan with adjustable pulley drive.

1.30 COMPLETION

- .1 The Contractor shall be aware that it is the Departmental Representative's intention to withhold recommendations for payment of progress claims totalling more than 95% of the mechanical contract until the project is declared Substantially Complete.

- .2 The close-out procedure may entail a take-over and occupancy of the building in more than one stage, depending on the specified phasing and the Departmental Representative's timetable.
- .3 SUBSTANTIAL COMPLETION
 - .1 The project will be ready for a Substantial Completion inspection only when it is ready for the Departmental Representative to occupy and utilize the building for it's intended purpose.
 - .2 At Substantial Completion, the Departmental Representative will realise that some deficiencies may still exist.
 - .3 In preparation for the inspection to determine Substantial Completion for all or a portion of the project, the Contractor shall ensure and declare in writing that:
 - .1 Except for seasonal deficiencies, the Start-up and Verification of the Commissioning Process has been completed, and all systems are fully functional.
 - .2 All systems and equipment have been cleaned.
 - .3 All systems and equipment have been identified and labelled.
 - .4 The preliminary Record drawings have been submitted for review.
 - .5 The Preliminary O and M Manuals have been submitted for review.
 - .6 The Preliminary Testing and Balancing Report has been submitted for review.
 - .7 Instructions to the Departmental Representative's Representative have been given.
 - .8 Maintenance Materials and Spare Parts have been provided.
 - .4 When the Contractor is satisfied that the entire project is completed, and after making his own inspection, he shall apply, in writing, to the Departmental Representative, for an inspection to determine if the project can be deemed to be Substantially Complete.
 - .5 In the letter of request, a date shall be specified upon which the project can be delivered and be Substantially Complete.
 - .6 During the inspection, a deficiency list will be compiled and a report will be issued. These deficiencies shall be corrected or completed in a satisfactory and timely manner.
 - .7 Based on the inspection report, the Departmental Representative will retain a sum of money, sufficient in his estimation to cover the cost of completing the deficiencies.
- .4 TOTAL COMPLETION
 - .1 When the Contractor has determined that the deficiencies noted during the Substantial Completion inspection have been completed or corrected, he shall apply, in writing, to the Departmental Representative, for a final inspection to determine if the project can be deemed to Totally Complete.

- .2 In the letter of request, a date shall be specified upon which the project can be delivered and be Totally Complete.
- .3 In preparation for the inspection to determine Total Completion for all or a portion of the project, the Contractor shall ensure and declare in writing that:
 - .1 All aspects of the Commissioning Process have been completed.
 - .2 The final Record and As-Constructed drawings have been submitted, reviewed and accepted.
 - .3 The final O and M Manuals have been submitted, reviewed and accepted.
 - .4 The final Balancing Reports have been submitted, reviewed and accepted.
 - .5 The deficiencies noted during the Substantial Completion inspection have been corrected or completed.
- .4 During the inspection, a deficiency list will be compiled and a report will be issued. These deficiencies shall be corrected or completed in a satisfactory and timely manner.
- .5 Based on the inspection report, the Departmental Representative will retain a sum of money, sufficient in his estimation to cover the cost of completing the deficiencies.
- .6 Final Payment will only be made after the project has been determined to be Totally Complete, with all deficiencies satisfactorily corrected.

PART 2 PRODUCTS

2.1 ACCESS PANELS AND DOORS

- .1 The Contractor and Sub-contractor shall coordinate as required to ensure that access doors supplied by different sub- and sub-sub-contractors shall be of the same manufacturer, and of a style appropriate for the intended use.
- .2 Provide access doors with the same fire rating of the wall or ceiling in which it is installed.
- .3 Lay-in type tiles, properly marked, may serve as access panels.
- .4 In concealed locations, provide access doors of welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat.
- .5 All access panels and doors shall be minimum 300 mm x 300 mm (12" x 12"). Where personnel entry is required, minimum size shall be 600 mm x 600 mm (24" x 24").

2.2 SLEEVES

- .1 Provide the following for pipe sleeves:
 - .1 Through interior walls, exterior walls above grade, interior non waterproof floors: Machine cut schedule 40 steel pipe, medium cast iron or 18 gauge galvanized steel or plastic.
 - .2 Through walls below grade, waterproof floors, floors in janitor's closets, equipment rooms, and kitchens: machine cut medium cast iron, D.W.V. copper or copper sheet extended 100 mm (4") above the floor and cut flush with the underside.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Conform to the requirements as outlined in this Section
- .2 Conform to the requirements of Section 210720 – Thermal Insulation for Piping.
- .3 Conform to the requirements of Section 230505 – Installation of Pipework.
- .4 Conform to the requirements of Section 230554 – Mechanical Identification.
- .5 Install equipment, ductwork, conduit and piping in a workmanlike manner to present a neat appearance and to function properly to the acceptance of the Departmental Representative.
 - .1 Install ducts and pipes parallel and perpendicular to building planes.
 - .2 Install piping and ductwork concealed in chases, behind furrings or above ceilings.
 - .3 Install exposed systems neatly, and group to present a neat appearance.
- .6 Include in the work all requirements of manufacturers shown on the shop drawings.
- .7 Replace all work unsatisfactory to the Departmental Representative without extra cost.
- .8 Leave space clear and install all work to accommodate future materials and/or equipment as indicated and to accommodate equipment and/or materials supplied by other trades.
 - .1 Coordinate and Verify spaces in which work is to be installed.
 - .2 Install pipe runs etc., to maintain maximum headroom and clearances and to conserve space in shaft and ceiling spaces.
- .9 Confirm on the site the exact location of outlets and fixtures. Confirm location of outlets for equipment supplied by other trades.

3.2 CLEARANCES:

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.
- .3 Install all equipment and apparatus requiring wiring, maintenance, adjustment or eventual replacement with due allowance therefore.

3.3 PROTECTION

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

- .2 Cover openings in equipment, and cover equipment where damage may occur to the finish from weather or construction.
- .3 Cover temporary openings in ducts and pipes with polyethylene sheets, until final connection is made.

3.4 RIGGING OF EQUIPMENT

- .1 Provide all rigging, hoisting and handling of equipment as necessary in order to place the equipment in the designated area in the building.
- .2 Direct this work by qualified people normally engaged in rigging, hoisting and handling of equipment.

3.5 FLASHING

- .1 Flash all mechanical parts passing through or built into an outside wall, or a waterproof floor.
- .2 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.
- .3 Provide counterflashing on stacks, ducts and pipes passing through roofs to fit over curb flashing.

3.6 PAINTING

- .1 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on the job. Clean up or wire brush all equipment, etc., before painting. Finish painting will be by other Divisions unless otherwise noted.
- .2 This Sub-Contractor is not required to prime coat or paint ductwork or piping, except to paint gas piping as per code requirements.
- .3 For factory applied finishes, including prime coats, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.7 ACCESS PANELS AND DOORS

- .1 Install all concealed Mechanical equipment requiring adjustment or maintenance in locations easily accessible through access panels or doors. Install systems and components to result in a minimum number of access panels.
- .2 Provide access doors in walls and ductwork at all fire dampers, motorized dampers, duct mounted coils, smoke detectors, fan inlets and outlets, etc. Indicate access panels on "Record" drawings.
- .3 Access doors shall be supplied by the trade requiring the door, and shall be installed by the appropriate architectural or finishing trade. All pertinent information required for the installation of the access door shall be provided by the supplying trade to the installing trade.
- .4 Prepare detail drawings showing location and type of all access doors in coordination with other trades before proceeding with installation and hand these to the Contractor for approval.
- .5 Size access doors to provide adequate access and commensurate with the type of structure and architectural finish.

