

REPLACEMENT OF STEAM BOILERS AND COOLING TOWERS

NATURAL HERITAGE CAMPUS
1740 PINK ROAD
GATINEAU, QUEBEC

CEML 13-029

Specifications

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Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- .1 A mechanical contractor will coordinate all associated works, supply all labor, tools, services, and equipment , and supply and install all materials required to complete the works indicated on the drawings.

- .2 The Scope of work for the dismantling and replacing of the cooling towers and replacing two existing steam humidification boilers at 1740 Pink Road, Gatineau, Québec generally includes:
 - .1 Steam Boilers:
 1. Replace both existing steam boilers one at a time and adjust all associated systems for a completely operational system.
 2. Address all combustion air and damper issues by adjusting the existing size dampers and repair/patch walls to match existing while ducting the combustion air the most appropriate location within the boiler room, and adjusting the boiler room heating and ventilation issues as described and shown in the contract documents.
 3. Make the necessary adjustments to the water filtration and treatment systems to minimize the effects of the “hard water” at the steam boilers, and potentially include this work to capture the feed water to the atmospheric boilers.
 4. Make all the changes to automate controls within the boiler room to address the combustion air issues, and boiler sequencing.
 5. Contractor to replace existing chimneys and breechings with all new materials as per manufacturer’s recommendation. Dispose of old chimneys and breechings.
 - .2 Cooling Towers:
 1. Replace existing cooling towers located on the roof, one at a time in order to allow for cooling at all times.
 - .3 Perform a full flush and clean the piping systems and all associated fittings and valves associated with steam boilers and cooling towers. Blow out all accumulated debris and scale.
 - .4 Dismantle and dispose of the existing cooling tower using appropriate means.
 - .5 Dismantle and dispose of the existing steam boilers.
 - .6 Confirm condition of existing support system and applicability for new cooling tower.
 - .7 Remove existing housekeeping pads for existing boilers and provide new 3” deep housekeeping pad that is 6” larger than the boiler footprint. Once the work is complete, epoxy paint the entire boiler room floor including the housekeeping pads and paint a 3” perimeter outline of the housekeeping in a distinct yellow.
 - .8 Install new cooling tower on new seismic vibration support system.

- .9 Contractor to commission cooling towers and steam boilers using manufacturer's recommended procedures and personnel. Contractor shall tie-in into existing Building Automated Control System.
- .10 Rigging of the dismantled cooling towers as well as the new cooling towers shall be the responsibility of Contractor. Obtain all permits required during the construction of the project and operation of crane.
- .11 Dispose of all construction and demolition materials off-site. Contractor to cover costs including associated tipping fee.
- .12 All work must be completed prior to 31 Oct 2013.

1.2 WORK SEQUENCE

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction
- .3 Construct Work in stages to provide for continuous public usage. Do not close off public usage of facilities until use of one stage of Work will provide alternate usage.
- .4 Maintain fire access/control.

1.3 CONTRACTOR USE OF PREMISES

- .1 Co-ordinate use of premises under direction of Owner's Representative.
- .2 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .3 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Owner's Representative.
- .4 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

1.4 OWNER OCCUPANCY

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.5 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute work with least possible interference or disturbance to building operations and normal use of premises. Arrange with Owner's Representative to facilitate execution of work.

1.6 EXISTING SERVICES

- .1 Notify, Owner's Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Owner's Representative 72 hours' notice for necessary interruption of mechanical or electrical service throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to tenant operations.
- .3 Provide alternative routes for personnel and vehicular traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Owner's Representative of findings.
- .5 Submit schedule to and obtain approval from Owner's Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Owner's Representative to maintain critical building and tenant systems.
- .7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .8 Where unknown services are encountered, immediately advise Owner's Representative and confirm findings in writing.
- .9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .10 Record locations of maintained, re-routed and abandoned service lines.

1.7 DOCUMENTS REQUIRED

- .1 Maintain at job site, one copy each document as follows:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Reviewed Shop Drawings.
 - .5 List of Outstanding Shop Drawings.
 - .6 Change Orders.
 - .7 Other Modifications to Contract.
 - .8 Field Test Reports.
 - .9 Copy of Approved Work Schedule.

- .10 Health and Safety Plan and Other Safety Related Documents. Other documents as specified.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 ACCESS AND EGRESS

- .1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders independent of finished surfaces and in accordance with relevant municipal, provincial and other regulations.

1.2 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Owner's Representative staff to facilitate work as stated.
- .2 Maintain existing services to building and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Owner's Representative will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean.
- .5 Closures: protect work temporarily until permanent enclosures are completed.

1.3 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

- .1 Execute work with least possible interference or disturbance to building operations and occupants and normal use of premises. Arrange with Owner's Representative to facilitate execution of work.

1.4 EXISTING SERVICES

- .1 Notify, Owner's Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Owner's Representative 72 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for personnel and vehicular traffic.

1.5 SPECIAL REQUIREMENTS

- .1 Carry out noise generating Work Monday to Friday from 18:00 to 07:00 hours and on Saturdays, Sundays and statutory holidays.
- .2 Submit schedule in Critical Path Method (CPM) format.
- .3 Ensure that Contractor personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.

- .4 Keep within limits of work and avenues of ingress and egress.

1.6 SECURITY CLEARANCES

- .1 Personnel employed on this project will be subject to security check. Obtain clearance as instructed for each individual who will require it to enter the premises.
- .2 Personnel will be checked daily at start of work shift and provided with pass which must be worn at all times. Pass must be returned at end of work shift and personnel checked out.

1.7 BUILDING SMOKING ENVIRONMENT

- .1 Comply with smoking restrictions. Smoking is not allowed in the building.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Submit to Consultant and Owner's Representative submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by submittal until review is complete.
- .3 Present shop drawings, product data in SI Metric units.
- .4 Where items or information is not produced in SI Metric units converted values are acceptable.
- .5 Review submittals prior to submission to Consultant and Owner's Representative. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .6 Notify Consultant and Owner's Representative, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .7 Verify field measurements and affected adjacent Work are co-ordinated.
- .8 Contractor's responsibility for errors and omissions in submission is not relieved by Consultant's and Owner's Representative review of submittals.
- .9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Consultant and Owner's Representative review.
- .10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

- .3 Allow 5 days for Consultant's and Owner's Representative review of each submission.
- .4 Adjustments made on shop drawings by Consultant and Owner's Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Consultant prior to proceeding with Work.
- .5 Make changes in shop drawings as Consultant may and Owner's Representative require, consistent with Contract Documents. When resubmitting, notify Consultant and Owner's Representative in writing of revisions other than those requested.
- .6 Accompany submissions with transmittal letter, in duplicate, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
- .7 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
- .8 After Consultant's and Owner's Representative review, distribute copies.
- .9 Submit 6 copies of shop drawings for each requirement requested in specification Sections and as Consultant and Owner's Representative may reasonably request.

- .10 Submit 6 copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Consultant and Owner's Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .11 Submit 6 copies of test reports for requirements requested in specification Sections and as requested by Consultant.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
- .12 Submit 6 copies of certificates for requirements requested in specification Sections and as requested by Consultant.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .13 Submit 6 copies of manufacturer's instructions for requirements requested in specification Sections and as requested by Consultant.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .14 Submit 6 copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Consultant and Owner's Representative.
 - .1 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .15 Submit 6 copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Consultant and Owner's Representative.
- .16 Delete information not applicable to project.
- .17 Supplement standard information to provide details applicable to project.
- .18 If upon review by Consultant and Owner's Representative, no errors or omissions are discovered or if only minor corrections are made, [transparency] [copies] will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.
- .19 The review of shop drawings by Owner's Representative is for sole purpose of ascertaining conformance with general concept.

- .1 This review shall not mean that Owner's Representative approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
- .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 CERTIFICATES AND TRANSCRIPTS

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.
- .2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Health and safety considerations required to ensure that the Museum shows due diligence towards health and safety on construction sites.

1.2 REFERENCES

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Province of Quebec
 - .1 An Act Respecting Occupational Health and Safety, R.S.Q. 1997 (updated 26 July 2005).

1.3 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
 - .1 Results of site specific safety hazard assessment.
 - .2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
- .3 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Owner's representative and/or authority having jurisdiction, weekly.
- .4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Owner's representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 7 days after receipt of plan. Revise plan as appropriate and resubmit plan to Owner's representative within 2 days after receipt of comments from Owner's representative.
- .7 Owner's representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.
- .8 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of

Work, and submit additional certifications for any new site personnel to Owner's representative.

- .9 On-site Contingency and Emergency Response Plan: address standard operating procedures to be implemented during emergency situations.

1.4 FILING OF NOTICE

- .1 File Notice of Project with Provincial authorities prior to beginning of Work.

1.5 SAFETY ASSESSMENT

- .1 Perform site specific safety hazard assessment related to project.

1.6 MEETINGS

- .1 Schedule and administer Health and Safety meeting with Owner's representative prior to commencement of Work.

1.7 REGULATORY REQUIREMENTS

- .1 Do Work in accordance Regulatory Requirements.

1.8 GENERAL REQUIREMENTS

- .1 Develop written site-specific Health and Safety Plan based on hazard assessment prior to beginning site Work and continue to implement, maintain, and enforce plan until final demobilization from site. Health and Safety Plan must address project specifications.
- .2 Owner's representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns.

1.9 RESPONSIBILITY

- .1 Be responsible for health and safety of persons on site, safety of property on site and for protection of persons adjacent to site and environment to extent that they may be affected by conduct of Work.
- .2 Comply with and enforce compliance by employees with safety requirements of Contract Documents, applicable federal, provincial, territorial and local statutes, regulations, and ordinances, and with site-specific Health and Safety Plan.

1.10 COMPLIANCE REQUIREMENTS

- .1 Comply with Occupational Health and Safety Regulations, 1996.
- .2 Comply with Occupational Health and Safety Act, General Safety Regulations, O.I.C..
- .3 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

1.11 UNFORSEEN HAZARDS

- .1 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, follow procedures in place for Employee's Right to Refuse Work in accordance with Acts and Regulations of Province having jurisdiction and advise Owner's representative verbally and in writing.

1.12 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:
 - .1 Have site-related working experience specific to activities.
 - .2 Have working knowledge of occupational safety and health regulations.
 - .3 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
 - .4 Be responsible for implementing, enforcing daily and monitoring site-specific Contractor's Health and Safety Plan.
 - .5 Be on site during execution of Work and report directly to and be under direction of and site supervisor] /.

1.13 POSTING OF DOCUMENTS

- .1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province having jurisdiction, and in consultation with Owner's representative.

1.14 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Owner's representative.
- .2 Provide Owner's representative with written report of action taken to correct non-compliance of health and safety issues identified.
- .3 Owner's representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from Owner's representative.

1.16 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.

Part 2 **Products**

2.1 **NOT USED**

.1 Not used.

Part 3 **Execution**

3.1 **NOT USED**

.1 Not used.

END OF SECTION

Part 1 General

1.1 INSPECTION

- .1 Allow Consultant and Owner's Representative access to Work. If part of Work is in preparation at locations other than Place of Work, allow access to such Work whenever it is in progress.
- .2 Give timely notice requesting inspection if Work is designated for special tests, inspections or approvals by Consultant and Owner's Representative instructions, or law of Place of Work.
- .3 If Contractor covers or permits to be covered Work that has been designated for special tests, inspections or approvals before such is made, uncover such Work, have inspections or tests satisfactorily completed and make good such Work.
- .4 Consultant and Owner's Representative will order part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction.

1.2 ACCESS TO WORK

- .1 Allow inspection/testing agencies access to Work, off site manufacturing and fabrication plants.
- .2 Co-operate to provide reasonable facilities for such access.

1.3 REJECTED WORK

- .1 Remove defective Work, whether result of poor workmanship, use of defective products or damage and whether incorporated in Work or not, which has been rejected by Consultant and Owner's Representative as failing to conform to Contract Documents. Contractor shall replace or re-execute in accordance with the contract documents.
- .2 Make good other Contractor's work damaged by such removals or replacements promptly.
- .3 If in opinion of Consultant and Owner's Representative it is not expedient to correct defective Work or Work not performed in accordance with Contract Documents, Owner will deduct from Contract Price difference in value between Work performed and that called for by Contract Documents, amount of which will be determined by Consultant.

1.4 EQUIPMENT AND SYSTEMS

- .1 Submit adjustment and balancing reports for mechanical, electrical and building equipment systems.

- .2 Refer to Section 23 05 00 for definitive requirements.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 23 65 10

1.2 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Owner's Representative. Do not burn waste materials on site, unless approved by Owner's Representative.

1.3 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste products and debris.
- .5 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

1.4 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 23 65 10.

1.2 REFERENCES

- .1 Provide inventory of quantities of materials to be salvaged for reuse, recycling, or disposal.

1.3 DISPOSAL OF WASTES

- .1 Do not bury rubbish or waste materials.
- .2 Do not dispose of waste into waterways, storm, or sanitary sewers.
- .3 Remove materials from deconstruction as deconstruction/disassembly Work progresses.
- .4 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in pre-demolition material audit.

1.4 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises.
- .2 Maintain security measures established by existing facility provide temporary security measures approved by Owner's Representative.

1.5 SCHEDULING

- .1 Co-ordinate Work with other activities at site to ensure timely and orderly progress of Work.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 APPLICATION

- .1 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

3.2 CLEANING

- .1 Remove tools and waste materials on completion of Work, and leave work area in clean and orderly condition.
- .2 Clean-up work area as work progresses.
- .3 Source separate materials to be reused/recycled into specified sort areas.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .3 Copy will be returned after final inspection, with Consultant's comments.
- .4 Revise content of documents as required prior to final submittal.
- .5 Two weeks prior to Substantial Performance of the Work, submit to the Consultant and Owner's Representative, four final copies of operating and maintenance manuals in English.
- .6 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.
- .7 Furnish evidence, if requested, for type, source and quality of products provided.
- .8 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .9 Pay costs of transportation.

1.2 FORMAT

- .1 Organize data as instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents.
- .5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.

- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format on CD.

1.3 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project; Date of submission; names.
 - .1 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties.
 - .2 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.
- .6 Training: refer to Section 01 79 00 - Demonstration and Training.

1.4 AS-BUILTS AND SAMPLES

- .1 Maintain, in addition to requirements in General Conditions, at site for Consultant and Owner's Representative one record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed shop drawings, product data, and samples. Field test records.
 - .6 Inspection certificates.
 - .7 Manufacturer's certificates.
- .2 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .3 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.