- .6 Ensure proper rating of doors in fire separations.

3.8 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and 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: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to the requirements of the Listed firestopping installation instructions and the requirements of the Local Authority Having Jurisdiction.
- .2 Uninsulated unheated pipes not subject to movement: No special preparation.
- .3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.10 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

END OF SPECIFICATION SECTION 23 05 01

PART 1 GENERAL

1.1 GENERAL

- .1 Common Work Requirements for all Mechanical Piping Systems, including valves, fittings, appurtenances and equipment.

1.2 REFERENCES

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

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Install in accordance with all applicable Local Code, and local authorities having jurisdiction.
- .2 Follow the Requirements of Section 230501 – Common Work Results – Mechanical
- .3 Install using Manufacturer's Recommended Installations.

3.2 INSTALLATION - PIPING

- .1 The piping shown on the drawings is diagrammatic for clearness in indicating the general run and connections, and may or may not be, in all instances, shown in its true position. This does not relieve the contractor from the responsibility for the proper erection of systems of piping in every aspect suitable for the work intended and as described in the specifications.
- .2 Install all piping in the best workmanlike manner in accordance with the best practices of the trade.
- .3 Install brass and copper pipe tubing free from surface damage. Replace damaged pipe or tubing.
- .4 Lay copper tubing so that it is not in contact with dissimilar metal and will not be kinked or collapsed.
- .5 Where steel piping is required to be buried, apply two coats of flint-guard 410-02 (or equal) bituminous paint to all buried surfaces after assembly and testing.
- .6 Install groups of piping parallel to each other on trapeze hangers, spaced to permit service access, application of insulation, and identification.

- .7 Install piping straight, parallel and close to walls and ceilings, with specified pitch. Use manufactured fittings for direction changes.
- .8 Install piping to avoid any interference with the installation of equipment, other piping, ducts etc. Where it is necessary to offset piping to avoid obstructions, use 45 degree rather than 90 degree elbows.
- .9 Provide long turn pipe fittings not less than pipe wall thickness. Provide line size tees, and where branch lines are more than two sizes smaller than the main, weldolets may be used.
- .10 All openings in pipes and fittings shall be kept plugged or capped during installation, to prevent the entry of dirt and debris.
- .11 Install systems so that they can be thoroughly drained and all air eliminated. Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
- .12 Slope all condensate drip drains, and provide suitable cleanouts on every other change in direction.
- .13 Ream the ends of pipes and tubes before installation. Clean the ends of pipes/tubing, and the recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .14 During welding or soldering procedures, provide a fire retardant cloth, mat or blanket to protect the structure, and adequate fire protection equipment at all locations where work is being done. Close off shaft or confined areas with a fire retardant mat or cloth to prevent sparks or pieces of hot metal from falling down the shaft or area way.
- .15 Make all threaded pipe joints using a thread paste or teflon tape applied to the male thread. Use only non-toxic lubricants which are non-injurious to the gasket material, and suitable for the service for which the pipe is to be used. Use of hemp or similar materials on threaded joints will not be permitted.
- .16 Place all valves and specialties to permit easy operation and access.
- .17 Install gauges and thermostats to permit easy observance.
- .18 Where pipe sizes differ from connection sizes of equipment, install reducing fittings close to equipment. Reducing bushings are not permitted.
- .19 Regulate and adjust all packing glands, regulating valves and relief valves on completion of the work.
- .20 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .21 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .22 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .23 Assemble piping using fittings manufactured to ANSI standards.
- .24 Install Cold piping below and away from hot piping so as to maintain temperature of cold water as low as possible.
- .25 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.
- .26 Screwed fittings jointed with Teflon tape.
- .27 Protect openings against entry of foreign material.
- .28 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .29 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .30 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .31 Group piping wherever possible and as indicated.
- .32 Ream pipes, remove scale and other foreign material before assembly.
- .33 Provide for thermal expansion as required.

3.3 EXCAVATION AND BACKFILL

- .1 Do all excavation, bedding, backfill and related work required for mechanical work in accordance with the requirements of the General Contractor's specifications, except as varied by this article.
- .2 Grade the bottom of the pipe trench excavation as required.
- .3 In firm undisturbed soil, lay pipes directly on the soil and shape soil to fit the lower 1/3 segment of all pipes and pipe bells. Ensure even bearing along the barrels. Backfill excavation and compact to the following standard Proctor densities:
 - .1 Under Floor slabs, sand to 100% P.D.
- .4 In rock and shale excavate to 150 mm (6") below and a minimum of 200 mm (8") to either side of the pipe. Fill back with a bedding of 10 mm (3/8") crushed stone or granular 'A' gravel.
- .5 Prepare new bedding under the pipe in unstable soil, in fill, and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, at manholes and catch basins. Compact to maximum possible density and support the pipe by 200 mm (8") thick concrete cradle, spanning full length between firm supports.
 - .1 Install reinforcing steel in cradle or construct piers every 2400 mm (8 ft.) or closer, down to solid load bearing strata. Provide a minimum of one pier per length of pipe. Use the same method where pipes cross.
- .6 Where excavation is necessary in proximity to, and below the level of, any footing, provide a bed of 14,000 kPa (2000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of response as established by the Departmental Representative.
- .7 Provide support over at least the bottom one third segment of the pipe in all bedding methods.
- .8 Do not open trench ahead of pipe laying and bedding more than weather will permit.
- .9 Break up rocks and boulders and remove these by drilling and wedging. Do not use blasting unless specifically approved by the Departmental Representative. Do not use for backfill.

- .10 Do all backfilling in 150 mm (6") layers with clean selected materials acceptable to the Departmental Representative.
- .11 During freezing weather or where frozen material is excavated, backfill with dry sand.
- .12 Provide concrete thrust blocks at each change of direction for underground water piping, as per drawing details.
- .13 Dispose of surplus excavated material as directed by the General Contractor.

3.4 INSTALLATION - EQUIPMENT

- .1 Install piping connections to pumps and all other equipment without strain at the pipe connection to this equipment. Where requested by the Departmental Representative, remove the bolts in flanged connections, or disconnect the piping after the installation is complete, to demonstrate that the piping has been so connected.
- .2 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .3 Allow for isolation and removal of equipment without interrupting operation of other equipment or systems.
- .4 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
 - .1 All fittings N.P.S. 2 and below connecting to equipment: use unions, extra heavy duty pattern, having ground joints, brass seats and diagonal screw.
 - .2 Connections to equipment N.P.S. 2.5 and above: Flanged, standard weight provided with ring gaskets.
- .5 Provide double swing pipe joints.
- .6 Install isolation valve on inlet and balancing valve on outlet.
- .7 Install drain valve at low point.
- .8 Install manual air vent at high point.
- .9 Clean finned tubes and comb straight.
- .10 Provide supplementary suspension steel as required.
- .11 Ensure proper installation of controls.
- .12 Before acceptance, set discharge patterns and fan speeds to suit requirements.
- .13 Check final location with Departmental Representative if different from that indicated prior to installation.
 - .1 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.

3.5 CLEARANCES

- .1 Provide clearance for installation of insulation, and access for maintenance of equipment, valves and fittings.

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

3.6 MISCELLANEOUS DRAINS

- .1 Pipe all discharge from relief valves to the floor.
- .2 Pipe all discharge from drain pans and drain valves to the nearest floor drain or suitable receptacle.
- .3 Provide N.P.S. 3/4 gate valves with hose end outlets at strainers, all low points, at pumps, coils and at each piece of equipment.