- .4 Keep record documents and samples available for inspection by Consultant.

1.5 RECORDING ACTUAL SITE CONDITIONS

- .1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Consultant and Owner's Representative.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.6 EQUIPMENT AND SYSTEMS

- .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .3 Include manufacturer's printed operation and maintenance instructions.
- .4 Include sequence of operation by controls manufacturer.

- .5 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .6 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .7 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .8 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 - General Commissioning (Cx) Requirements.
- .9 Additional requirements: as specified in individual specification sections.

1.7 MATERIALS AND FINISHES

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-Protection and Weather-Exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual specifications sections.

1.8 SPARE PARTS

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

1.9 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site; place and store.

- .4 Receive and catalogue items. Submit inventory listing to Consultant and Owner's Representative. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.10 SPECIAL TOOLS

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

1.11 STORAGE, HANDLING AND PROTECTION

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

1.12 WARRANTIES AND BONDS

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

- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten days after completion of applicable item of work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .7 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .8 Conduct joint 4 month and 9 month warranty inspection, measured from time of acceptance, with Owner's Representative.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the organizations of Contractors, subcontractors, manufacturers or suppliers involved.
 - .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include balancing of glycol system.
 - .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
 - .4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.
 - .5 Procedure and status of tagging of equipment covered by extended warranties.

- .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .10 Respond in a timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification will follow oral instructions. Failure to respond will be cause for the Consultant and Owner's Representative to proceed with action against Contractor.

1.13 PRE-WARRANTY CONFERENCE

- .1 Meet with Consultant and Owner's Representative, to develop understanding of requirements of this section. Schedule a meeting prior to contract completion, and at a time designated by Consultant and Owner's Representative.
- .2 Consultant and Owner's Representative will establish communication procedures for:
 - .1 Notification of construction warranty defects.
 - .2 Determine priorities for type of defect.
 - .3 Determine reasonable time for response.
- .3 Provide name, telephone number and address of licensed and bonded company that is authorized to initiate and pursue construction warranty work action.
- .4 Ensure contact is located within local service area of warranted construction, is continuously available, and is responsive to inquiries for warranty work action.

1.14 WARRANTY TAGS

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Consultant and Owner's Representative.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.
- .4 Indicate following information on tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number. Warranty period.
 - .5 Inspector's signature.
 - .6 Construction Contractor.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 23 65 10.

1.2 DESCRIPTION

- .1 Demonstrate operation and maintenance of equipment and systems to Owner's personnel one week prior to date of final inspection.
- .2 Owner will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

1.3 QUALITY CONTROL

- .1 When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.

1.4 CONDITIONS FOR DEMONSTRATIONS

- .1 Equipment has been inspected and put into operation in accordance with Section 26 32 03.
- .2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (CX) Requirements and equipment and systems are fully operational.
- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.5 PREPARATION

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated personnel are present.

1.6 DEMONSTRATION AND INSTRUCTIONS

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled agreed upon times, at the equipment location.
- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.

- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

1.7 TIME ALLOCATED FOR INSTRUCTIONS

- .1 Ensure adequate amount of time required for instruction are allocated for power distribution changes caused by this project.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2 Related Sections:
 - .1 All divisions
- .3 Acronyms:
 - .1 Cx - Commissioning.
 - .2 EMCS - Energy Monitoring and Control Systems.
 - .3 O&M - Operation and Maintenance manual
 - .4 PI - Product Information.
 - .5 PV - Performance Verification.
 - .6 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
- .2 Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the O&M manual.
 - .3 Effectively train O&M staff.
- .3 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .4 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .2 Cx responsibilities is to ensure the built system is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .3 Consultant will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Commissioning manager.
 - .2 Equipment, components and systems have been commissioned.
 - .3 O&M Manual received, reviewed and approved.
 - .4 O&M training has been completed.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the non-functional system, including related systems as deemed required by consultant, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to consultant.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Ensure installation of related components, equipment, sub-systems, and systems are complete.
 - .2 Fully understand Cx requirements and procedures.
 - .3 Have Cx documentation shelf-ready.
 - .4 Understand completely design criteria and intent and special features.
 - .5 Submit complete start-up documentation to Commissioning manager and Consultant

- .6 Have Cx schedules up-to-date.
- .7 Ensure systems have been cleaned thoroughly.
- .8 Complete TAB procedures on systems; submit TAB reports to Consultant for review and approval and submit copy to Owner's Representative.
- .9 Ensure "As-Built" system schematics are available.
- .4 Inform consultant and Owner's Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

- .1 Report conflicts between requirements of this section and other sections to consultant before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 SUBMITTALS

- .1 Submittals:
 - .1 Submit no later than 4 weeks after award of Contract:
 - .1 Name of Contractor's Cx agent.
 - .2 Draft Cx documentation.
 - .3 Preliminary Cx schedule.
 - .2 Request in writing to consultant for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to consultant where not specified and obtain written approval at least 8 weeks prior to start of Cx.
 - .4 Provide additional documentation relating to Cx process required by Commissioning manager.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use.
- .2 Consultant shall review and approve Cx documentation. Submit a copy of the Cx documentation to Owner's Representative.
- .3 Provide completed and approved Cx documentation to consultant and Cx Manager.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:

- .1 Approval of Cx reports.
- .2 Verification of reported results.
- .3 Repairs, retesting, re-commissioning, re-verification.
- .4 Training.

1.10 COMMISSIONING MEETINGS

- .1 Convene Cx meetings following project meetings.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage: Consultant to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by consultant, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.11 STARTING AND TESTING

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

1.12 WITNESSING OF STARTING AND TESTING

- .1 Provide 14 days notice prior to commencement.
- .2 Commissioning manager to witness of start-up and testing.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

1.13 MANUFACTURER'S INVOLVEMENT

- .1 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with consultant

- .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
- .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .2 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .3 Qualifications of manufacturer's personnel:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from consultant after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by consultant. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by consultant.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by consultant.
 - .3 If evaluation report concludes that major damage has occurred, consultant shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.

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

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to consultant for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Commissioning manager to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit consultant for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

- .1 If start-up, testing and/or PV produce unacceptable results, repair, replace or repeat specified starting and/or PV procedures until acceptable results are achieved.
- .2 Provide manpower and materials, assume costs for re-commissioning.

1.18 START OF COMMISSIONING

- .1 Notify consultant and commissioning manager at least 14 days prior to start of Cx.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

1.19 INSTRUMENTS / EQUIPMENT

- .1 Submit to consultant for review and approval:
 - .1 Complete list of instruments proposed to be used.

- .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 2-way radios.
 - .2 Ladders.
 - .3 Equipment as required to complete work.

1.20 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under actual operating conditions, over entire operating range, in all modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

1.21 WITNESSING COMMISSIONING

- .1 Commissioning manager to witness activities and verify results.
- .2 Engineer to certify all PV results.
- .3 Contractors to be present at all tests.

1.22 AUTHORITIES HAVING JURISDICTION

- .1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.
- .2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.
- .3 Provide copies to consultant within 5 days of test and with Cx report.

1.23 EXTENT OF VERIFICATION

- .1 Elsewhere:
 - .1 Provide manpower and instrumentation to verify all reported results, unless specified otherwise in other sections.
- .2 Number and location to be at discretion of consultant.

- .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .4 Perform additional commissioning until results are acceptable to consultant.

1.24 REPEAT VERIFICATIONS

- .1 Assume costs incurred by consultant for third and subsequent verifications where:
 - .1 Verification of reported results fail to receive Consultant's approval.
 - .2 Repetition of second verification again fails to receive approval.
 - .3 Consultant deems Contractor's request for second verification was premature.

1.25 SUNDRY CHECKS AND ADJUSTMENTS

- .1 Make adjustments and changes which become apparent as Cx proceeds.
- .2 Perform static and operational checks as applicable and as required.

1.26 DEFICIENCIES, FAULTS, DEFECTS

- .1 Correct deficiencies found during start-up and Cx to satisfaction of consultant.
- .2 Report problems, faults or defects affecting Cx to consultant in writing. Stop Cx until problems are rectified. Proceed with written approval from consultant.

1.27 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by consultant.

1.28 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.29 TRAINING

1.30 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.31 OCCUPANCY

- .1 Cooperate fully with Owner Representative during stages of acceptance and occupancy of facility.

1.32 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been deposited with Commissioning manager.
- .2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.33 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:

Specified range of acceptable deviations of measured values from specified values or specified design criteria.
- .2 Instrument accuracy tolerances:
 - .1 To be of higher order of magnitude than equipment or system being tested.
- .3 Measurement tolerances during verification:
 - .2 Unless otherwise specified actual values to be within +/- 2% of recorded values.

1.34 OWNER'S PERFORMANCE TESTING

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Description of overall structure of Cx Plan and roles and responsibilities of Cx team.
- .2 Related Sections:
 - .1 Section 01 91 33.
 - .2 Section 01 91 41.
 - .3 Section 01 91 51.

1.2 REFERENCES

- .1 American Water Works Association (AWWA)
- .2 Public Works and Government Services Canada (PWGSC)
 - .1 PWGSC - Commissioning Guidelines CP.4 -3rd edition-03.
- .3 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

- .1 Provide a fully functional facility:
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and Owner's Representative personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
- .2 Term "Cx" in this section means "Commissioning".
- .3 Use this Cx Plan as master planning document for Cx:
 - .1 Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Cx.
 - .2 Communicates responsibilities of team members involved in Cx Scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to Owner's Representative, process and administration of Cx.
 - .4 Describes the process of verification of how built works meet Owner design requirements.

- .5 Produces a complete functional system prior to issuance of Certificate of Occupancy.
- .6 Management tool that sets out scope, standards, roles and responsibilities, expectations, deliverables, and provides:
 - .1 Overview of Cx.
 - .2 General description of elements that make up Cx Plan.
 - .3 Process and methodology for successful Cx.
- .4 Acronyms:
 - .1 Cx - Commissioning.
 - .2 BMM - Building Management Manual.
 - .3 EMCS - Energy Monitoring and Control Systems.
 - .4 MSDS - Material Safety Data Sheets.
 - .5 PI - Product Information.
 - .6 PV - Performance Verification.
 - .7 TAB - Testing, Adjusting and Balancing.
 - .8 WHMIS - Workplace Hazardous Materials Information System.
- .5 Commissioning terms used in this Section:
 - .1 Bumping: short term start-up to prove ability to start and prove correct rotation.
 - .2 Deferred Cx - Cx activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.

1.4 DEVELOPMENT OF 100% CX PLAN

- .1 Cx Plan to be 100% completed within 8 weeks of award of contract to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Cx schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Cx team's requirements.
- .2 Submit completed Cx Plan to Engineer and obtain written approval.

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
- .2 Revise, refine and update every 2 weeks during construction phase. At each revision, indicate revision number and date.
- .3 Submit each revised Cx Plan to Engineer for review and obtain written approval.

- .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Engineer to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:
 - .1 Owner's Representative Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
 - .2 Owner's Representative Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O&M personnel.
 - .4 Monitoring of Cx activities, training, and development of Cx documentation.
 - .5 Work closely with members of Cx Team.
 - .3 Engineer is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying TAB and other tests.
 - .5 Ensuring implementation of final Cx Plan.
 - .6 Performing verification of performance of installed systems and equipment.
 - .7 Implementation of Training Plan.
 - .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
 - .1 Testing.
 - .2 TAB.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.
 - .5 Assigning one person as point of contact with Engineer and PWGSC Cx Manager for administrative and coordination purposes.
 - .5 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.

- .3 Testing.
- .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

- .1 Employ the following Cx participants to verify performance of equipment and systems:
 - .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
 - .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include performance verification.
 - .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
 - .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
 - .5 Client: responsible for intrusion and access security systems.
 - .6 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of Owner's Representative personnel, including:
 - .1 Modify ventilation rates to meet changes in off-gassing.
 - .2 Changes to heating or cooling loads beyond scope of EMCS.
 - .3 Changes to EMCS control strategies beyond level of training provided to O&M personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
 - .7 Provide names of participants to Engineer and details of instruments and procedures to be followed for Cx prior to starting date of Cx for review and approval.

1.8 EXTENT OF CX

- .1 Commission mechanical systems and associated equipment:

- .1 Cooling Tower and associated systems:
 - .1 Cooling Tower systems.
 - .2 Pumping systems related to project.
 - .3 Controls related to project.
- .2 Seismic restraint and control measures.
- .3 EMCS:
- .2 Commission electrical systems and equipment:
 - .1 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .2 Low voltage distribution systems.
 - .3 Voice communications systems.
 - .4 Electronic data and communications information systems.
 - .5 Variable Frequency Drive.

1.9 DELIVERABLES RELATING TO O&M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English and French documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 MSDS data sheets.
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

- .1 General:
 - .1 Start-up, testing and Cx requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2 Definitions:
 - .1 Cx as used in this section includes:
 - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
 - .2 Factory inspections and performance verification tests.

- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Start-up, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Tests of following witnessed by PWGSC Design Quality Review Team:
 - .1 Operation of Cooling Tower.
 - .10 Training Plans.
 - .11 Cx Reports.
 - .12 Prescribed activities during warranty period.
- .4 Engineer to witness and certify tests and reports of results provided to Engineer.
- .5 Engineer to participate.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Engineer prior to permission to start up and rectification of deficiencies to Engineer's satisfaction.
 - .2 Engineer to use approved check lists.
 - .3 Engineer will monitor all of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Engineer and does not form part of Cx specifications.
 - .6 Engineer will monitor inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - MECHANICAL:
 - .1 Cooling Tower equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be approved by Engineer.
 - .2 EMCS:

- .1 Demonstrate performance of systems, to be witnessed by Engineer prior to start of Final Acceptance Test period.
 - .2 Perform final Cx and operational tests during demonstration period test period.
 - .3 Only additional testing after foregoing has been successfully completed to be "Off-Season Tests".
- .3 Pre-Cx activities - ELECTRICAL:
- .1 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .2 Low voltage systems: these include:
 - .1 Low voltage lighting control systems and data communications systems.
 - .3 Confirm compatibility to a Variable Frequency Drive.

1.12 START-UP

- .1 Start-up components, equipment and systems of the cooling tower.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
- .3 Engineer to monitor start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Engineer.
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Engineer.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Engineer to witness and certify reported results using approved PI and PV forms.
 - .4 Engineer to approve completed PV reports and provide to Engineer.
 - .5 Engineer reserves right to verify up to 30% of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Perform Cx by specified Cx agency using procedures developed by Engineer and approved by Engineer.
- .2 Engineer to monitor Cx activities.
- .3 Upon satisfactory completion, Cx agency performing tests to prepare Cx Report using approved PV forms.

- .4 Engineer to witness, certify reported results of, Cx activities and forward to Engineer.
- .5 Engineer reserves right to verify a percentage of reported results at no cost to contract.

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

- .1 Cx to be performed by specified Cx specialist, using procedures developed by Engineer and approved by Engineer.
- .2 Tests to be witnessed by Engineer and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified by Engineer and submitted to Engineer for review.
- .4 Engineer reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 Cooling Tower and associated systems forming part of integrated Cooling Tower systems.
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Engineer, Contractor, Project Manager, and Cx Manager to co-operate to complete inventory data sheets and provide assistance to PWGSC in full implementation of MMS identification system of components, equipment, sub-systems, systems.

1.15 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

1.19 CX SCHEDULES

- .1 Prepare detailed critical path Cx Schedule and submit to Engineer for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:

- .1 Design criteria, design intents.
- .2 Pre-TAB review: 28 days after contract award.
- .3 Cx procedures: 28 days after award of contract.
- .4 Cx Report format: 28 days after contract award.
- .5 Submission of list of instrumentation with relevant certificates: 28 days before start of Cx.
- .6 Notification of intention to start TAB: 14 days before start of TAB.
- .7 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
- .8 Notification of intention to start Cx: 14 days before start of Cx.
- .9 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
- .10 Identification of deferred Cx.
- .11 Implementation of training plans.
- .12 Cx reports: immediately upon successful completion of Cx.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Consultant, Contractor, Contractor's Cx agent, and Engineer will monitor progress of Cx against this schedule.

1.20 CX REPORTS

- .1 Submit reports of tests, witnessed and certified by Engineer to Engineer who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Engineer.

1.21 TRAINING PLANS

- .1 Refer to Section 01 91 41 - Commissioning (Cx) – Training.

1.22 FINAL SETTINGS

- .1 Upon completion of Cx to satisfaction of Engineer lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.
- .2 Related Sections:
 - .1 All divisions

1.2 INSTALLATION/START-UP CHECK LISTS

- .1 Include the following data:
 - .1 Product manufacturer's installation instructions and recommended checks.
 - .2 Special procedures as specified in relevant technical sections.
 - .3 Items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
- .2 Equipment manufacturer's installation/start-up check lists are acceptable for use. As deemed necessary by Owners Representative. Supplemental additional data lists will be required for specific project conditions.
- .3 Use check lists for equipment installation. Document check list verifying checks have been made, indicate deficiencies and corrective action taken.
- .4 Installer to sign check lists upon completion, certifying stated checks and inspections have been performed. Return completed check lists to Commissioning manager. Check lists will be required during Commissioning and will be included in Operations and Maintenance Manual (OMM) at completion of project.
- .5 Use of check lists will not be considered part of commissioning process but will be stringently used for equipment pre-start and start-up procedures.

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Product Information (PI) forms compiles gathered data on items of equipment produced by equipment manufacturer, includes nameplate information, parts list, operating instructions, maintenance guidelines and pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of equipment. This documentation is included in the OMM at completion of work.
- .2 Prior to Performance Verification (PV) of systems complete items on PI forms related to systems and obtain Owners Representative approval.

1.4 PERFORMANCE VERIFICATION (PV) FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.
- .2 PV report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.
- .3 Prior to PV of integrated system, complete PV forms of related systems and obtain Commissioning manager or Consultant's approval.

1.5 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Consultant provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and witnessed by Commissioning manager.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Commissioning manager with originals of completed forms.
 - .12 Maintain copy on site during start-up, testing and commissioning period.
 - .13 Forms to be both hard copy and electronic format.

1.6 LANGUAGE

- .1 To suit the language profile of the awarded contract.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 This Section specifies roles and responsibilities of Commissioning Training.

1.2 TRAINEES

- .1 Trainees: personnel selected for operating and maintaining this facility. Includes Property, Facility Manager, building operators, maintenance staff, and technical specialists as required.
- .2 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.3 INSTRUCTORS

- .1 Owner's Representative will provide:
- .1 Descriptions of systems.
- .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
- .1 Start-Up, operation, shut-down of equipment, components and systems.
- .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
- .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
- .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

1.4 TRAINING OBJECTIVES

- .1 Training to be detailed and duration to ensure:
- .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
- .2 Effective on-going inspection, measurements of system performance.
- .3 Proper preventive maintenance, diagnosis and trouble-shooting.
- .4 Ability to update documentation.
- .5 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

1.5 TRAINING MATERIALS

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
 - .1 "As-Built" Contract Documents.
 - .2 Operating Manual.
 - .3 Maintenance Manual.
 - .4 Management Manual.
 - .5 TAB and PV Reports.
- .3 Project Manager, Commissioning Manager and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer's training videos.
 - .4 Equipment models.

1.6 SCHEDULING

- .1 Include in Commissioning Schedule time for training.
- .2 Deliver training during regular working hours, training sessions to be 3 hours in length.
- .3 Training to be completed prior to acceptance of facility.

1.7 RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Owner's Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Owner's Representative.

1.8 TRAINING CONTENT

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.

- .2 Content includes:
 - .1 Review of facility and occupancy profile.
 - .2 Functional requirements.
 - .3 System philosophy, limitations of systems and emergency procedures.
 - .4 Review of system layout, equipment, components and controls.
 - .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
 - .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
 - .7 Maintenance and servicing.
 - .8 Trouble-shooting diagnosis.
 - .9 Inter-Action among systems during integrated operation.
 - .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 This section is limited to portions of the Operations and Maintenance Manual (O&M) provided to Consultant, Project Manger, Facility Manger and Cx Manager by the contractor.

.2 Related Sections:

- Division 01 - General Requirements
- Division 07 - Thermal and Moisture Protection
- Division 26 – Electrical
- Division 27 – Communications

.3 Acronyms:

- .1 BMM - Building Management Manual.
- .2 Cx - Commissioning.
- .3 HVAC - Heating, Ventilation and Air Conditioning.
- .4 PI - Product Information.
- .5 PV - Performance Verification.
- .6 TAB - Testing, Adjusting and Balancing.
- .7 WHMIS - Workplace Hazardous Materials Information System.

1.2 GENERAL REQUIREMENTS

- .1 Standard letter size paper 8.5 x 11.5 inches
- .2 Methodology used to facilitate updating.
- .3 Drawings, diagrams and schematics to be professionally developed.
- .4 Electronic copy of data to be in a format accepted and approved by Project Manager and Facility Manager
- .5 Prior to commencement, co-ordinate requirements for preparation, submission and approval with Cx Manager

1.3 GENERAL INFORMATION

- .1 Provide to consultant and Cx Manager for review the O & M Manual as per the following Checklist

- Must be in a 3 “**D**” ring type loose leaf binder labelled on the front cover and on the binder edge with the following information: Building Name and address, project name, project number, completed date (ex. October 2011).
- **Title Page** : O&M manual for building name, address, date, general contractor information: name address & phone numbers, consultant: name address & phone numbers.
- **Index**: sections as follows
- **A – Warranties** - Signed ‘ Letter of warranty’ : dated, identifying project by name, project number, location as well as warranty period. Any extended warranty of equipment only must be identified also.
- **B - Contact information** - for all sub-contractors & suppliers.
- **C - Reports**: copy of all start-up reports, functional test reports, completed performance verification forms, cabling verifications, ESA certification, and all other required certifications required by National Building Code.
- **D – As built drawings** – changes marked in ‘Red ink’
- **E - Sequence of operation**: Not Required.
- **F – CMMS Data Sheets**: All equipment which is to be deleted, removed, added or replaced from site is to have a CMMS inventory sheet completed and included in the O&M manual.
- **G, H... – Tab for each piece of new equipment (i.e. ‘boiler # 1)**
 - to include:
 - Copy of approved shop drawing
 - Copy of Specific Service and Maintenance manual for each.
- **Last Tab : misc.**
 - Disposal Records
 - MSDS of all materials used, paint, glue, caulking, fire stop...

END OF SECTION

Part 1 General

1.1 SUBMITTALS

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

- .2 Equipment performance verification test results.
- .3 Special performance data as specified.
- .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Owner's Representative and Consultant for approval. Submission of individual data will not be accepted unless directed by Owner's Representative, Consultant.
 - .2 Make changes as required and re-submit as directed by Owner's Representative, Consultant.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .3 Submit to Owner's Representative, Consultant for approval and make corrections as directed.
 - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
 - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.3 MAINTENANCE

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One glass for each gauge glass.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

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

1.4 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

- .1 Prime and touch up marred finished paintwork to match original.
- .2 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

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

3.3 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control] and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 DEMONSTRATION

- .1 Owner's Representative, Consultant will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:

- .1 Boilers.
- .2 Cooling Towers.
- .3 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.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Owner's Representative, Consultant will record these demonstrations on video tape for future reference.

3.5 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for copper domestic water service used in the following:
 - .1 Copper incoming domestic water service, up to NPS 2 1/2.
 - .2 Hard drawn copper domestic hot and cold water services inside building.
 - .3 Soft copper tubing inside building.
 - .4 Soft copper buried tubing outside building, as in between potable water source and meter inside building.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 35 30 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 01 91 00 - Commissioning.
- .6 Section 23 05 00 - Common Work Results - Mechanical.
- .7 Section 23 05 01 - Installation of Pipework.
- .8 Section 23 05 22 - Valves - Bronze.
- .9 Section 23 05 23 Valves - Cast Iron: Gate, Globe, Check.
- .10 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).
 - .1 ANSI/ASME B16.15-02, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22-01, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24-01, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2 American Society for Testing and Materials International, (ASTM).

- .1 ASTM A307-03, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube (Metric).
- .3 ASTM F492-95, Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-02, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
- .8 National Research Council (NRC)/Institute for Research in Construction.
 - .1 NRCC 38728, National Plumbing Code of Canada (NPC) - 2005.
- .9 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data for following: valves.
- .3 Submit WHMIS MSDS - Material Safety Data Sheets.
- .4 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

□

Part 2 Products

2.1 PIPING

- .1 Domestic hot, cold and recirculation systems, within building.
 - .1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.
 - .2 Buried or embedded: copper tube, soft annealed, type L: to ASTM B88M, in long lengths and with no buried joints.

2.2 FITTINGS

- .1 Bronze pipe flanges and flanged fittings, Class 150: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS 2 and larger: roll grooved to CSA B242.

2.3 JOINTS

- .1 Rubber gaskets, latex-free 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: 95/5 tin copper alloy.
- .4 Teflon tape: for threaded joints.
- .5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM flush seal gasket.
- .6 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner.

2.4 GATE VALVES

- .1 NPS 2 and under, soldered:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 22 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
 - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 22 - Valves - Bronze.
- .3 NPS 2-1/2 and over, in mechanical rooms, flanged:

- .1 Rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, OS&Y bronze trim specified Section 23 05 23 - Valves - Cast Iron.
- .4 NPS 2-1/2 and over, other than mechanical rooms, flanged:
 - .1 Non-rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

2.5 GLOBE VALVES

- .1 NPS2 and under, soldered:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 22 - Valves - Bronze.
 - .2 Lockshield handles: as indicated.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, screwed over bonnet, renewable composition disc as specified Section 23 05 22 - Valves - Bronze.
 - .2 Lockshield handles: as indicated.

2.6 SWING CHECK VALVES

- .1 NPS 2 and under, soldered:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 22 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 22 - Valves - Bronze.
- .3 NPS 2-1/2 and over, flanged:
 - .1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

2.7 BALL VALVES

- .1 NPS 2 and under, screwed:
 - .1 Class 150.
 - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE or BunaN seat, steel lever handle as specified Section 23 05 22 - Valves - Bronze.
- .2 NPS 2 and under, soldered:
 - .1 To ANSI/ASME B16.18, Class 150.

- .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE or BunaN seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 22 - Valves - Bronze.

2.8 BUTTERFLY VALVES

- .1 NPS 2-1/2 and over, wafer or lug:
 - .1 To MSS-SP-67, Class 200.
 - .2 Cast iron body, ductile iron chrome plated disc, stainless steel stem, EPT liner.
 - .3 Lever operated, NPS 8 and over, gear operated.
- .2 NPS 2-1/2 and over, grooved ends:
 - .1 Class 300, bubble tight shut-off, bronze body.
 - .2 Operator:
 - .1 NPS 4 and under: lever handle.
 - .2 NPS 6 and over: gear operated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install in accordance with NPC and local authority having jurisdiction.
- .2 Install pipe work in accordance with Section 23 05 01 - Installation of Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.
- .5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .6 Buried tubing:
 - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
 - .2 Bend tubing without crimping or constriction. Minimize use of fittings.

3.2 VALVES

- .1 Isolate equipment, fixtures and branches with gate, butterfly, or ball valves.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.3 PRESSURE TESTS

- .1 Conform to requirements of Section 23 05 00 - Common Work Results - Mechanical.
- .2 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.4 FLUSHING AND CLEANING

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

3.5 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

3.6 DISINFECTION

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction approval of Owner's Representative, Consultant.
- .2 Upon completion, provide laboratory test reports on water quality for Owner's Representative, Consultant approval.

3.7 START-UP

- .1 Timing: Start up after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.
 - .3 Certificate of static completion has been issued.
 - .4 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
 - .1 Establish circulation and ensure that air is eliminated.
 - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
 - .3 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

END OF SECTION

Part 1 General

1.1 SUBMITALS

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

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

1.2 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.3 MAINTENANCE

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

Part 2 Products

Part 3 Execution

3.1 CLEANING

- .1 Clean interior and exterior of all systems including strainers.

3.2 DEMONSTRATION

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

3.3 PROTECTION

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

END OF SECTION

Part 1 General

1.1 REFERENCES

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

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 CONNECTIONS TO EQUIPMENT

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

3.2 CLEARANCES

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

3.3 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.

3.4 DIELECTRIC COUPLINGS

- .1 General: Compatible with system, to suit pressure rating of system.

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- .2 Locations: Where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: Isolating flanges.

3.5 PIPEWORK INSTALLATION

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

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

3.6 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and 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.

3.7 FLUSHING OUT OF PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant sections of Division 23.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.8 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Consultant 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: Test as specified in relevant sections of Divisions 22 and 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Division 15.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Consultant.
- .6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Consultant.