3.7 LOW POINT DRAIN VALVES

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Provide hose end valves at all low points for complete system drainage, whether shown on the drawings or not.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.8 HIGH POINT AIR VENTS

- .1 Provide air vents on closed-loop water piping at all high points in the system and at each piece of equipment.
- .2 Provide automatic air vents on piping mains except where a possibility from water damage would occur, in which case, use manual vents.
- .3 Install isolating valve at each automatic air valve.
- .4 Provide manual air vents at each piece of equipment.
- .5 Install drain piping to approved location and terminate where discharge is visible.

3.9 CIRCUIT BALANCING VALVES

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

3.10 INSTALLATION - VALVES

- .1 Install in accessible locations.
- .2 Valves accessible for maintenance without removing adjacent piping.
- .3 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 Verify suitability of valve for application by inspection of identification tag.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.
- .4 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 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.
- .7 Install butterfly valves with disc in almost closed position.
- .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
- .9 Install valves with stems upright or above horizontal unless otherwise approved by Departmental Representative.
 - .1 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
 - .2 Install rising stem valves in upright position with stem above horizontal.
- .10 Install gate, ball or butterfly valves at branch take-offs, and to isolate each piece of equipment, and as indicated.
 - .1 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
 - .2 Isolate equipment, fixtures and branches with valves.
- .11 Install globe valves for balancing and in by-pass around control valves as indicated.
- .12 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- .13 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .14 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.
- .15 Install plug cocks or ball valves for glycol service.

- .16 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.
- .17 Remove interior parts before soldering.

3.11 INSTALLATION - VALVE ACTUATOR

- .1 Mount actuator on to valve prior to installation.
- .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.

3.12 CONTROL COMPONENTS

- .1 Mount all pipe line devices supplied by the control sub-contractor such as flow switches, valves, separable wells for temperature controllers and sensors.
- .2 Install control devices to guarantee proper sensing. Shield elements from direct radiation and avoid placing them behind obstructions.

3.13 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.

3.14 SLEEVES

- .1 Refer to section 230501 – Common work Results – Mechanical

3.15 PREPARATION FOR FIRESTOPPING

- .1 Refer to section 230501 – Common work Results – Mechanical

3.16 ESCUTCHEONS

- .1 Refer to section 230501 – Common work Results – Mechanical

3.17 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, prior to testing, flushing/cleaning, and start-up.
- .2 Verify that systems can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.

- .4 Ensure that air chambers, expansion compensators are installed properly.
- .5 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.
- .6 Performance Verification:
 - .1 Test performance of all components.
 - .2 Ensure all Valves are installed correctly, located where required, are operational, and are left in their final operating position.
 - .3 Measure and Adjust Pressure Regulating and Pressure Relief Valves
 - .4 Monitor Piping systems for freedom of movement and pipe expansion.
 - .5 Ensure piping has applicable labels and flow arrows.

3.18 PRESSURE TESTS

- .1 After pre-start inspection, and prior to flushing and cleaning, systems shall be pressure tested.
- .2 Do not insulate, cover or bury piping systems until completed, perfected, and proven tight.
- .3 Should leaks develop in any part of the piping system, remove and replace defective sections, fittings, etc.
- .4 Test piping system in sections as required by the progress of this and other contractors work and provide all required isolating valves.
- .5 Test piping systems and prove tight.
 - .1 Test all drain and vent piping pneumatically to a pressure of 14 kPa (2 psi) and prove tight for a period of 1 hour.
 - .2 Test all domestic water piping hydraulically to a pressure of 518 kPa (75 psi) and prove tight for a period of 4 hours.
 - .3 Test all chilled glycol and heating glycol piping hydraulically to a pressure of 690 kPa (100 psi) and prove tight for a period of 8 hours.
 - .4 For sprinkler, propane and fuel oil piping, test as required to the satisfaction of the Authorities Having Jurisdiction.
- .6 Advise Departmental Representative prior to performance of pressure tests.
- .7 Maintain specified test pressure without loss for the time noted, unless a longer period of time is required by code.
- .8 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .9 Conduct tests in presence of Departmental Representative.

- .10 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .11 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.19 FLUSHING AND CLEANING, AND CHEMICAL TREATMENT

- .1 After pressure tests have proven acceptable, and prior to chemical treatment, hydronic systems shall be flushed and cleaned as per Section 230802 – Cleaning and Start-up of Mechanical Piping Systems.
- .2 After flushing and cleaning, hydronic systems shall have chemical treatment added as per Section 232500 – HVAC Water Treatment.
- .3 Before start-up, clean interior of piping systems in accordance with requirements of Section 017411 - Cleaning.

3.20 START-UP

- .1 In accordance with Section 230802 - Cleaning and Start-Up of Mechanical Piping Systems.

3.21 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.
- .2 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .3 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
- .4 Testing:
 - .1 Test systems in accordance with Section 230801 - Performance Verification of Mechanical Piping Systems.
 - .2 For glycol systems, retest after cleaning. Repair leaking joints, fittings or valves.
- .5 Balancing:
 - .1 Balance system in accordance with Section 230593 - Testing, Adjusting and Balancing for HVAC.
 - .2 Balance water systems to within plus or minus 5% of design.

END OF SPECIFICATION SECTION 23 05 05

PART 1 GENERAL

1.1 GENERAL

- .1 Materials and installation for flexible connections, expansion joints, anchors and guides for building services piping.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Shop Drawings:
 - .1 Submit data for installed items specified in this section.
 - .2 Submit product data and indicate for item(s) as applicable:
 - .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.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .1 Data to include servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.
 - .2 Provide Spare Parts, including packing 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 and flanges to match pipe.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM 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.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug

2.2 BELLOWS TYPE EXPANSION JOINTS

- .1 For axial, lateral or angular movements, as indicated.
- .2 Type A: free flexing, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.
- .3 Type B: externally pressurized, factory tested to 1 1/2 times maximum working pressure. Furnish test certificates.
- .4 Bellows:

- .1 Multiple bellows, hydraulically formed, for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .5 Reinforcing or control rings:
 - .1 2 piece nickel iron.
- .6 Ends:
 - .1 flanges to match pipe.
- .7 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .8 Shroud:
 - .1 Carbon steel, painted.

2.3 FLEXIBLE CONNECTION

- .1 Application: to suit motion as required.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: bronze or stainless steel, corrugated.
- .4 Braided wire mesh bronze or stainless steel outer jacket.
- .5 Diameter and type of end connection: as required
- .6 Operating conditions:
 - .1 To match system requirements.

2.4 ANCHORS AND GUIDES

- .1 Anchors:
 - .1 Provide as indicated, and as required.
- .2 Alignment guides:
 - .1 Provide as indicated by conduit manufacturer.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the Requirements of Section 230501 – Common Work Results – Mechanical
- .2 Follow the Requirements of Section 230505 - Installation of Pipework.
- .3 Install using Manufacturer's Recommended Instructions.

3.2 INSTALLATION

- .1 Install expansion joints with cold setting. Make record of cold settings.
- .2 Install pipe anchors and guides as indicated. Anchors to withstand 150 % of axial thrust.

3.3 COMMISSIONING

- .1 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .2 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.

END OF SPECIFICATION SECTION 23 05 16

PART 1 GENERAL

1.1 GENERAL

- .1 Hangers and supports for mechanical piping, ducting and equipment.

1.2 REFERENCES

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

1.3 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
 - .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.