3.9 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Consultant.
- .2 Request written approval 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-1998, Power Piping.
 - .2 ANSI/ASME B31.3-2000, Process Piping Addenda A.
 - .3 ANSI/ASME B31.3-2001, Process Piping Addenda B.
 - .4 ANSI/ASME Boiler and Pressure Vessel Code-1998:
 - .1 Section I: Power Boilers.
 - .2 Section V: Nondestructive Examination.
 - .3 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-97, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-M1987(R1998), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48 series-01, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-97, Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-01, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-02, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-01, Certification of Welding Inspectors.

1.3 QUALIFICATIONS

- .1 Welders

- .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Furnish welder's qualifications to Consultant.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
 - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors
 - .1 Inspectors qualified to CSA W178.2.

1.4 QUALITY ASSURANCE

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

Part 2 Products

2.1 ELECTRODES

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

Part 3 Execution

3.1 WORKMANSHIP

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

3.2 INSTALLATION REQUIREMENTS

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

3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS

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

3.4 SPECIALIST EXAMINATIONS AND TESTS

- .1 General
 - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Consultant.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 10% of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests] and spot full gamma ray radiographic (hereinafter referred to as "radiography") tests].
- .2 Hydrostatically test welds to requirements of ANSI/ASME B31.1.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Consultant of total of up to 10 % of welds, selected at random by Consultant by radiographic particle tests.
- .5 Full radiographic tests for piping systems.
 - .1 Spot radiography to CAN/CGSB-48.2.
 - .1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Consultant from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
 - .1 Identify each radiographic film with date, location, name of welder, and submit to Consultant. Replace film if rejected because of poor quality.
 - .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
 - .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.

- .6 Magnetic particle tests for piping systems.

3.5 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 In addition, chilled water systems
 - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
 - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
 - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
 - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
 - .5 Repair cracks and defects in excess of 0.8 mm in depth.
 - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic particle tests.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for thermometers and pressure gauges in piping systems.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 23 05 54 - Mechanical Identification.

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B40.100-01, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-01, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Stop cocks.
 - .4 Syphons.
 - .5 Wells.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 GENERAL

- .1 Design point to be at mid point of scale or range.
- .2 Ranges: as required.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB14.4 ASME B40.200.

2.3 REMOTE READING THERMOMETERS

- .1 100 mm diameter mercury-free, liquid filled activated dial type: to CAN/CGSB-14.5 ASME B40.200, accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished brass or stainless steel case for wall mounting.

2.4 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or stainless steel.

2.5 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel, phosphor bronze bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
 - .1 Siphon for steam service.
 - .2 Snubber for pulsating operation.
 - .3 Diaphragm assembly for corrosive service.
 - .4 Gasketed pressure relief back with solid front.
 - .5 Bronze stop cock.
 - .6 Oil filled for high vibration applications.

Part 3 Execution

3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

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3.2 THERMOMETERS

- .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Water heating and cooling coils.
 - .3 Water boilers.
 - .4 Chillers.
 - .5 Cooling towers.
 - .6 DHW tanks.
- .3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of PRV's.
 - .3 Upstream and downstream of control valves.
 - .4 Inlet and outlet of coils.
 - .5 Inlet and outlet of liquid side of heat exchangers.
 - .6 Outlet of boilers.
 - .7 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated and/or as required.
- .3 Use extensions where pressure gauges are installed through insulation.

3.4 NAMEPLATES

- .1 Install engraved lamicoïd nameplates as specified in Section 23 05 54 - Mechanical Identification, identifying medium.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Bronze - valves.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
 - .3 Section 01 35 30 - Health and Safety Requirements.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 01 - Installation of Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified in this section.
- .2 Closeout Submittals:

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- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 MAINTENANCE

- .1 Extra Materials:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

Part 2 Products

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 All products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: Solder ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.

- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
- .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
- .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: Handwheel or Lockshield.
- .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: Handwheel.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed, union bonnet.
 - .2 Operator: Handwheel.
- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc, composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel or Lockshield.
 - .3 NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel, Lockshield.

- .4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
 - .3 Operator: Handwheel.
- .5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - .1 Body and bonnet: union bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - .3 Operator: Handwheel, Lockshield.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
 - .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE, no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
 - .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .7 Silent Check Valves:
 - .1 NPS 2 and under:
 - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
 - .2 Pressure rating: Class 125.

- .3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
- .4 Disc and seat: renewable rotating disc.
- .5 Stainless steel spring, heavy duty.
- .6 Seat: regrindable.
- .8 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class 125, 2760-kPa CWP, 4140-kPa CWP, 860 kPa steam.
 - .3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders, solder ends to ANSI.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and teflon seats.
 - .7 Stem seal: PTFE with external packing nut.
 - .8 Operator: removable lever handle.

Part 3 Execution

3.1 INSTALLATION

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves, gate, globe, and check.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
 - .3 Section 01 35 30 - Health and Safety Requirements.
 - .4 Section 01 78 00 - Closeout Submittals.
 - .5 Section 23 05 01 - Installation of Pipework.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.1-1998, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 American Society for Testing and Materials International (ASTM).
 - .1 ASTM A49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A126-04(2009), Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM B61-93, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B85-03, Specification for Aluminum-Alloy Die Castings.
 - .6 ASTM B209-04, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .4 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets.

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit data for valves specified in this section.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .2 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.

Part 2 Products

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
 - .2 Standard specifications:
 - .1 Gate valves: MSS SP-70.
 - .2 Globe valves: MSS SP-85.

- .3 Check valves: MSS SP-71.
- .3 Requirements common to valves, unless specified otherwise:
 - .1 Body, bonnet: cast iron to ASTM B209 Class B.
 - .2 Connections: flanged ends plain face with 2 mm raised face with serrated finish to ANSI B16.1.
 - .3 Inspection and pressure testing: to MSS SP-82.
 - .4 Bonnet gasket: non-asbestos.
 - .5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - .6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - .7 Gland packing: non-asbestos.
 - .8 Handwheel: Die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49. Nut of bronze to ASTM B62.
 - .9 Identification tag: with catalogue number, size, other pertinent data.
- .4 All products to have CRN registration numbers.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 8, non-rising stem, inside screw, bronze or iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62.
 - .3 Seat rings: renewable bronze to ASTM B62, screwed into body.
 - .4 Stem: bronze to ASTM B62.
 - .5 Disc: solid offset taper wedge, cast iron to ASTM A126 Class B, secured to wrought steel stem.
 - .6 Seat: Integral with body.
 - .7 Stem: wrought steel.
 - .8 Operator: Handwheel.
 - .9 Bypass: complete with union and gate or globe] valve as Section 23 05 22 - Valves - Bronze.
- .2 NPS 10 - 24, non-rising stem, inside crew, bronze or iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: cast iron to ASTM A126 Class B for sizes up to NPS 14, Class C for sizes NPS 16 and over, with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges.
 - .2 Pressure ratings: Class 125.
 - .3 Disc: solid offset taper wedge, with bronze rings to ASTM B62 rolled into cast iron disc, secured to stem.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.

- .5 Stem: bronze to ASTM B62.
- .6 Disc: solid offset taper wedge, cast iron secured to stem.
- .7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
- .8 Stem: wrought steel.
- .9 Operator: Handwheel.
- .10 Bypass: complete with union gate or globe valve as Section 23 05 01 - Installation of Pipework, paragraph.
- .3 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze or iron trim, solid wedge disc:
 - .1 Body and multiple-bolted bonnet: with [bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - .2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - .3 Seat rings: renewable bronze screwed into body.
 - .4 Stem: nickel-plated steel or manganese-bronze.
 - .5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - .6 Seat rings: integral with body.
 - .7 Stem: nickel-plated steel.
 - .8 Pressure-lubricated operating mechanism.
 - .9 Operator: Handwheel.
 - .10 Bypass: complete with union and gate or globe valve as Section 23 05 01 - Installation of Pipework.

2.3 UNDERWRITERS APPROVED GATE VALVE

- .1 NPS 2 1/2 - 14, OS&Y:
 - .1 Approvals: UL and FM approved for fire service.
 - .2 UL and FM Label: on valve yoke.
 - .3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC 262 (B).
 - .4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
 - .5 Packing gland: bronze.
 - .6 Stem: manganese bronze. Diameter to ULC C-262 (B).
 - .7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
 - .8 Bosses for bypass valve, drain: on NPS 4 and over.
 - .9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: cast iron with bronze disc rings.
 - .10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
 - .11 Pressure rating:
 - .1 NPS 2-1/2 - 12: 1.7 Mpa CWP.

- .2 NPS 14-1.2: 1.2 MPa CWP.
- .12 Operator: handwheel.
- .13 Bypass: complete with union and gate or globe valve as Section 23 05 22 - Valves - Bronze.

2.4 GLOBE VALVES

- .1 NPS 2 1/2 - 10, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, regrindable, screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: Handwheel.
 - .8 Bypass: complete with union and gate or globe valve as Section 23 05 22 - Valves - Bronze.

2.5 BYPASSES FOR GATE AND GLOBE VALVES

- .1 Locations: on valves as indicated.
- .2 Position of bypass valve on main valves: Above horizontal.
- .3 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
 - .2 Main valve NPS 10 and over: NPS 1.
- .4 Type of bypass valves:
 - .1 On gate valve: globe, with composition or bronze disc, bronze trim, to Section 23 05 22 - Valves - Bronze. Pressure rating to match main valve.
 - .2 On globe valve: globe, with composition or bronze disc, bronze trim, to Section 23 05 22 - Valves - Bronze. Pressure rating to match main valve.

2.6 VALVE OPERATORS

- .1 Install valve operators as follows:
 - .1 Handwheel: on valves except as specified.
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

2.7 CHECK VALVES

- .1 Swing check valves, Class 125:

- .1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.
 - .1 Up to NPS 16: cast iron to ASTM A126 Class B.
 - .2 NPS 18 and over: cast iron to ASTM A126 Class C.
 - .2 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - .2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.
 - .3 NPS 18 and over: 1.03 MPa CWP.
 - .3 Disc: rotating for extended life.
 - .1 Up to NPS 6: bronze to ASTM B 62.
 - .2 NPS 8 and over: bronze-faced cast iron.
 - .4 Seat rings: renewable bronze to ASTM B62 screwed into body.
 - .5 Hinge pin, bushings: renewable bronze to ASTM B62.
 - .6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - .7 Seat: cast iron, integral with body.
 - .8 Hinge pin: exelloy; bushings: malleable iron.
 - .9 Identification tag: fastened to cover.
 - .10 Hinge: galvanized malleable iron.
- .2 Swing check valves, NPS 2 1/2 - 8 Class 250:
 - .1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.
 - .2 Flanged ends: 2 mm raised face with serrated finish.
 - .3 Rating: 250 psi steam; 500 psi CWP.
 - .4 Disc: rotating for extended life.
 - .1 Up to NPS 3: bronze to ASTM B61.
 - .2 NPS 4 - 8: Iron faced with ASTM B61 bronze.
 - .5 Seat rings: renewable bronze to ASTM B61, screwed into body.
 - .6 Hinge pin, bushings: renewable, bronze to ASTM B61.
 - .7 Hinge: galvanized malleable iron.
 - .8 Identification tag: fastened to cover.

2.8 SILENT CHECK VALVES

- .1 Construction:
 - .1 Body: [malleable] [or] [ductile iron] with integral seat.
 - .2 Pressure rating: class 125, WP = 860 kPa.
 - .3 Connections: grooved ends.
 - .4 Disc: bronze or stainless steel renewable rotating disc.
 - .5 Seat: renewable, EPDM.
 - .6 Stainless steel spring, heavy duty.

Part 3 Execution

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

1.2 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

- .1 ANSI/ASME B31.1-04, Power Piping.

.2 American Society for Testing and Materials International (ASTM)

- .1 ASTM A125-1996(R2001), Specification for Steel Springs, Helical, Heat-Treated.
- .2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

.5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)

- .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
- .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
- .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.6 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

.1 Design Requirements:

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by 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.
- .2 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers, to withstand seismic events as specified Section 23 05 48.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .3 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Consultant will make available 1 copy of systems supplier's installation instructions.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS SP58.

- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
 - .2 Use electro-plating galvanizing process hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed FM approved.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed FM approved to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed [FM approved to MSS SP69.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies:
 - .2 Steel brackets: Sway braces for seismic restraint systems: to Section 23 05 48.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP58:

- .1 Attachments for steel piping: carbon steel black or galvanized.
- .2 Attachments for copper piping: copper plated black steel.
- .3 Use insulation shields for hot pipework.
- .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69 UL listed FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black or galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black or galvanized, with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.3 RISER CLAMPS

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

2.4 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.

2.5 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.

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- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.7 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 HOUSE-KEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-place Concrete.

2.10 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code Provincial Code 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.

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- .5 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .6 Within 300 mm of each elbow.

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

- .7 Pipework greater than NPS 12: to MSS SP69.

3.4 HANGER INSTALLATION

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

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

- .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

3.7 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests [in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Vibration isolation materials and components, seismic control measures and their installation.
- .2 Related Sections:
 - .1 23 65 10.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA)
- .3 National Building Code of Canada (NBC) - 2005

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .2 Provide detailed drawings of seismic control measures for equipment and piping.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2

Products

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Performance: as indicated or as required.

2.3 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with precompression washer and nut with deflection indicator.
- .6 Performance: as indicated or as required.

2.4 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

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

2.5 HORIZONTAL THRUST RESTRAINT

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

2.6 STRUCTURAL BASES

- .1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.
- .2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.
- .3 Bases to clear housekeeping pads by 25 mm minimum.

2.7 INERTIA BASE

- .1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.
- .2 Pump bases: "T" shaped, where applicable, to provide support for elbows.

2.8 SEISMIC CONTROL MEASURES

- .1 General:
 - .1 Seismic control systems to work in every direction.
 - .2 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .3 Drilled or power driven anchors and fasteners not permitted.
 - .4 No equipment, equipment supports or mounts to fail before failure of structure.
 - .5 Supports of cast iron or threaded pipe not permitted.
 - .6 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Suspended equipment:

- .1 Use one or more of following methods depending upon site conditions and or as indicated:
 - .1 Install tight to structure.
 - .2 Cross brace in every direction.
 - .3 Brace back to structure.
 - .4 Cable restraint system.
- .3 Seismic restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
 - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
 - .3 As indicated.
- .4 Piping systems:
 - .1 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .2 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
 - .1 Approved by Engineer.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 FIELD QUALITY CONTROL

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

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Seismic restraint systems for statically supported and vibration isolated equipment and systems; including cooling tower.
- .2 Related Sections:
 - .1 23 65 10.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA G40.20/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 National Building Code of Canada (NBC) - 2005

1.3 DEFINITIONS

- .1 Priority Two (P2) Buildings: buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2 SRS: acronym for Seismic Restraint System.

1.4 SYSTEM DESCRIPTION

- .1 SRS fully integrated into, and compatible with:
 - .1 Noise and vibration controls specified elsewhere.
 - .2 Structural, mechanical, electrical design of project.
- .2 Systems, equipment not required to be operational during and after seismic event.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.
- .4 Designed by Professional Engineer specializing in design of SRS and registered in Province of Quebec.

1.5 SUBMITTALS

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

- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Quebec, Canada.
- .3 Submit design data including:
 - .1 Full details of design criteria.
 - .2 Working drawings (prepared to same standard of quality and size as documents forming these [tender] [bid] documents), materials lists, schematics, full specifications for components of each SRS to be provided.
 - .3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
 - .4 Separate shop drawings for each SRS and devices for each system, equipment.
 - .5 Identification of location of devices.
 - .6 Schedules of types of SRS equipment and devices.
 - .7 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
 - .8 Installation procedures and instructions.
 - .9 Design calculations including restraint loads to [NBC and Supplement.
 - .10 Detailed work sheets, tables Simplified, Detailed work sheets, tables. Simplified, conservative assumptions may be acceptable.
 - .11 Detailed design of SRS including complete working drawings [prepared to same standard of quality and size as Contract Documents, materials lists, design calculations, schematics, specifications.
- .4 Submit additional copy of shop drawings and product data to Structural Engineer for review of connection points to building structure.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Engineer will make available 1 copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
 - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.6 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 SRS MANUFACTURER

- .1 SRS from one manufacturer regularly engaged in SRS production.

2.2 GENERAL

- .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS of Piping systems compatible with:
 - .1 Expansion, anchoring and guiding requirements.
 - .2 Equipment vibration isolation and equipment SRS.
- .5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .6 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.

2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS

- .1 Floor-mounted equipment, systems:
 - .1 Anchor equipment to equipment supports.
 - .2 Anchor equipment supports to structure.
 - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Install tight to structure.
 - .2 Cross-brace in every direction.
 - .3 Brace back to structure.
 - .4 Slack cable restraint system.
 - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
 - .3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT

- .1 Floor mounted equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Vibration isolators with built-in snubbers.

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- .2 Vibration isolators and separate snubbers.
- .3 Built-up snubber system approved by Engineer, consisting of structural elements and elastomeric layer.
- .2 SRS to resist complete isolator unloading.
- .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
- .4 Cushioning action: gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system.
 - .2 Brace back to structure via vibration isolators and snubbers.

2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

2.6 SERVICE UTILITIES ENTRANCE INTO BUILDING

- .1 Provide flexibility to prevent breakage in the event of earthquake activity.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Attachment points and fasteners:
 - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .2 Slack Cable Systems (SCS):
 - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.

- .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
- .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
- .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
- .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
- .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
- .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .3 Install SRS at least 25 mm from equipment, systems, services.
- .4 Miscellaneous equipment not vibration-isolated:
 - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.
- .6 Vertical tanks:
 - .1 Anchor through house-keeping pad to structure.
 - .2 Provide steel bands above centre of gravity.
- .7 Horizontal tanks:
 - .1 Provide at least two straps with anchor bolts fastened to structure.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at 25% and 60% completion stages.
 - .4 Upon completion of installation.
 - .3 Submit manufacturer's reports to Engineer within 3 days of manufacturer representative's review.
- .2 Inspection and Certification:
 - .1 SRS: inspected and certified by Seismic Engineer and Manufacturer upon completion of installation.
 - .2 Provide written report to Engineer with certificate of compliance.

- .3 Commissioning Documentation:
 - .1 Upon completion and acceptance of certification, hand over to Engineer complete set of construction documents, revised to show "as-built" conditions.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

1.2 REFERENCES

.1 Canadian Gas Association (CGA)

- .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
- .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA)

- .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
- .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 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.

1.4 SYSTEM NAMEPLATES

.1 Colours:

- .1 Hazardous: red letters, white background.
- .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

- .1 3 mm thick [laminated plastic] [or] [white anodized aluminum], matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

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

.4 Locations:

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

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

1.5 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

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

.3 Before starting work, obtain written approval of identification system from Consultant.

1.6 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Chill Water.

1.7 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:

.1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:

.1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:

.1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

- .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
- .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive [plastic-coated cloth] [vinyl] with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Consultant.
 - .2 Colours for legends, arrows: to following table:

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

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

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Raw water	Green	RAW WATER
River water	Green	RIVER WATER
Sea water	Green	SEA WATER
City water	Green	CITY WATER
Treated water	Green	TREATED WATER
Brine	Green	BRINE
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Glycol Hot water heating supply	Yellow	GLYCOL HEATING SUPPLY
Glycol Hot water heating return	Yellow	GLYCOL HEATING RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
High temp HW Htg. supply	Yellow	HTHW HTG. SUPPLY++
High temp HW Htg. return	Yellow	HTHW HTG. RETURN++
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Steam []kPa	Yellow	[] kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Continuous blow-off	Yellow	CONT. BLOW-OFF
Chilled drinking water	Green	CH. DRINK WTR
Drinking water return	Green	CH. DRINK WTR. CIRC
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Contaminated lab waste	Yellow	CONT. LAB WASTE
Acid waste	Yellow	ACID WASTE (add source)
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
No. [] fuel oil suction	Yellow	# [] FUEL OIL
No. [] fuel oil return	Yellow	# [] FUEL OIL
Engine exhaust	Yellow	ENGINE EXHAUST
Lubricating oil	Yellow	LUB. OIL
Hydraulic oil	Yellow	HYDRAULIC OIL
Gasoline	Yellow	GASOLINE
Natural gas	to Codes	
Propane	to Codes	
Gas regulator vents	to Codes	
Distilled water	Green	DISTILL. WTR
Demineralized water	Green	DEMIN. WATER
Chlorine	Yellow	CHLORINE
Nitrogen	Yellow	NITROGEN
Oxygen	Yellow	OXYGEN
Compressed air (<700kPa)	Green	COMP. AIR [] kPa
Compressed air (>700kPa)	Yellow	COMP. AIR [] kPa
Vacuum	Green	VACUUM
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS
Carbon dioxide	Red	CO2
Instrument air	Green	INSTRUMENT AIR

1.8 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

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1.9 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

1.10 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.

1.11 LANGUAGE

- .1 Identification in English and French.

Part 2 Execution

2.1 MANUFACTURER'S INSTRUCTIONS

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

2.2 TIMING

- .1 Provide identification only after painting.

2.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and or CSA registration plates as required by respective agency.

2.4 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
 - .1 Do not paint, insulate or cover.

2.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

2.6 VALVES, CONTROLLERS

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

2.7 FIELD QUALITY CONTROL

2.8 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

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

1.3 PURPOSE OF TAB

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

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

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

1.6 PRE-TAB REVIEW

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

1.7 START-UP

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

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

- .1 Notify Consultant 7 days prior to start of TAB.
- .2 Start TAB when cooling tower installation is essentially completed, including:
- .3 Other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

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

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

- .1 Submit, prior to commencement of TAB:

- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

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

1.16 VERIFICATION

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

1.17 SETTINGS

- .1 After TAB is completed to satisfaction Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by Consultant.

1.19 Water Systems

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC, NEBB, SMACNA or ASHRAE.

- .2 Do TAB of systems, equipment, components, controls specified Division 23 and following systems, equipment, components, controls:
 - .1 Cooling Tower.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB qualified to standards of AABC or NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by to standards of AABC or NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-01, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-02, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-95, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-97, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-00, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-00, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-00a, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-92, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921-92(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).
- .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-M88(R2000), Surface Burning Characteristics of Building Materials and Assemblies.

- .2 CAN/ULC-S701-01, Thermal Insulation Polyotrene, Boards and Pipe Covering.

1.3 DEFINITIONS

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

1.4 SHOP DRAWINGS

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

1.5 MANUFACTURERS' INSTRUCTIONS

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

1.6 QUALIFICATIONS

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

1.7 DELIVERY, STORAGE AND HANDLING

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

1.8 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

□

- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Consultant.
- .5 Divert unused adhesive material from landfill to official hazardous material collections site approved by Consultant.
- .6 Do not dispose of unused adhesive materials into sewer systems, into lakes, streams, onto ground or in other locations where it will pose health or environmental hazard.

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma as scheduled in PART 3 of this Section.
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma as scheduled in PART 3 of this section.
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

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

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, plain, reinforced, 50 or 75 mm wide minimum.
- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

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

3.2 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.

□

- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.3 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served			
Outside air ducts to mixing plenum	C-1	yes	25
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Rectangular ducts outside	C-1]	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts			

- .2 HERE Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

- .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

- .1 Finishes: Conform to following table:

	TIAC Code	TIAC Code
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to	CRF/3	CRD/4

	TIAC Code	
	Rectangular	Round
precipitation Outdoor, elsewhere	CRF/4	CRD/5

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Related Sections:
 - .1 23 65 10.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Boiler and/or chiller operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Maximum cooling demand.
 - .7 Boiler and/or chiller failure.
 - .8 Cooling tower (and/or industrial fluid cooler) fan failure.
 - .9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.

- .3 Verification of primary and secondary pump flow rates.
- .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to Owner's Representative for testing by PWGSC to determine if chemical treatment is correct. Include cost.
- .6 Chilled water system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Adding heat from building heating system or;
 - .2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater than OAT. RAT to be at least 23 degrees C minimum.
 - .2 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, and condenser water flow rates and supply and return temperatures simultaneously.

1.6 CONDENSER WATER AND HUMIDIFICATION SYSTEMS

- .1 In addition to procedures specified above, perform following:
 - .1 Add chemicals once per week as required.
 - .2 Perform TAB as specified Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .3 Set up and adjust drip feeders, timer controls, pump strokes as required to maintain required chemical feed rates.
 - .4 Inject inhibitor into cooling tower sump.

1.7 REPORTS

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

1.8 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements:
Training of O&M Personnel, supplemented as specified herein.
 - .1 Include following:
 - .1 Building O & M Staff.

Part 2 Products

2.1 NOT USED

- .1 Not Used.

Part 3 Execution

3.1 NOT USED

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions: submit manufacturer's installation instructions.
 - .1 Consultant will make available 1 copy of systems supplier's installation instructions.

Part 2 Products

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING COOLING SYSTEM

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 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.
- .5 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .6 Chill Water Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Coordinate with Owner's Representative who will direct O&M staff to add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
 - .9 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF CHILL WATER SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Commission water treatment systems as specified in Section 23 25 00 - HVAC Water Treatment Systems.
 - .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .8 Repeat with water at design temperature.
 - .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .10 Bring system up to design temperature and pressure slowly.
 - .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for Cooling Tower.
 - .12 Adjust pipe supports, hangers, springs as necessary.
 - .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
 - .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .16 Check operation of drain valves.
 - .17 Adjust valve stem packings as systems settle down.
 - .18 Fully open balancing valves (except those that are factory-set).
 - .19 Check operation of over-temperature protection devices on circulating pumps.
 - .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for piping, valves and fittings for gas fired equipment.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 78 00 - Closeout Submittals.
 - .3 Section 23 05 05 - Installation of Pipework.
 - .4 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
 - .5 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22-01, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1-96, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B75M-99, Standard Specification for Seamless Copper Tube Metric.
 - .4 ASTM B837-01, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1HB-00, Natural Gas and Propane Installation Code Handbook.
 - .2 CAN/CSA B149.2-00, Propane Storage and Handling Code.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .5 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS 2 1/2 and over, plain end.
- .2 Copper tube: to ASTM B837.

2.2 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: non-metallic flat.
- .4 Brazing: to ASTM B837.

2.3 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:

- .1 Cast copper fittings: to ASME B16.18.
- .2 Wrought copper fittings: to ASME B16.22.

2.4 VALVES

- .1 Provincial Code approved, lubricated plug or ball type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install in accordance with Section 23 05 05 - Installation of Pipework, applicable Provincial/Territorial Codes, CAN/CSA B149.1, supplemented as specified.
- .2 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless otherwise approved by Consultant.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.
- .2 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, and 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 Schedule site visits to review work at stages listed:

- .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
- .2 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within 3 days of review and submit immediately to Consultant.
- .4 Performance Verification:
 - .1 Refer to Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
- .5 Application tolerances:
- .6 PV procedures:
 - .1 Test performance of components.

3.5 ADJUSTING

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
- .2 Pre-Start-Up Inspections:
 - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.
 - .2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 CLEANING

- .1 Cleaning: in accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems and CAN/CSA B149.1, supplemented as specified.
- .2 Perform cleaning operations as specified in Section 01 74 11 and in accordance with manufacturer's recommendations.
- .3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
- .2 Related Sections.
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 78 00 - Closeout Submittals.
 - .3 Section 23 05 00 - Common Work Results - Mechanical.
 - .4 Section 23 05 17 - Pipe Welding.
 - .5 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - .6 Section 23 05 23 - Valves - Cast Iron.
 - .7 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .8 Section 23 08 01 - Performance Verification of Mechanical Piping.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-01, Factory-Made Wrought Butt welding Fittings.
 - .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .3 American Water Works Association (AWWA).

- .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67-025, Butterfly Valves.
 - .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

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

1.4 MAINTENANCE

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

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.
- .3 Roll grooved: standard rigid coupling to CSA B242.
- .4 Flanges: plain or raised face, slip-on 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.

2.3 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 ductile iron to ASTM A536.

2.4 VALVES

- .1 Connections:
 - .1 NPS2 and smaller: screwed ends.
 - .2 NPS2.1/2 and larger: Flanged ends.
- .2 Gate valves: to MSS-SP-70 to 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 23 05 22 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Mechanical Rooms: rising stem, split wedge disc, lead free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
 - .2 Elsewhere: Non- rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (eg. multi-section coils, multi-cell cooling towers):
 - .1 NPS2 1/2 and over: Lug type as specified Section 23 05 17 - Pipe Welding.