- .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

1.4 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Submit shop drawings and product data for following items:
 - .1 Fabricated stands (structural assemblies only)

PART 2 PRODUCTS

2.1 GENERAL

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

2.2 PIPE HANGERS

- .1 General:
 - .1 Provide adjustable Clevis type comparable to Grinnell Fig. 65 for pipe sizes up to and including N.P.S. 2.5. For pipe sized N.P.S. 3 and over, provide adjustable Clevis type comparable to Grinnell Fig. 260. Use rod sizes as recommended by the manufacturer.
 - .2 On copper piping, provide copper plated type hanger or separate piping from hanger with an approved insulating tape or plastic coating.
 - .3 Provide oversized hangers to pass over insulation on all insulated water piping. Use insulation saddles to protect insulation.
- .2 Finishes:
 - .1 Pipe hangers and supports: galvanized or painted with zinc-rich paint after manufacture.
 - .2 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .3 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.
 - .1 Rod: minimum 13 mm.
- .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers.
- .4 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.
 - .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.
- .5 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 to MSS SP69.
- .6 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
 - .3 Sway braces for seismic restraint systems.
- .7 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.
- .8 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .9 Adjustable clevis: material to MSS SP69, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
 - .2 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

- .3 Finishes for steel pipework: black or galvanized.
- .4 Finishes for copper, glass, brass or aluminum pipework: black or galvanized, with formed portion plastic or epoxy coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 INSERTS

- .1 Use factory-made threaded or toggle type inserts as required for supports and anchors, properly sized for the load to be carried.
- .2 Use factory made expansion shields where inserts cannot be placed, but only as approved by the Departmental Representative in writing and for light weights.
- .3 Do not use explosive powder activated tools except with the written permission of the Departmental Representative.

2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42
- .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/m³ 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.
- .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.
- .2 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 150 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 033000 - Cast-in-place Concrete.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the Requirements of Section 230501 – Common Work Results – Mechanical
- .2 Follow the Requirements of Section 230505 - Installation of Pipework.

- .3 Install using Manufacturer's Recommended Instructions.

3.2 INSTALLATION

- .1 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .2 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .3 Clevis plates:
 - .1 Attach to concrete with concrete inserts, one at each corner.
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .5 Use approved constant support type hangers where:
 - .1 vertical movement of pipework is 13 mm or more,
 - .2 transfer of load to adjacent hangers or connected equipment is not permitted.
- .6 Use variable support spring hangers where:
 - .1 transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 variation in supporting effect does not exceed 25 % of total load.

3.3 INSERTS, SLEEVES AND ESCUTCHEONS

- .1 Place inserts only in portion of the main structure and not in any finishing material.
- .2 Supply and locate all inserts, holes, anchor bolts and sleeves in time when walls, floors and roof are erected.

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.

- .4 Hanger rods may be attached to beam or joist clamps, brackets, or concrete inserts. Explosive actuated tools are not permitted. Do not weld to structural steel unless Departmental Representative's approval is given.

3.5 HANGER SPACING

- .1 Plumbing piping: to Plumbing Code and 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 Within 300 mm of each elbow.
- .6 The following tables will determine support points for all piping on this installation:

STEEL PIPE:	<u>NOMINAL SIZE</u>	<u>DISTANCE BETWEEN SUPPORTS</u>
	Up to N.P.S. 1.25	2,400 mm (8 ft.)
	N.P.S. 1.5 - N.P.S. 2.5	3,000 mm (10 ft.)
	N.P.S. 3 and over	3,600 mm (12 ft.)
COPPER PIPE:	<u>NOMINAL SIZE</u>	<u>DISTANCE BETWEEN SUPPORTS</u>
	Up to N.P.S. 3/4	1,800 mm (6 ft.)
	N.P.S. 3/4 - N.P.S. 1	2,400 mm (8 ft.)
	N.P.S. 1.25 - N.P.S. 2	3,000 mm (10 ft.)
	N.P.S. 2.5 and over	3,600 mm (12 ft.)

3.6 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.

3.7 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.

3.8 COMMISSIONING

- .1 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .2 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.

END OF SPECIFICATION SECTION 23 05 29

PART 1 GENERAL

1.1 GENERAL:

- .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
 - .1 All equipment, including motors shall come with proper nameplates affixed thereto, showing the manufacturer, make, model, size, serial number, horsepower, voltage, cycles, and all other pertinent data usually provided.
 - .2 Identify all new equipment, panels and controls with lamacoid nameplates indicating Identification Name and Number.
 - .3 Identify all new piping with direction-of-flow-arrows and service.
 - .4 Identify all new valves with brass or Lamacoid numbered tags.

1.2 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13, Standard for the Installation of Sprinkler Systems.

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Shop Drawings:
 - .1 Provide a list of all Nameplates.
 - .2 Provide a list of all Valve Tags.
- .5 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.

1.4 MAINTENANCE MATERIALS

- .1 Furnish Valve Identification Schedule

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.

2.2 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.

2.3 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 the following table

Size #	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

.4 Use maximum of 25 letters/numbers per line.

.5 Identify the name of the equipment or equipment service and it's number, ie: 'Fume Hood Exhaust Fan EF-27'.

.1 The wording shall be the same as the Drawings and Specifications. Prior to ordering, the wording of all equipment tags shall be submitted to the Departmental Representative for review.

.6 Locations:

.1 Terminal cabinets, control panels: use size # 5.

.2 Equipment in Mechanical Rooms: use size # 9.

.3 Equipment in Mechanical Room:

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Main identifier: size #9.

.3 Source and Destination identifiers: size #6.

.4 Terminal cabinets, control panels: size #5.

.4 Equipment elsewhere: sizes as appropriate.

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1 and authority having jurisdiction.

.2 Sprinklers: to NFPA 13.

2.5 IDENTIFICATION OF PIPING SYSTEMS

.1 Piping identification shall be pre-manufactured labels, suitably attached for permanence, or stencils with painted lettering. Painted stencils shall be of a suitable color to contrast with the pipe/insulation color.

- .2 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .3 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations
- .4 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .5 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.
- .6 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .7 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 or 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.
- .8 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative
 - .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	Black
Green	White
Red	White

- .3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Heating Water supply	Yellow	HGS
Heating Water return	Yellow	HGR
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR
Safety valve vent	Yellow	STEAM VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Propane gas	to Codes	
Gas regulator vents	to Codes	
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.6 VALVES, CONTROLLERS

- .1 35 mm (1-3/8") diameter Laminated Plastic or Brass tags with 12 mm high identification data. Brass tags shall have the imprinted data filled with black paint. Tags shall be secured by brass chains or thick plastic straps to the valve.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.7 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.

2.8 LANGUAGE

- .1 Identification in English.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Install using Manufacturer's Recommended Instructions.
- .3 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .4 Provide identification only after painting specified Section 099123 - Interior Painting has been completed.

3.2 NAMEPLATES

- .1 Identify all equipment, panels, automatic control devices, etc., with lamacoid name plates.
 - .1 Mechanically affix the tags to the equipment using pop rivets or sheet metal screws.
- .2 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .3 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .4 Protection:
 - .1 Do not paint, insulate or cover.

3.3 PIPING

- .1 Identify all piping as to service and direction of flow:
- .2 The service designations (i.e.: DHW, DCW, HWS, HWR, etc.) shall be the same as the Drawings and Specifications.

3.4 LOCATION OF IDENTIFICATION ON PIPING 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.

3.5 VALVES, CONTROLLERS

- .1 Provide all major valves with brass or Lamacoid numbered tags,
- .2 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.
- .3 Prepare an approved list detailing the valve location, tag numbers and purpose it serves.
 - .1 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .4 Number valves in each system consecutively.
- .5 The numbering system shall include the service designation (i.e.: DHW, DCW, HWS, HWR, etc.). The service designations shall be the same as the Drawings.

3.6 COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical
- .2 Conform to the requirements of Section 230505 – Performance Verification of Mechanical Piping Systems
- .3 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

END OF SPECIFICATION SECTION 23 05 54

PART 1 GENERAL

1.1 GENERAL

- .1 Test, adjust and balance the Mechanical Systems to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 REFERENCE STANDARDS

- .1 TAB to be to most stringent of this section or TAB standards of AABC / NEBB / SMACNA / ASHRAE.
- .2 Conform with the requirements of the drawings and specifications, the local Authorities Having Jurisdiction and the Building Code. In the case of conflicting requirements, be governed by the most severe regulations.
- .3 Conform to the most recent Associated Air Balance Council's 'National Standards for Field Measurement and Instrumentation - Total System Balance'.

1.3 QUALIFICATIONS OF TESTING AGENCY

- .1 Minimum qualifications shall be General Membership Standards of Associated Air Balance Council, as published in the AABC 'National Standards for Field Measurement and Instrumentation - Total System Balance'.
- .2 Testing Agency must be independent of affiliation with manufacturers and contractors.
- .3 The testing agency shall be a certified member of Associated Air Balance Council (AABC).
- .4 Qualifications of tab personnel
 - .1 To be current member in good standing of AABC or NEBB - or - qualified to standards of AABC or NEBB and working under direction of supervisor qualified to standards of AABC or NEBB.
 - .2 Provide documentation confirming qualifications, successful experience.
 - .3 Names of personnel it is proposed to perform TAB to be submitted and approved within 90 days of award of contract.

1.4 ACCURACY OF INSTRUMENTATION

- .1 Measuring instruments shall be accurate. Factory re-calibrate and/or recheck calibration of equipment immediately prior to use on this project.
 - .1 Prior to TAB, submit to Departmental Representative list of instruments to be used together with serial numbers.
 - .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
 - .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.
- .2 Include in the final air balance report, separate test results indicating accuracy of instrumentation.

- .3 Departmental Representative may request re-calibration or use of other instruments where accuracy is questionable.
- .4 When requested by the Departmental Representative, provide certified proof of accuracy of instrumentation at no extra cost.

1.5 APPLICATION TOLERANCES

- .1 Measured values to be accurate to within plus or minus 2 % of actual values.
- .2 Do TAB to following tolerances of design values:
 - .1 Air systems: plus or minus 5 %.
 - .2 Hydronic systems: plus or minus 10 %.

1.6 GENERAL OUTLINE OF WORK

- .1 Provide personnel for the purpose of making site visits, preparing reports and taking responsibility for ensuring that the specified air and water systems operate in accordance with specified requirements, within a tolerance of plus or minus 5%.
- .2 Review and check the Contract Drawings and specifications, and installed work, to ensure that modifications, if required, are implemented prior to the execution of the work. Provide a report to the Departmental Representative as required, making whatever recommendations are necessary in the interests of ensuring proper system balance.
- .3 After the installation is adequately completed, inspect, test and balance the specified air and water systems. Co-operate with the Controls Contractor to achieve required air quantities where modulating dampers etc., are installed.
- .4 After inspecting, testing and balancing the systems, provide a preliminary written report to the Departmental Representative.
- .5 Make any modifications to the systems as recommended by the Departmental Representative, Retest and Rebalance the System(s) as required, and submit a final report to the Departmental Representative.
- .6 In general terms, the outline of work comprises the following:
 - .1 Perform all necessary testing to confirm system conformance to the specifications and drawings.
 - .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 Perform all necessary testing, balancing and adjustments to provide peak performance of systems.
 - .1 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

- .2 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.
- .3 Submit complete reports for review by the Departmental Representative.
On the following systems:
 - .1 Heat Recovery Ventilation Units c/w associated S/A outlets and R/A inlets.
 - .2 Air Handling Units c/w associated S/A outlets and R/A inlets.
 - .3 Ceiling and In-line Washroom Exhaust Fans
 - .4 In-line S/A and T/A Fans c/w associated inlets and outlets
 - .5 Hydronic Heating Water System including:
 - .1 Boilers
 - .2 Boiler Circ Pumps
 - .3 System Circ Pumps
 - .4 Entrance Heaters
 - .5 Unit Heaters
 - .6 Heating and Reheat Coils

1.7 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 20 % of reported results.
- .3 Number and location of verified results to be at discretion of Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Departmental Representative.

1.8 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 - Closeout Procedures.
- .3 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .4 Shop Drawings:
 - .1 Submit Proposed methodology and procedures for performing TAB if different from referenced standard.
- .5 Close-out Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 017800 – Closeout Submittals.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.

2.2 REPORTS - GENERAL

- .1 Preliminary tab report
 - .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.
 - .4 Summaries.
 - .2 The Contractor shall provide two copies of the preliminary Testing/Balancing Report directly to the Departmental Representative's office for review and comment. Make any changes requested by the Departmental Representative, and re-submit two copies. Submission and re-submission shall continue in this manner until the preliminary Testing/Balancing Report has been accepted by the Departmental Representative. Copies of the final Testing/Balancing Report shall be included in the Operation and Maintenance Manuals.
 - .1 Submit 3 copies of Final TAB Report, in English in D-ring binders, complete with index tabs.
- .3 Allow for technically qualified personnel to attend meetings at the Departmental Representative's office to discuss and clarify the preliminary Testing/Balancing Report.
- .4 The review of the Testing/Balancing Report is for the sole purpose of ascertaining conformance with the general design concept. The review shall not mean approval of the detailed testing and balancing procedures inherent in the work, the responsibility for which shall remain with the contractor. The review shall not relieve the contractor of the responsibility to meet the requirements of the contract documents. The contractor shall remain responsible for confirming and correlating the information on the jobsite, and for coordinating the work with the other contractors.

2.3 REPORTS

- .1 Reports shall contain the following:
 - .1 System schematics.
 - .2 Installed Equipment Identification including:

- .1 Location and Unit Identification data.
- .2 Nameplate Data: Manufacturer, Model, Size, Discharge arrangement and class, HP, voltage, phase, cycles, and full load amps.
- .3 Installed overload heater size and manufacturer.
- .4 Identify all required pulleys, sheaves, belts, and adjustments, including sizes and quantities.
- .3 Specified design data and achieved performance data, including:
 - .1 General: HP, voltage, phase, cycles, and full load amps.
 - .2 Air Systems: Total air flow, individual air flow per outlet with supporting schematic diagrams, fan total static pressures with breakdown showing inlet and discharge pressures, fan R.P.M., O/A and R/A and REL/A air volumes, and inlet and outlet dry bulb and wet bulb temperatures across thermal transmission and mixing equipment.
 - .3 Duct Systems: Air volumes and velocities at equipment and main branches.
 - .4 Hydronic Systems: Total fluid flow, Individual fluid flow of each pump, individual fluid flow per outlet with supporting schematic diagrams, pump total static pressures with breakdown showing inlet and discharge pressures, pump R.P.M., and inlet and outlet temperatures across thermal transmission and mixing equipment.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.
- .6 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.
- .3 Co-ordination:
 - .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
 - .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

3.2 PRE-TAB REVIEW

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

3.3 START OF TAB

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

- .5 Calibrated balancing valves installed, at factory settings.
- .6 Chemical treatment systems complete, operational.