- .4 Globe valves: to MSS-SP-80 85 Application: Throttling, flow control, emergency bypass:
 - .1 NPS2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 22 - Valves - Bronze.
 - .2 Elsewhere: Globe, with composition disc, as specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 With composition lead free bronze disc, lead free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check .
- .5 Balancing, for TAB:
 - .1 Sizes: Calibrated balancing valves, as specified this section.
 - .2 NPS2 and under:
 - .1 Mechanical Rooms: Globe, with plug disc as specified Section 23 05 22 - Valves - Bronze.
 - .2 Elsewhere: Globe, with plug disc as specified Section 23 05 22 - Valves - Bronze.
- .6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
- .7 Bypass valves on globe valves NPS8 and larger: NPS3/4, Globe, with PTFE disc as specified Section 23 05 22 - Valves - Bronze.
- .8 Swing check valves: to MSS-SP-71.
 - .1 NPS2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Flanged] Grooved ends: as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .9 Silent check valves:
 - .1 NPS2 and under:
 - .1 As specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS2 1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .10 Ball valves:
 - .1 NPS2 and under: as specified Section 23 05 22 - Valves - Bronze.
- .11 Lubricated Plug Valves
 - .1 NPS2 and under

- .2 NPS21/2 and over:
 - .1 As specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

Part 3 Execution

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 01 - Installation of Pipe Work.

3.2 CIRCUIT BALANCING VALVES

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

3.3 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

3.4 TESTING

- .1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.
- .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 BALANCING

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.6 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for steam and condensate building services piping.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 35 30 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 01 91 00 - Commissioning.
- .6 Section 23 05 00 - Common Work Results - Mechanical.
- .7 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .8 Section 23 05 01 - Installation of Pipework.
- .9 Section 23 05 22 - Valves - Bronze.
- .10 Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .11 Section 23 08 01 - Performance Verification of Mechanical Piping.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI/ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B16.25-97, Buttwelding Ends.
 - .3 ANSI/ASME B16.3-98, Malleable Iron Threaded Fittings.
 - .4 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .5 ANSI/ASME B16.9-01, Factory-Made Wrought Steel Buttwelding Fittings.
 - .6 ANSI B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - .7 ANSI/ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
- .2 American Water Works Association (AWWA).
 - .1 AWWA C111-2000, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .3 American Society for Testing and Materials International, (ASTM).

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- .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .3 ASTM A126-95(2001), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- .5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
 - .1 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS-SP-71-97, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-80-97, Bronze Gate, Globe, Angle and Check Valves.
 - .4 MSS-SP-85-94, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data and include manufacturer's literature data sheets for following: valves.
- .3 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.6 EXTRA MATERIALS

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

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:

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- .1 Steam;
 - .1 To NPS 6: Class 125.
 - .2 NPS 8 and over: Class 250
 - .3 Condensate: Class 125.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with PTFE tape or lead-free dope.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.
- .3 Flanges: plain or raised face. Flange gaskets to AWWA C111.
- .4 Pipe thread: taper.
- .5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.
- .6 Buttwelding ends: to ANSI/ASME B16.25.

2.3 FITTINGS

- .1 Pipe flanges: cast-iron to ANSI/ASME B16.1, Class 125.
- .2 Screwed fittings: malleable iron to ANSI/ASME B16.3, Class 150.
- .3 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.
- .4 Buttwelding fittings: steel to ANSI/ASME B16.9.
- .5 Unions: malleable iron, to ASTM A47/A47M and ANSI/ASME B16.3.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2 1/2 and larger:
 - .1 Equipment: Flanged ends.
 - .2 Elsewhere: Flanged ends.
- .2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 22- Valves-Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22- Valves-Bronze.
 - .2 NPS 2 1/2 -8:

- .1 Mechanical Rooms: Class 150, rising stem, split wedge disc, cast iron, lead- free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .2 Elsewhere: Class 150, Non-rising stem, solid wedge disc, cast iron with lead- free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .3 Globe valves: Application: Steam service, throttling, flow control, emergency bypass.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc as specified Section 23 05 22 - Valves - Bronze.
 - .2 Elsewhere: with composition disc as specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 With composition lead-free bronze disc, cast iron with bronze trim, to Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .4 Gate valves: Application: Pumped and gravity condensate return service, steam drip point assemblies.
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 22 - Valves-Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Mechanical Rooms: Class 125, rising stem, split wedge disc, cast iron, lead-free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, cast iron with lead-free bronze trim, as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.
- .5 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.
- .6 Lift check valves:
 - .1 NPS 2 and under: Class 125, lift, with composition disc, as specified Section 23 05 22 - Valves - Bronze.
 - .2 NPS 2 1/2 and over: as specified Section 23 05 23 - Valves - Cast Iron: Gate, Globe, Check.

2.5 VALVE OPERATORS

- .1 Handwheel: on valves except as specified.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment rooms.

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Part 3 Execution

3.1 PIPING

- .1 Install pipework in accordance with Section 23 05 01 - Installation of Pipework.
- .2 Connect branch lines into top of mains.
- .3 Install piping in direction of flow with slopes as follows, unless otherwise indicated:
 - .1 Steam: 1:240.
 - .2 Condensate return: 1:70.
- .4 Make provision for thermal expansion.
- .5 Drip pocket: line size.

3.2 VALVES

- .1 Install globe valves around, NPS 8 and over, gate valves.

3.3 TESTING

- .1 Test system in accordance with Section 23 05 00 - Common Work Results - Mechanical.
- .2 Test pressure: 1-1/2 times maximum system operating pressure or 860 kPa whichever is greater.

3.4 CLEANING, FLUSHING, START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.5 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping supplemented as specified herein.
- .2 Timing, only after:
 - .1 Pressure tests successfully completed.
 - .2 Flushing as specified has been completed.
 - .3 Water treatment system has been commissioned.
- .3 PV Procedures:
 - .1 Verify complete drainage of condensate from steam coils.
 - .2 Verify proper operation of system components, including, but not limited to:
 - .1 Steam traps - verify no blow-by.
 - .2 Flash tanks.

- .3 Thermostatic vents.
- .3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.
 - .1 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .4 Condensate pumping units: for commissioning procedures, refer to Section 01 91 00 - Commissioning.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of steel piping valves, fittings for steam and condensate building services piping.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.
- .3 Section 01 35 30 - Health and Safety Requirements.
- .4 Section 01 78 00 - Closeout Submittals.
- .5 Section 23 08 01 - Performance Verification of Mechanical Piping.

1.3 REFERENCES

- .1 American Society for Mechanical Engineers (ASME International).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A126-95(2001), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM A167-99, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - .3 ASTM A216/A216M-2003, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
 - .4 ASTM A240/A240M-04, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .5 ASTM A276-03, Standard Specification for Stainless Steel Bars and Shapes.
 - .6 ASTM A278/A278M-01, Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).
 - .7 ASTM A351/A351M-03, Standard Specification for Steel Castings, Austenitic, Austenitic- Ferritic (Duplex) for Pressure-Containing Parts.
 - .8 ASTM A564/A564M-02a, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - .9 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data and include manufacturer's literature indicating Canadian Registration Number (CRN): Steam traps, Vacuum breakers, Pressure reducing valves, Air Vents, Safety relief valves.
- .3 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 MATERIALS

- .1 Cast steel: to ASTM A216/A216M.
- .2 Cast iron: to ASTM A278, Class 300.
- .3 Bronze: to ASTM B62.
- .4 Stainless steel: to ASTM A351/A351M.

2.2 FLOAT AND THERMOSTATIC STEAM TRAPS 0-110 KPA

- .1 Application: for modulating steam service on heating coils, convertors, radiation or as indicated.
- .2 Materials: body - cast iron; valve - stainless steel with stainless steel seat; float and mechanisms - stainless steel; air vent - phosphor bronze or stainless steel thermostatic type.
- .3 Capacity: as indicated.

2.3 FLOAT AND THERMOSTATIC STEAM TRAPS 111-1000 KPA

- .1 Application: for modulating steam service on heating coils, convertors, radiation, or as indicated.
- .2 Materials: body - cast iron; valve - stainless steel or bronze with stainless steel seat; air vent - stainless steel or phosphor bronze thermostatic type.
- .3 Capacity: as indicated.

2.4 VACUUM BREAKERS 0.85-68 KPA

- .1 Application: on inlets to steam coils, heat exchangers or as indicated.
- .2 Materials: body and cap - lead-free brass or stainless steel; spring - stainless steel; stem and seat - lead-free brass or stainless steel.
- .3 Capacity: as indicated.
- .4

2.5 SAFETY AND RELIEF VALVES

- .1 Spring loaded type of bronze with high capacity and full nozzle or cast iron with high capacity and semi-nozzle and to ASME code.
- .2 Material: body -cast iron or forged copper alloy; valve - housing lead-free or cast bronze or malleable iron; spring - steel, cadmium plated; lead-free bronze/brass trim.
- .3 Capacity: as indicated.

2.6 DRIP PAN ELBOWS

- .1 Application: on discharge of steam safety relief valves as indicated.
- .2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.7 PIPE LINE STRAINERS UP TO NPS 2

- .1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.
- .2 Working pressure: 860 kPa.
- .3 Body: lead-free bronze or cast iron.
- .4 Connections: screwed.
- .5 Screen: stainless steel with 0.8 mm perforations.
- .6

2.8 PIPE LINE STRAINERS NPS 2-1/2 AND OVER

- .1 Application: ahead of condensate pumps, steam traps, control valves as indicated.
- .2 Working pressure: 860 kPa.
- .3 Body: cast iron.
- .4 Connections: flanged.

- .5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.
- .6 Screen: stainless steel with 3.2 mm perforations.

Part 3 Execution

3.1 GENERAL

- .1 Install in accordance with manufacturers' recommendations.
- .2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

- .1 Install as indicated.
- .2 Ensure clearance for removal of basket.
- .3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

- .1 Pipe to atmosphere independent of other vents and in accordance with applicable code.
- .2 Support discharge pipe against reaction forces and to take up thermal movement.
- .3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

- .1 Install unions on inlet and outlet.

3.5 PRESSURE REDUCING VALVES

- .1 Install on 3-valve bypass with strainer on inlet.
- .2 Pipe as indicated. Follow manufacturer's installation instructions.

3.6 FLASH TANKS

- .1 Pipe arrangement as indicated.

3.7 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials, components, equipment and chemicals for installation of complete HVAC water treatment system.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

- .1 ASME Boiler and Pressure Vessel Code, Section VII-2004.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)

- .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

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

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

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

.4 Closeout Submittals:

- .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .2 Include following:

- .1 Log sheets as recommended by manufacturer.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions.
 - .2 Waste Management and Disposal:
 - .3 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MANUFACTURER

- .1 Equipment, chemicals, service provided by one supplier.
- .2 Prequalified supplier: H2O Technologies

2.2 WATER TREATMENT FOR STEAM SYSTEMS

- .1 Performance: to control sludge, scale, dissolved solids, provide corrosion protection.
- .2 Meter-timer operated diaphragm pump c/w injection fitting, suction tubing, foot valve and strainer.
- .3 The Mechanical Contractor shall supply and install a completely automatic chemical feed system to control scale and corrosion in the steam boiler.
- .4 One (1) only 45 gal. poly tank and wall mounting diaphragm pump.
- .5 One (1) only contact head meter sized to boiler's maximum make-up.
- .6 One (1) only prewired control panel c/w one (1) auto reset timer, an H.O.A. switch, a manual switch and status lights.
- .7 Provide test equipment c/w wall mounting cabinet and treatment chemicals for initial start-up plus one month's supply after turnover of the system. Technical service calls and reports for one year.
- .8 All steam boilers are to be chemically cleaned under the supervision of the water treatment company and approved by them. Written reports to be submitted to the architects on the systems acceptance.

2.3 AUTOMATIC CHEMICAL FEED & BLEED FOR COOLING TOWER TREATMENT

- .1 Meter controlled timer for feed; Conductivity controlled bleed; Poly tank; Piston pump and mixer.
- .2 The M.C. shall supply & install a completely automatic Chem. feed system to control corrosion, scale and bleed-off.
- .3 One (1) only 45 Gal. poly Chem. feed unit C/W ¼ H.P. mixer & 150S piston pump, 0-6 gph at 750 psi.
- .4 One (1) only contact head meter sized to meet the tower requirements.
- .5 One (1) only solenoid valve sized for bleed-off control.
- .6 One (1) only Auto-trol conductivity controller C/W probe.
- .7 One (1) only manual flow control valve.
- .8 One (1) only Auto-reset timer, 0-30 minutes, c/w enclosure.
- .9 One (1) only H.O.A. switch.
- .10 Two (2) only 1061 manual heater switches.
- .11 One (1) only by-pass feeder for algaecide feed.
- .12 Each closed hot water heating & chilled water system shall have a by-pass Chem. feeder & a micron filter equal to 5% of the circulation rate of the Recirc. pump. Supply one spare set of filter tubes.
- .13 Provide test equipment c/w wall mounting cabinet & treatment chemicals for initial start-up plus one mon. supply after turnover of the system. Technical service calls & reports for one year.
- .14 All closed Recirc. systems to be chemically cleaned under the supervision of the water treatment company and approved by them.. Written reports to be submitted to the Architects on system's acceptance

2.4 CHEMICALS

- .1 Provide 1 year supply.

2.5 TEST EQUIPMENT

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CHEMICAL FEED PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING OF MECHANICAL SYSTEM

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Consultant.
- .2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .4 Drain and flush system until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 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 30 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 Provide clear, concise, written instructions and advice to operating staff.

3.6 WATER SOFTENER

- .1 Install in accordance with manufacturer's instructions.
- .2 Install water metre in water softener inlet piping.