3.4 AIR SYSTEMS

- .1 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).
- .4 Prior to final inspection, adjust air systems to provide required or specified design air flow quantities. Balance systems to suit space cooling requirements, unless otherwise specified.
- .5 Measure air flow in ducts by velocity traverse of entire cross-sectional area of duct. Measure air flow with appropriate micro-manometers and/or state of the art instruments. Instrument test holes must be approved by Departmental Representative.
- .6 Measure air quantities at each inlet and outlet. Use approved tube or vane type meters.
- .7 Use volume control devices to regulate air quantities at supply air inlets and exhaust air outlets without creating objectionable air motion or sound levels.
- .8 Make final measurements only after air inlets and outlets are adjusted for optimum air distribution patterns.
- .9 Vary total system air quantities by adjustment of fan speeds. Vary branch duct air quantities by damper regulation.
- .10 Air inlet and outlet air quantities shall be within +/- 10% of specified values. Fan air quantities shall be +/- 5% of specified values.
- .11 General Balancing Procedure For Low Pressure Bypass boxes:
 - .1 This balancing procedure depends on the fan supplying the system maintaining a constant static pressure in the supply duct to the terminal unit. Bypass terminal units are pressure dependent and will need rebalancing if system duct static pressure changes. The 3400 series are shipped with both inlet and bypass balancing dampers as standard to permit ease of field balancing and to ensure accurate adjustment and optimum operation.
 - .1 Fully open the dampers of all supply outlets on the discharge duct from the terminal unit.

- .2 Place terminal in the full open position, supplying 100% air to the occupied space.
- .3 Adjust the balancing dampers located in the terminal inlet to provide the required total airflow.
- .4 Starting with the outlet furthest downstream, adjust the damper of each air outlet to the required air volume.
- .5 Take a static pressure reading at the terminal unit, using a magnehelic gauge or equivalent.
- .6 Adjust the room thermostat to provide 100% bypass airflow or the minimum air volume to the room, if a mechanical minimum air volume stop is utilized. An indicator mark on the end of the driveshaft shows damper position, 90° rotation CW to close.
- .7 Adjust the bypass outlet damper(s) on the terminal until the static pressure reading equals that obtained in step 5.

3.5 HYDRONIC SYSTEMS

- .1 Definitions: for purposes of this section, to include heating water system.
- .2 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, noise, vibration.
- .3 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of boiler, coils, pumps, PRVs, control valves, and other equipment causing changes in conditions.
 - .2 At controllers, and controlled devices.
- .4 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of primary and secondary loops (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.
- .5 Where more than one pump is connected on a hydronic system, achieved performance shall be recorded when all pumps are operating at the same time, and also when each pump is operating without the other pumps.
- .6 Ensure specified temperature drops across, and fluid flows through, all thermal transmission equipment.
- .7 Instruct piping system installers on proper locations of flow measurement ports.
- .8 Permanently mark settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

3.6 FINAL INSPECTION AND ACCEPTANCE

- .1 At final inspection, recheck to the approval of the Departmental Representative, data recorded in certified report. Points or areas for check shall be selected by the Departmental Representative.

- .2 If report is rejected, re-balance systems, submit new certified reports, and make re-inspection at no extra cost.
- .3 After acceptance of certified reports by the Departmental Representative and TAB is completed to satisfaction of Departmental Representative, permanently mark settings of valves, splitters, dampers and other adjustment devices so that adjustments can be restored if disturbed.
 - .1 Replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .4 TAB to be considered complete when final TAB Report received and approved by Departmental Representative.

3.7 START-UP AND COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Refer to Section 230801 - Performance Verification of Mechanical Piping Systems.
- .3 Provide the Equipment, Personnel, Materials and Information necessary to assist the Mechanical Contractor in completing the Commissioning Process.
- .4 Provide instructions to Departmental Representative as required.
- .5 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .6 Follow special start-up procedures specified elsewhere in these Specifications.

END OF SPECIFICATION SECTION 23 05 93

PART 1 GENERAL

1.1 GENERAL:

- .1 Procedures for performance verification of mechanical piping systems.

1.2 REFERENCES

- .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Closeout Submittals
 - .1 Provide reports for incorporation into manual specified in Section 017800 - Closeout Submittals.

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used

PART 3 EXECUTION

3.1 PERFORMANCE VERIFICATION - GENERAL

- .1 Equipment Installation:
 - .1 Ensure ease of maintenance access.
 - .2 Ensure Isolation Valves and unions are installed correctly, located where required, are operational, and are left in their final operating position.
- .2 Ensure that units are properly anchored, connected to system and effectively connected.
- .3 Ensure piping has applicable labels c/w directional arrows.
- .4 Ensure proper operation of controls.
- .5 Monitor piping systems for freedom of movement and pipe expansion.

- .6 Verify compliance with all safety and health requirements.
- .7 Ensure backflow preventers are located where required, are accessible and operational.

3.2 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Timing:
 - .1 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 in relevant technical sections, 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 Boiler and/or chiller failure.
 - .7 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

3.3 HYDRONIC SYSTEM TESTS

- .1 Timing: 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 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .3 Calculate system capacity at test conditions.

- .1 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .2 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .4 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 at all times 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 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.
 - .3 Test procedures:
 - .1 Open fully cooling coil control valves.
 - .2 Set thermostats on associated AHU's for maximum cooling.
 - .3 Set AHU's for design maximum air flow rates.
 - .4 Set load or demand limiters on chillers to 100%
 - .5 After system has stabilized, record chilled water, condenser water, etc., flow rates and supply and return temperatures simultaneously.

3.4 REPORTS

- .1 In accordance with Section 230501 under- Commissioning

3.5 TRAINING

- .1 In accordance with Section 230501 under- Commissioning: Training of O&M Personnel

END OF SPECIFICATION SECTION 23 08 01

PART 1 GENERAL

1.1 GENERAL:

- .1 Procedures for cleaning and degreasing mechanical piping systems.
- .2 Procedures for starting-up Mechanical Piping Systems.
- .3 Provide report of recommended cleaning procedures and chemicals for approval by Departmental Representative.
- .4 Flush all Heat Transfer Piping.
- .5 Clean/Degrease Heat Transfer Piping
- .6 Installation of chemicals for scale, corrosion, algae, and bacteriological control of the closed-loop circulating piping system(s).

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Shop Drawings:
 - .1 Submit data for procedures.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common work Results – Mechanical.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Follow the requirements of Section 230505 – Installation of Pipework.
- .3 Follow the requirements of Section 232500 – HVAC Water Treatment.
- .4 Install using Manufacturer's Recommended Instructions.

3.2 FLUSHING AND CLEANING OF MECHANICAL SYSTEMS - GENERAL

- .1 Flush and clean in presence of Departmental Representative's Representative.
- .2 Add chemicals under direct supervision of chemical treatment supplier.
- .3 Timing:
 - .1 Flush and clean system before the installation of any of the new Control Valves.
 - .2 Flush and clean system again after the installation of all of the new Control Valves. Systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
 - .3 Flush after pressure test for minimum of 4 hours.
 - .4 Flush, clean and disinfect systems only after all pipes, valves, fittings, fixtures and other components have been installed, tested, and proven ready for operation.
- .4 Thoroughly flush and degrease hydronic heat transfer systems and equipment with fresh water and approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Chemicals to inhibit corrosion of various system materials and be safe to handle and use. Refer to Section 232500 – HVAC Water Treatment.
- .5 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.
- .6 When filling systems with water:
 - .1 ensure air is vented from system.
 - .2 fill expansion tanks and charge system with air.
 - .3 use water meter to record volume of water in system to +/- 0.5%.
- .7 During circulation of cleaning solution, periodically examine and clean filters and screens and monitor changes in pressure drop across equipment.
- .8 If at any time during the treatment, test results prove unsatisfactory, treatment shall be stopped and redone until results prove satisfactory.

- .9 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.
- .10 Disposal of cleaning solutions to be approved by authority having jurisdiction.
- .11 Submit a written report showing methods, tests and results.
- .12 DIRT ACCUMULATION UNDER CONTROL VALVES
 - .1 If dirt accumulates under the seats of automatic control valves, this Sub-Contractor is responsible, during the first year's operation, to remove the collected materials under the valve seats and if the seat is damaged, replace same, at no additional cost to the Departmental Representative.

3.3 PROCEDURE FOR CLOSED LOOP SYSTEMS

- .1 Fill and circulate system, cleaning strainer baskets as often as necessary to ensure that scale, metal particles, etc. have been completely removed.
 - .1 Establish circulation, raise temperature slowly to maximum design. 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 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water.
- .2 Drain, flush and refill system.
- .3 Inject degreasants and circulate the fluid at temperatures, and for time periods, as required to ensure that the system is thoroughly cleaned.
 - .1 Circulate system cleaner at 60 degrees C for at least 36 h.
 - .2 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.
- .4 Drain and flush system until alkalinity of rinse water is the same as the make-up water.
 - .1 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.
 - .2 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
 - .3 Drainage to include drain valves, dirt pockets, strainers, every low point in system.
- .5 Re-install strainer screens/baskets after obtaining approval.
- .6 Refill system with clean water in preparation for administration of chemical treatment (to prevent scale and corrosion during system operation).
- .7 Administer chemical treatment and circulate the fluid.

- .8 Carefully monitor the condition of the systems from initial fill to the point at which the systems are considered under stable operating conditions.
- .9 Provide oral and written instructions to the Departmental Representative's operating personnel, for the monitoring and maintenance of the water conditioning program.
- .10 Submit a written report showing methods, tests and results.
- .11 Submit a written report of the system start-up showing water analysis and corrosion check test. Include copies in the O & M manuals.
- .12 For the first year of operation, provide service calls once every ninety days, and provide written reports to operating personnel showing details of each service call, with a copy to the Departmental Representative.

3.4 HYDRONIC SYSTEMS CLEANING REPORTS

- .1 Provide detailed report outlining proposed cleaning procedures at least 3 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.
- .2 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.
- .3 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

3.5 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, fully flushed and tested, and ready for start-up.

- .2 Verify that system can be completely drained.
- .3 Ensure that air chambers, expansion compensators are installed properly.
- .4 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
- .5 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 START-UP OF HYDRONIC SYSTEMS

- .1 Provide continuous supervision during start-up.
- .2 After pressure tests, flushing, cleaning and chemical treatment is completed and system is filled:
 - .1 Commission water treatment systems
 - .2 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .3 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.
 - .4 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .5 Establish circulation and expansion tank level, set pressure controls.
 - .1 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .2 Ensure air is removed.
 - .6 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .7 Bring system up to design temperature and pressure slowly.
 - .8 Monitor piping systems for freedom of movement, and performance of expansion joints, loops, guides, anchors.
 - .1 Adjust pipe supports, hangers, springs as necessary.
 - .2 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
 - .3 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .9 Perform TAB as specified in Section 230593 - Testing, Adjusting and Balancing for HVAC.
 - .1 Balance water systems to within plus or minus 5 % of design output.
 - .10 Check operation of drain valves.
 - .11 Adjust valve stem packings as systems settle down.

- .12 Fully open balancing valves (except those that are factory-set).
- .13 Check control, limit, safety devices for normal and safe operation.
 - .1 Measure and adjust pressure regulating valves and pressure relief valves.
- .14 Check operation of over-temperature protection devices on circulating pumps.
- .3 Rectify start-up deficiencies.

3.7 COMMISSIONING

- .1 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .2 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
- .3 Testing:
 - .1 Test systems in accordance with Section 230801 - Performance Verification of Mechanical Piping Systems.

END OF SPECIFICATION SECTION 23 08 02

PART 1 GENERAL

1.1 GENERAL:

- .1 Copper piping, valves and fittings for hydronic systems.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M, Specification Filler Metals for Brazing and Bronze Welding.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.4, Gray-Iron Threaded Fittings.
 - .2 ANSI/ASME B16.15, Cast Bronze Threaded Fittings.
 - .3 ANSI B16.18, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B32, Standard Specification for Solder Metal.
 - .2 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B88M, Standard Specification for Seamless Copper Water Tube.
- .4 Manufacturers Standardization Society (MSS)
 - .1 MSS SP67, Butterfly Valves.
 - .2 MSS SP70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP71, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP80, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS SP85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.

.4 Shop Drawings:

- .1 Submit data for valves specified in this section.

.5 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
- .2 Provide Spare Parts

1.4 MAINTENANCE MATERIALS

.1 Furnish following spare parts:

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical

2.2 TUBING

- .1 Type B hard drawn copper tubing: to ASTM B88M.

2.3 FITTINGS

- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.4 FLANGES

- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.

- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.5 JOINTS

- .1 Silver solder BCUP: to ANSI/AWS A5.8.
- .2 Brazing: as indicated.

2.6 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: flanged or grooved ends.
- .2 Gate Valves (Application: isolating equipment, control valves, pipelines):
 - .1 NPS 2 and under:
 - .1 Class 125, rising or non-rising stem, wedge disc, as specified Section 230522 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Rising or non-rising stem, wedge disc, bronze trim, as specified Section 230523 - Valves - Cast Iron.
- .3 Butterfly valves: (application: isolating each cell or section of multiple component equipment (eg. multi-section coils, multi-cell cooling towers):
 - .1 NPS 2 1/2 and over: lug type with grooved ends: as specified Section 230526 – Butterfly Valves.
- .4 Globe valves: (application: throttling, flow control, emergency bypass):
 - .1 NPS 2 and under:
 - .1 as specified Section 230522 - Valves – Bronze
 - .2 NPS 2 1/2 and over:
 - .1 With composition bronze disc, bronze trim, as specified Section 230523 - Valves - Cast Iron.
- .5 Balancing: (for TAB):
 - .1 Sizes: calibrated balancing valves, as specified.
 - .2 NPS 2 and under:
 - .1 globe, with plug disc as specified Section 230522 - Valves - Bronze
- .6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 230522 - Valves – Bronze.

- .7 Bypass valves on valves NPS 8 and larger: NPS 3/4, globe, as specified Section 230522 - Valves - Bronze.
- .8 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 230522 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 230523 - Valves - Cast Iron.
- .9 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 230522 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 230523 - Valves - Cast Iron.
- .10 Ball valves:
 - .1 NPS 2 and under: as specified Section 230522 - Valves - Bronze.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the Requirements of Section 230501 – Common Work Results – Mechanical
- .2 Follow the Requirements of Section 230505 - Installation of Pipework.
- .3 Install using Manufacturer's Recommended Instructions.

3.2 COMMISSIONING

- .1 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .2 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
- .3 Testing:
 - .1 Test system in accordance with Section 230505 – Installation of Pipework.
 - .2 Test system in accordance with Section 230801 - Performance Verification of Mechanical Piping Systems.
- .4 Balancing:

- .1 Balance system in accordance with Section 230593 - Testing, Adjusting and Balancing for HVAC.
- .2 Balance water systems to within plus or minus 5% of design.

END OF SPECIFICATION SECTION 23 21 15

PART 1 GENERAL

1.1 GENERAL

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

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2, Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67, Butterfly Valves.
 - .2 MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71, Cast Iron Swing Check Valves Flanged and Threaded Ends.

- .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
- .5 MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Shop Drawings:
 - .1 Submit data for valves specified in this section.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .2 Provide Spare Parts

1.4 MAINTENANCE MATERIALS

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.

2.2 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS6: Sched 40.
 - .2 NPS8 and over: Sched 10.

2.3 PIPE JOINTS

- .1 screwed fittings with PTFE tape or lead-free pipe dope.

- .2 welding fittings and flanges to CAN/CSA W48
- .3 Roll grooved: standard coupling to CSA B242.
- .4 Flanges: plain or raised face, slip-on or weld neck, to AWWA C111.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: to AWWA C111.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM.