3.7 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
 - .1 Commissioning Agency: to be [installing water treatment sub-contractor] [water treatment supplier] [holder of service contract].
 - .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
 - .3 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of [raw] [initial] [____] water analysis.
 - .4 Required quality of treated water.
 - .4 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record 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 Consultant in writing on matters regarding installed water treatment systems.
- .5 Commissioning procedures - Water Softeners:

- .1 Demonstrate compliance with specifications by chemical analyses of raw water and treated water.
- .2 Determine, demonstrate actual softening capacity between regenerations.
- .3 Establish regeneration intervals and procedures.
- .4 Train O&M personnel in regeneration procedures.
- .6 Commissioning procedures - Water side of closed circuit coolers, Cooling Tower Systems:
 - .1 Verify operation of bleed-off system.
 - .2 Establish bleed-off flow rate.
 - .3 Establish rate of chemical feed - continual and periodic.
 - .4 Test system water for chlorides, TDS, suspended solids, algae, slime, inhibitor level, pH, alkalinity, hardness, other impurities and microbiological organisms.
 - .5 Compare with readings of total dissolved and suspended solids metre.
 - .6 Read make-up water metre, compare with chiller load summation (ton-hours).
 - .7 Test make-up water for chlorides, hardness.
 - .8 Compare test results with readings from TDS metre.
 - .9 Record quantity of make-up water, compare with summation of chiller load (in ton-hours).
 - .10 Record types, quantities of chemicals applied.
- .7 Commissioning procedures - Closed Circuit Hydronic Systems:
 - .1 Analyze water in system.
 - .2 Based upon an assumed rate of loss approved by Consultant, 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.
 - .2 Train O&M personnel in softener regeneration procedures.
- .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 Consultant.
- .11 Commissioning activities during Warranty Period:
 - .1 Check out water treatment systems on regular basis and submit written report to Consultant.

3.8 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.

- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
- .2 Related Sections:
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 01 35 30 - Health and Safety Requirements.
 - .3 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
 - .4 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .5 Section 23 05 94 - Pressure Testing of Ducted Air Systems.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

- .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, [1997].
- .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
- .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.

Part 2 Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

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

2.2 SEALANT

- .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

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

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
 - .1 Rectangular: standard radius or short radius with single thickness turning vanes
Centreline radius: 1.5 times width of duct.
 - .2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
 - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: with splitter damper.
- .5 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
 - .1 Full radiused elbows.

2.6 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE or SMACNA.
- .3 Joints: to ASHRAE or SMACNA. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

□

2.7 HANGERS AND SUPPORTS

- .1 Hangers and Supports: [in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment].
 - .1 Strap hangers: of same material as duct [but next sheet metal thickness heavier than duct].
 - .1 Maximum size duct supported by strap hanger: 500.
 - .2 Hanger configuration: to ASHRAE and SMACNA.
 - .3 Hangers: black or galvanized steel angle with black or galvanized steel rods to ASHRAE and SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10
 - .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .2 For steel joist: manufactured joist clamp, steel plate washer.
 - .3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 GENERAL

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

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA

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

3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

- .1 Fresh air intake.
- .2 Minimum 3000 mm from duct mounted humidifier in all directions.
- .3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

- .1 Solder or weld joints of bottom and side sheets.
- .2 Seal other joints with duct sealer.

.3 Slope horizontal branch ductwork down towards fume hoods served.

- .1 Slope header ducts down toward risers.

.4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve, trap primer and discharging to open funnel drain.

3.4 SEALING AND TAPING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.5 LEAKAGE TESTS

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

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.6 Complete test before performance insulation or concealment Work.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems as well as combustion air dampers.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .2 Indicate the following:
 - .1 Performance data.
- .2 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 MULTI-LEAF DAMPERS

- .1 Opposed and/or parallel blade type as indicated.
- .2 Structurally formed steel, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Performance:

- .1 Leakage: in closed position less than 2% of rated air flow.

2.2 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi or single leaf, steel construction with nylon bearings, centre pivoted spring assisted or counterweighted.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper.
- .5 Ensure dampers are observable and accessible.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, accessories and installation for breechings, chimneys and stacks.
- .2 Related Sections:
 - .1 23 52 00 Boilers

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.
 - .4 Bases/Foundations.
 - .5 Supports.
 - .6 Guy details.
 - .7 Rain caps.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Closeout Submittals
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.
- .3 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions.

Part 2 Products

2.1 BREECHINGS

- .1 Shop fabricated 3.5 mm thick stainless steel welded, with sweep bends from boiler outlet to thimble or chimney as indicated.
- .2 Remove, dispose of existing breechings and install new as shown on drawings.

2.2 TYPE B GAS VENT

- .1 ULC labelled, 288 degrees C rating maximum, atmospheric gas vent only.
- .2 Sectional, prefabricated, double wall with 13 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

2.3 ACCESSORIES

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single or double acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA).
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION - GENERAL

- .1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at 1.5 m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Heating boiler units:
 - .1 Cast iron.
 - .2 Steam boilers.
 - .3 Gas burners.
 - .4 Installation.
 - .5 Commissioning.

1.2 REFERENCES

- .1 American Boiler Manufacturer's Association (ABMA)
- .2 American National Standards Institute (ANSI)
 - .1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- .3 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.
- .4 Canadian Gas Association (CGA)
 - .1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.
 - .2 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.
- .5 Canadian Standards Association (CSA International)
 - .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
- .6 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:

- .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.6 MAINTENANCE

- .1 Extra materials:
 - .1 Special tools for burners, manholes, handholes and Operation and Maintenance.
 - .2 Spare parts for 1 year of operation.
 - .3 Spare gaskets.
 - .4 Spare gauge glass inserts.
 - .5 Probes and sealants for electronic indication.
 - .6 Spare burner tips.
 - .7 Spare burner gun.
 - .8 Safety valve test gauge.

Part 2 Products

2.1 GENERAL

- .1 Packaged boiler: Provide 2 low pressure steam boilers
 - .1 Complete with burner and all the necessary accessories and controls.
 - .2 Laboratory and/or Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7, CAN1-3.1, witnessed and certified by Consultant.
 - .3 Un-assembled low pressure steam boiler c/w force draft gas burner with lo/hi/lo firing mode to assembled on site and ready for attachment to piping, electrical power, controls, flue gases exhaust.
 - .4 All steam trim, GSP guarded status panel & controls, as per TSSA.
 - .5 Designed and constructed to ANSI/ASME Boiler and Pressure vessel Code.
 - .6 CRN (Canadian Registration Number), to CSA B51.
 - .7 Boiler/burner package to bear ULC, CGA label.
- .2 Performance:
 - .1 In accordance with American Boiler Manufacturers Association (ABMA), [or ANSI Z21.13/CSA 4.9 (gas burning) testing procedures.
 - .2 Steam: Net Output: 2,000 MBH, Design steam pressure: 860 kPa. Operating pressure: 103 kPa.
 - .3 Firing rate: natural gas; L/h gas pressure at metre outlet: 1.75 to 3.5 kPa.
 - .4 Boiler efficiency: 85 % minimum at 30% to 100% firing rates.
 - .5 Flue gas temperature leaving boiler:

- .1 Not to exceed 260 degrees C.
- .2 Above dewpoint conditions at minimum firing rate.
- .6 Acceptable Manufacturer: Weil-McLain 88 Series 2 Commercial Gas Boiler.
- .3 Electrical:
 - .1 Power: 120 V, 1 phase, 60 Hz.
 - .2 Controls: 120 V, 1 phase, 60 Hz.
 - .3 Electrical components: CSA approved.
- .4 Controls: factory wired. Enclosed in Electrical and Electronic Manufacturers' Association of Canada (EEMAC) 1 steel cabinet.
- .5 Thermal insulation:
 - .1 50 mm thick mineral fibre. Seal insulation at handholes, manholes, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
- .6 Jackets: heavy gauge metal, finished with heat resisting paint.
- .7 Mounting:
 - .1 Structural steel base, lifting lugs.
- .8 Anchor bolts and templates:
 - .1 Supply for installation by other Divisions. Anchor bolts to be sized to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .9 Start-up, instruction, on-site performance tests: 3 days per boiler.
- .10 Trial usage:
 - .1 Consultant may use boilers for test purposes prior to acceptance and commencement of warranty period.
 - .2 Supply labour, materials and instruments required for tests.
- .11 Temporary use by contractor:
 - .1 Contractor may use boilers only after written approval from Consultant.
 - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
 - .3 Refurbish to as-new condition before final inspection and acceptance.

2.2 CAST IRON BOILER

- .1 Sectional forced draft firing, water wall design, complete with site assembled water cooled sections, front plate and removable panels.

- .2 Design of sections to provide balanced water circulation and flue gas travel. Make sections gas-tight and water-tight through use of high temperature rope, elastomer seals, pull-up bolts.
- .3 Flue passages: readily accessible without use of special tools.
- .4 Provide supply and return headers, elbows to manufacturers recommendations and to suit installation.
- .5 Include mudholes, inspection and cleanout handholes.

2.3 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ANSI/ASME requirements.
- .2 Steam boilers:
 - .1 Safety valves : ANSI/ASME rated, set at 103 kPa, to release entire boiler capacity, complete with drip pan elbow and vent pipe.
 - .2 Pressure gauge: 130 mm diameter range 0 to 200 kPa, complete with syphon and cock.
 - .3 Water column assembly: with tri-cocks, gauge glass, protective rods, blowdown valves operated from firing floor.
 - .4 High water level: audible alarm.
 - .5 Low water level: fuel cut-off with visual and audible alarms and feedwater pump control switch.
 - .6 Feedwater regulator on 3-valve bypass with drain valve, stop valve and check valve.
 - .7 Continuous blow-down stop valve.
 - .8 Soot blower element, supply valve and drain valve.
 - .9 Auxiliary low water cut-off with separate cold water connection to boiler.
 - .10 Steam stop-check valve.
 - .11 Quick-opening blowdown valve and shut-off valve.
 - .12 Stack thermometer: range 65 to 400 degrees C.
 - .13 Drain valve: NPS 2.
 - .14 One 1 set cleaning tools.
- .3 See water treatment section for chemical feed system.

2.4 GAS BURNERS

- .1 General:
 - .1 Forced draft with:
 - .1 Built-in blower to supply combustion air, complete with motor, silencer and damper.
 - .2 High voltage ignition transformer.

- .3 Flame observation port.
- .4 Easy access to nozzles and electrodes.
- .2 Gas pilot:
 - .1 To building code and provincial regulations including solenoid gas valve, pressure regulator, pressure gauge, manual shut-off valve.
- .3 Main gas train:
 - .1 To building code and provincial regulations including main shut-off valve, pressure regulator, motorized electric shut-off valve, downstream block-test valve with test connection and pressure gauge.
- .4 Controls:
 - .1 Electronic combustion control relay with ultra-violet or infra-red flame detector for combustion control and flame supervision.
 - .2 Control to shut off fuel within 5 seconds upon pilot flame or main flame failure or upon signal of safety interlock and to ensure, when restarted, in sequence:
 - .1 Pre-purge.
 - .2 Pilot ignition and supervision.
 - .3 Main gas valve opening.
 - .4 Pilot cut-off. Pilot-proving period not to exceed 10 seconds.
 - .5 Burner operation.
 - .6 Post-purge burner shut-down.
 - .3 Static pressure interlock. To shut off burner upon loss of combustion air pressure.
 - .4 Fuel-air mixture: control through:
 - .1 2-position motor with end switch to provide for low-fire start and high fire run.
 - .2 Two-position motor with linkage to control fuel and air and with end switches to prove low-fire start and energize high fire solenoid valve for high-low fire operation.
 - .3 Modulating motor with end switch to provide for low-fire start and fully modulating operation down to 20 % of design capacity.
 - .5 Immersion controllers:
 - .1 Operating: to start and stop burner, and operating between adjustable setpoints.
 - .2 High-low: to shift burner operation to high or low fire.
 - .3 Modulating: to modulate burner output.
 - .4 High limit: manual reset,
 - .5 Controller range: 0 to 103 kPa, 30 to 121 degrees C.
 - .6 Visual and audible alarms: to indicate burner shutdown due to flame failure, low water level, high pressure, temperature, low air pressure, low gas pressure.
 - .7 Selector switch: to permit manual and automatic firing at any rate between low and high fire.

- .8 Pilot lights: to indicate:
 - .1 Normal burner operation.
 - .2 All stages of burner operation.
- .9 Burner to start up in low fire position.
- .10 Provide a boiler control package that will house all of the points of control as well outdoor temperature reset, lead/lag.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province of Québec having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level [using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Pipe steam relief valve through roof with drip pan elbow piped to nearest drain.
- .6 Pipe blowdown/drain to blowdown tank/floor drain.
- .7 Natural gas fired installations - in accordance with CAN/CSA-B149.1.
- .8 LP gas installations - in accordance with CAN/CSA-B149.1.

3.3 MOUNTINGS AND ACCESSORIES

- .1 Safety valves and relief valves:
 - .1 Run separate discharge from each valve.
 - .2 Terminate discharge pipe as indicated.
 - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.
- .2 Blowdown valves:

- .1 Run discharge to terminate as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Commissioning:
 - .1 Manufacturer to:
 - .1 Certify installation.
 - .2 Start up and commission installation.
 - .3 Carry out on-site performance verification tests.
 - .4 Demonstrate operation and maintenance.
 - .2 Provide Consultant at least 24 hours' notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Materials, components, framing, installation and testing for an evaporative condenser open circuit cooling tower.

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- .1 Anchor bolts: size anchor bolts to withstand seismic acceleration and velocity forces as defined in Section 23 05 49 - Seismic Restraint Systems (SRS) - Type P2 Buildings and 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

1.3 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A48/A48M-03, Standard Specification for Gray Iron Castings.
 - .2 ASTM A123/A123M-2001, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .3 ASTM A153/A153M-04, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - .4 ASTM D520-2000, Standard Specification for Zinc Dust Pigment.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B52-1999(R2004), Mechanical Refrigeration Code.
- .3 Cooling Technology Institute (CTI)
 - .1 CTI-ATC-105-2000, Acceptance Test Code.
 - .2 CTI-STD-201-2004, Standard for the Certification of Commercial Water Cooling Tower Thermal Performance.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Underwriters Laboratories' of Canada (ULC)
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .6 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG 1-2003, Motors and Generators.

1.4 PERFORMANCE REQUIREMENTS

- .1 Performance certified in accordance with CTI-STD-201.

- .2 Cooling tower:
 - .1 Capacity: 975 usgpm of water from 95°F to 85.5°F with 76°F ambient wet bulb temperature. Rejecting 4,875 MBH of heat. 330 Tons.
 - .2 Pressure drop: 14' WC
 - .3 Fill system with water.
 - .4 Electrical: 15 HP, axial flow fan, 575/3/60.
 - .5 Corrosion Protection System.
 - .6 Acceptable Manufacturer: Evapco, Baltimore, Marley

1.5 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Shop Drawings:
 - .1 Indicate:
 - .1 Connections, piping, fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.
 - .2 Wiring as assembled and schematically.
 - .3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.
 - .4 Vibration and seismic control measures.
 - .5 Manufacturers recommended clearances.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Test reports:
 - .1 Submit certified test reports for cooling towers from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.
 - .4 Manufacturer's Field Reports: manufacturer's field reports specified.
 - .4 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

- .2 Include:
 - .1 Description of equipment giving manufacturers name, type, model year, capacity.
 - .2 Start-up and commissioning procedures.
 - .3 Details of operation, servicing and maintenance.
 - .4 Recommended spare parts list.