2.4 FITTINGS

- .1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1, Class 125.
 - .2 Steel: to ASME B16.5.
- .3 Butt-welding fittings: steel, to ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.
- .5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M or ductile iron to ASTM A536.

2.5 VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
 - .2 NPS2.1/2 and larger: Flanged or grooved ends.
- .2 Gate valves: to MSS-SP-70 or MSS-SP-80
Application: Isolating equipment, control valves, pipelines:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 230522 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 230522 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 230523 - Valves - Cast Iron: Gate, Globe, Check.

- .2 Elsewhere: Non-rising stem, solid wedge disc, bronze trim, as specified Section 230523 - Valves - Cast Iron: Gate, Globe, Check.
- .3 Butterfly valves: to MSS-SP-67
Application: Isolating cells or sections of multiple component equipment (eg. multi-section coils, multi-cell cooling towers):
 - .1 NPS21/2 and over: Lug type Grooved ends: as specified Section 230517 - Pipe Welding.
- .4 Globe valves: to MSS-SP-80 or 85
Application: Throttling, flow control, emergency bypass:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 230522 - Valves - Bronze.
 - .2 Elsewhere: with composition disc, as specified Section 230522 - Valves - Bronze.
 - .2 NPS21/2 and over:
 - .1 With composition bronze disc, bronze trim, as specified Section 230523 - Valves - Cast Iron: Gate, Globe, Check.
 - .2 Operators: Manual.
- .5 Balancing, for TAB:
 - .1 Sizes: Calibrated balancing valves, as specified this section.
 - .2 NPS2 and under:
 - .1 Globe, with plug disc as specified Section 230522 - Valves - Bronze.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 230522 - Valves - Bronze.
- .7 Bypass valves on gate and globe valves NPS8 and larger: NPS3/4, Globe, with PTFE disc as specified Section 230522 - Valves - Bronze.
- .8 Swing check valves: to MSS-SP-71.
 - .1 NPS2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 230522 - Valves - Bronze.
 - .2 NPS21/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 230523 - Valves - Cast Iron: Gate, Globe, Check.
- .9 Silent check valves:
 - .1 NPS2 and under:

- .1 As specified Section 230522 - Valves – Bronze.
- .2 NPS21/2 and over:
 - .1 Flanged or Grooved ends: as specified Section 230523 - Valves - Cast Iron: Gate, Globe, Check.
- .10 Ball valves:
 - .1 NPS2 and under: as specified Section 230522 - Valves - Bronze.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the Requirements of Section 230501 – Common Work Results – Mechanical
- .2 Follow the Requirements of Section 230505 - Installation of Pipework.
- .3 Install using Manufacturer's Recommended Instructions.

3.2 COMMISSIONING

- .1 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .2 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
- .3 Testing:
 - .1 Test systems in accordance with Section 230505 – Installation of Pipework.
 - .2 Test systems in accordance with Section 230801 - Performance Verification of Mechanical Piping Systems.
- .4 Balancing:
 - .1 Balance system in accordance with Section 230593 - Testing, Adjusting and Balancing for HVAC.
 - .2 Balance water systems to within plus or minus 5% of design.

END OF SPECIFICATION SECTION 23 21 16

PART 1 GENERAL

1.1 GENERAL:

- .1 Provision of all required equipment, piping, and chemicals, for the flushing, cleaning and degreasing of all piping systems.
- .2 Provision of all required equipment, piping, and chemicals, for scale, corrosion, algae, and bacteriological control of the closed-loop circulating piping system(s).

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, Section VII.

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Shop Drawings:
 - .1 Submit data for items specified in this section.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .2 Provide Spare Log Sheets, Chemicals and Test Kits

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Use only chemicals and methods that comply with local health codes and do not have a detrimental effect on non-metallic materials such as rubber, neoprene etc., used in the systems.

2.2 MANUFACTURERS

- .1 Equipment, chemicals, and service by one supplier.

2.3 WATER TREATMENT EQUIPMENT FOR HYDRONIC SYSTEMS

- .1 Heating Water system: Pot feeder, 25 L, operating pressure 450 kPa.
- .2 Micron filter for each pot feeder:
 - .1 Capacity 2% of pump recirculating rate at operating pressure.
 - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

2.4 POT FEEDER

- .1 Welded steel, pressure rating 1000 kPa. Temperature rating: 90°C.

2.5 CHEMICAL FEED PIPING

- .1 Resistant to chemicals employed.

2.6 SHIPPING / FEEDING CHEMICAL CONTAINERS

- .1 High density moulded polyethylene, with liquid level graduations, cover.

2.7 CONDUCTIVITY CONTROLLER

- .1 Fully transistorized, suitable for wall or flush panel mounting, linear over full measuring range of 0-5000 micromhs.
- .2 Insensitive to phase angle shifts, capable of operating on 95-130 Volts without affecting accuracy, power, bleedoff status lights.

2.8 CONDUCTIVITY PROBES

- .1 Dual carbon elements in PVC holder, quick disconnect, self-locking connection.

2.9 CHEMICALS

- .1 Provide 1 years supply.
- .2 Disinfection
 - .1 Chlorine (gas or liquid).
 - .2 Calcium or Sodium Hypochlorite.
 - .3 other approved disinfectant
- .3 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.

2.10 TEST EQUIPMENT

- .1 Provide one set of test equipment for each system to verify performance.
- .1 Complete with carrying case, reagents for chemicals, all specialized or supplementary

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Follow the Requirements of Section 230501 – Common Work Results – Mechanical
- .2 Follow the Requirements of Section 230505 - Installation of Pipework.
- .3 Follow the Requirements of Section 230802 – Cleaning and Startup of Mechanical Piping Systems
- .4 Install using Manufacturer's Recommended Instructions.
- .5 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.

3.2 INSTALLATION

- .1 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.
- .2 Chemical feed piping:
 - .1 Install crosses at all changes in direction. Install plugs in unused connections.

3.3 WATER TREATMENT SERVICES

- .1 Provide water treatment monitoring and consulting services for period of one year after system start-up. Service to include:
 - .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant every 90 days during period of operation and as required until system stabilizes, and advise on treatment system performance.

- .5 Provide necessary recording charts and log sheets for one year operation.
- .6 Provide necessary laboratory and technical assistance.
- .7 Instructions and advice to operating staff to be clear, concise and in writing.

3.4 COMMISSIONING

- .1 Conform to the requirements of Section 230501 - Common Work Results - Mechanical.
- .2 Conform to the requirements of Section 230801 - Performance Verification of Mechanical Piping Systems.
- .3 Testing:
 - .1 Test systems in accordance with Section 230505 – Installation of Pipework.
 - .2 Test systems in accordance with Section 230801 - Performance Verification of Mechanical Piping Systems.
 - .3 For glycol systems, retest after cleaning. Repair leaking joints, fittings or valves.
- .4 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
- .5 Pre-commissioning Inspections:
 - .1 Verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests to be performed, operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of water analysis.
 - .4 Required quality of treated water.
- .6 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record all automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.

- .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
- .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
- .7 Advise Departmental Representative in writing on matters regarding installed water treatment systems.
- .7 Commissioning procedures - Closed Circuit Hydronic Systems:
 - .1 Analyse water in system.
 - .2 Based upon an assumed rate of loss approved by Departmental Representative, establish rate of chemical feed.
 - .3 Record types, quantities of chemicals applied.
- .8 Training:
 - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.
- .9 Certificates:
 - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .10 Commissioning Reports:
 - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- .11 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

END OF SPECIFICATION SECTION 23 25 00