1.6 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company or person specializing in cooling towers installations with 5-years documented experience approved by manufacturer.
 - .2 Regulatory Requirements: work to be performed in compliance with CEPA, CEEA, and applicable Provincial /Territorial regulations.
 - .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.

1.8 MAINTENANCE

- .1 Extra Materials:
 - .1 Furnish spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 1 month prior to date of occupancy.
 - .2 Include with data complete list of parts and supplies, with current unit prices, source of supply, recommended spare parts list for 1 year of operation, and list of parts recommended by manufacturer to be replaced on routine basis.

Part 2 Products

2.1 GENERAL

- .1 Factory assembled forced draft vertical discharge cooling tower.

- .2 Ensure major equipment including cooling towers, cooling tower gear drive assemblies, fans, and motors have manufacturer's name, address, style, model and serial number, catalog number on plate secured to item of equipment.
- .3 Plates: durable and legible throughout equipment life and made of anodized aluminum or stainless steel.
- .4 Fix plates in prominent locations with nonferrous screws or bolts.

2.2 SIZE AND WEIGHT

- .1 Dimensions: approximately 2.6 m x 3.6 m x 3.9 m maximum height.
- .2 Shipping weight: maximum 5,550 lbs.
- .3 Operating Weight: 9,410 lbs

2.3 CASING AND FRAMEWORK

- .1 Materials: upper casing, channels and angle supports shall be constructed of heavy gauge mill hot-dip galvanized steel. Fan cowl and guard to be constructed of galvanized steel. All galvanized steel shall be coated with zinc G-235. During fabrication, all galvanized panel edges shall be coated with 95% pure zinc-rich compound.
- .2 Provide straight-rung ladders of standard design, starting at roof level and extending as high as required to gain access to fan decks and water distribution systems.
 - .1 Stairways and ladders: hot-dip, zinc-coated steel.
 - .2 Equip ladders higher than 3.66 m with safety cage.

2.4 COLD WATER BASIN

- .1 The cold water basin shall be constructed to be watertight and from 304 stainless steel.

2.5 HOT WATER DISTRIBUTION

- .1 Water distribution: shall be constructed of heavy gauge stainless steel 304 shall be open gravity-flow type system. Distribution weirs and plastic metering orifices shall be provided which distributes waters evenly over entire fill surface.
- .2 Design tower cells so that water flow of 140 % capacity will not cause overflowing or splashing.
- .3 Include with distribution system for each cell, adjustable flow control valves.
- .4 Gravity-Flow System: provided with open basins which include splash box baffles to minimize splashing of incoming hot water and holes that evenly distribute water over entire decking area.
 - .1 Equip water basin holes with plastic orifice inserts.

- .5 Provide hot water distribution basins with tower manufacturer's standard removable, stainless covers to prevent airborne debris from entering basin.

2.6 FILL, ELIMINATORS AND LOUVRES

- .1 Provide eliminators in tower outlet to limit drift loss to not over 0.001 % of circulating water rate. Drift eliminators shall be constructed of PVC in easily handled sections.

2.7 FAN

- .1 Fan: axial flow, with aluminum blades, statically and dynamically balanced.
- .2 Fan drive: one-piece multi-groove, neoprene/polyester belt.
- .3 Motor: multi speed, totally enclosed, insulation Class B, continuous-rated type which conforms to NEMA MG 1.
 - .1 Fan motors: totally enclosed enclosures; locate outside discharge airstream.
 - .2 Mount motors in accordance with manufacturer's recommendations.
 - .3 Motor: variable torque characteristics.
- .4 Drives, fans, and moving parts: protected by galvanized wire guards.

2.8 ACCESSORIES

- .1 Inlet sound attenuator: the manufacturer of the tower will provide an acoustically lined intake plenum, equipped with access door, constructed from hot-dip galvanized steel.
- .2 Corrosion Protection System: the cooling tower corrosion protection system shall consist of hot-dip galvanized steel sub-frame and have an electrostatically applied thermosetting, hybrid polymer fuse-bonded to the sub-frame steel during a thermally activated curing stage. All protected parts are to be coated prior to assembly.
- .3 Electronic water level control package c/w 3 stainless steel water level sensors, one (1) high level, one (1) low level and one (1) ground with a NEMA 4x enclosure mounted in a cleanable Schedule 40 PVC external standpipe with slow closing solenoid valves and y strainers. Contractor to provide field mounting wiring. Valves shall be sized for 25 psig minimum to 125 psig maximum pressure. Provide heat tracing for standpipe.
- .4 Pan strainer shall be stainless Steel 304 construction with large removeable perforated screens.
- .5 Internal working platform shall provide for easy access to the fan, belts, motor, sheaves, bearings, all mechanical equipment and complete water distribution system.
- .6 An OSHA approved aluminum sloped ladder shall be provided for access to the motor access door, provide 3' ladder extension.

- .7 Basin Heater Package: Clod water basin shall be fitted with copper-element, electric immersion heaters with a separate thermostat and low water protection device. Heaters selected to maintain +40°F pan water at 0°F ambient temperature.

2.9 VIBRATION ISOLATORS

- .1 To Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .2 Provide a DPDT vibration cutout switch, operating at 120V to protect fan in case of excessive vibration.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

- .1 Mount on structural supports and vibration isolators and to manufacturer's recommendations.
- .2 Ensure clearance for servicing and maintenance as recommended by manufacturer.
- .3 Manufacturers field service representative to approve installation, to supervise start up and to instruct operators.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests:
 - .1 Test under actual operating conditions in accordance with CTI-ATC-105 to verify specified performance.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 ADJUSTING

- .1 Lubricate bearings with oil or grease as recommended by manufacturer.

- .2 Tighten belts to manufacturer's specified tension.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Wipe equipment clean, and remove traces of oil, dust, dirt, or paint spots.
- .3 Maintain system in clean condition until final acceptance.
- .4 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 GENERAL

1.1 RELATED DOCUMENTS

- .1 The General Provisions of the Contract, including General, Supplementary, and Special Conditions, and Division 1 - General Requirements, apply to work specified in this section. Subcontractor must familiarize himself with the terms of the above documents.

1.2 QUALIFICATIONS OF BIDDER

- .1 All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 10 years.
- .2 All bidders must be authorized distributors or branch offices of the manufacturers specified.
- .3 All bidders must have a trained staff of application engineers, who have been certified by the manufacturer in the configuration, programming and service of the automation system.
- .4 The following bidders have been pre-qualified:
 1. Lar-Mex Inc.

1.3 SCOPE OF WORK

- .1 Except as otherwise noted, the control system shall consist of all Standalone Digital Control Units, sensors, relays, valves, dampers, damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- .2 The BAS contractor shall review and study all Mechanical and Electrical drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- .3 All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.
- .4 The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification. At a minimum, provide controls for the following:
 1. Boilers
 2. Cooling Towers

3. Boiler Room Ventilation System

- .5 Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative.
- .6 All work performed under this section of the specifications will comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project to meet code restrictions. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

1.4 TRAINING

- .1 Provide minimum of (8) hours of on-site training for system operators. The training will be hands-on type at the owner's office. The training class will use the actual Operator's Manual that will be submitted for this project.

1.5 SYSTEM DESCRIPTION

- .1 The Building Automation System (BAS) shall consist of PC-based workstations and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.

For this project the system shall consist of the following components:

- .2 Operator Workstation(s). Existing Operator Workstation will be reused
- .3 Ethernet-based Network Controller(s). Existing Network Controller will be reused
- .4 Standalone Digital Control Units (SDCUs). Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment.

1.6 WORK BY OTHERS

- .1 The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- .2 The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - 1. Automatic control dampers.
 - 2. Boiler Controls
 - 3. Cooling Tower Controls
- .3 The Electrical Contractor shall provide:
 - 1. All power wiring to motors, junction boxes for power to BAS panels.

1.7 CODE COMPLIANCE

- .1 Provide BAS components and ancillary equipment, which are UL-916 listed and labelled.
- .2 All wiring shall conform to the National Electrical Code.
- .3 Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- .4 Comply with FCC, Part 68 rules for telephone modems and data sets.
- .5 The system components and installation shall be BACNET compatible.

1.8 SUBMITTALS

- .1 All shop drawings shall be prepared in Visio Professional or AutoCAD software. In addition to the drawings, the Contractor shall furnish a CD containing the identical information. Drawings shall be B size or larger.
- .2 Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.
- .3 Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and air flow station schedules shall indicate size, configuration, capacity and location of all equipment.
- .4 Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.
- .5 Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. The Contractor prior to submitting shall check all documents for accuracy.
- .6 The Engineer will make corrections, if required, and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- .7

1.9 SYSTEM STARTUP AND COMMISSIONING

- .1 Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- .2 The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water and all air handling systems, in the

presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives.

- .3 The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

1.10 TRAINING

- .1 The BAS Contractor shall provide on-site training to the Owner's representative and maintenance personnel per the following description:
- .2 On-site training shall consist of a minimum of (8) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include
 1. System Overview
 2. System Software and Operation
 3. System access
 4. Software features overview
 5. Changing setpoints and other attributes
 6. Scheduling
 7. Editing programmed variables
 8. Displaying color graphics
 9. Running reports
 10. Workstation maintenance
 11. Application programming
 12. Operational sequences including start-up, shutdown, adjusting and balancing.
 13. Equipment maintenance.

1.11 OPERATING AND MAINTENANCE MANUALS

- .1 The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the leadtime and expected frequency of use of each part clearly identified.
- .2 Following project completion and testing, the BAS contractor will submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on diskette.

1.12 WARRANTY

- .1 The BAS contractor shall warrant the system for 12 months after system acceptance and beneficial use by the owner. During the warranty period, the BAS contractor shall be

responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the specification.

- .2 Updates to the manufacturer's software shall be provided at no charge during the warranty period.

Part 2 PART 2 – PRODUCTS

2.1 SYSTEM ARCHITECTURE

- .1 General
The Building Automation System (BAS) shall consist of Network Control Units (NCUs), a family of Standalone Digital Control Units (SDCUs), Input/Output Unit Modules (IOU Modules), Operator Workstations (OWs), and one File Server to support system configurations where more than one operator workstation is required. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant database.
- .2 Level 1 Network Description
 - .1 Existing
- .3 Level 2 Network Description: Level 2 of the system shall consist of one or more field buses managed by the Network Control Units. The Level 2 field buses may consist of one or both of the following types:
 - .1 An RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC equipment and lighting, or
 - .2 An RS485 field bus that supports up to 32 devices from a family of plug-in, IOU modules.
 - .3 These IOU modules may be mounted within the NCU enclosure or remotely mounted via a single, twisted, shielded pair of wires.
- .4 System Expansion: The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
- .5 The BAS shall be expandable to include Security and Access Control functions at any time in the future with no additional workstations, front-end software or Level 1 controllers required. Standalone Digital Control Units or IOU modules shall be able to be added to the existing Level 1 controller's field bus(es), to perform security and card access applications. In this way, an owner's existing investment in wiring infrastructure may be leveraged and the cost and inconvenience of adding new field bus wiring will be minimized.
- .6 Additionally, an integrated video badging option must be able to be included with no additional workstations required. This photo ID option must share the same database as the BAS in order to eliminate the need for updating multiple databases.

- .7 The system shall use the same application programming language for all levels: Operator Workstation, Network Control Unit, Remote Site Control Unit and Standalone Digital Control Unit. Furthermore, this single programming language shall be used for all applications: environmental control, card access control, intrusion detection and security, lighting control, leak detection / underground storage tank monitoring, and digital data communication interfaces to third party microprocessor-based devices.

2.2 NETWORK CONTROL UNITS (NCUs)

- .1 Existing.

2.3 STANDALONE DIGITAL CONTROLS UNITS (SDCUs)

- .1 General: Standalone Digital Control Units shall provide control of Boiler controls and operation and cooling tower controls and operation. Each controller shall have its own control programs and will continue to operate in the event of a failure or communication loss to its associated NCU.
- .2 Memory: Control programs shall be stored in battery backed-up RAM and EPROM. Each controller shall have a minimum of 32K bytes of user RAM memory and 128K bytes of EPROM.
- .3 Communication Ports: SDCUs shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the NCU online. It shall be possible from a service port on any SDCU to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any NCU or any SDCU on a different field bus.
- .4 Input/Output: Each SDCU shall support the addition of the following types of inputs and outputs:
- .1 Digital Inputs for status/alarm contacts
 - .2 Counter Inputs for summing pulses from meters.
 - .3 Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
 - .4 Analog inputs for pressure, humidity, flow and position measurements.
 - .5 Digital Outputs for on/off equipment control.
 - .6 Analog Outputs for valve and damper position control, and capacity control of primary equipment.
- .5 Expandability: Input and output capacity shall be expandable through the use of plug-in modules. A minimum of two modules shall be added to the base SDCU before additional power is required.
- .6 Networking: Each SDCU will be able to exchange information on a peer to peer basis with other Standalone Digital Control Units during each field bus scan. Each SDCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled either locally through a portable service tool or through a workstation connected to an NCU.
- .7 Indicator Lamps: SDCUs will have as a minimum, LED indication of CPU status, and field bus status.

- .8 Real Time Clock (RTC): An SDCU shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NCU which synchronizes all SDCU real time clocks.
- .9 Automatic Restart After Power Failure: Upon restoration of power, the SDCU shall automatically and without human intervention, update all monitored functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
- .10 Battery Back Up: Each SDCU shall have at least 3 years of battery back up to maintain all volatile memory.
- .11 Alarm Management: For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the SDCU and can result in the display of one or more alarm messages or reports. Up to 8 alarms can be configured for each point in the controller enabling the escalation of the alarm priority (urgency) based upon which alarm(s) is/are triggered.
- .12 Alarm messages can be sent to a local terminal or modem connected to an NCU or to the Operator's Workstation(s). Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided. If communication with the NCU is temporarily interrupted, the alarm will be buffered in the SDCU. When communications return, the alarm will be transmitted to the NCU if the point is still in the alarm condition.

2.4 OPERATOR WORKSTATION REQUIREMENTS

- .1 Existing

2.5 DDC SENSORS AND POINT HARDWARE

- .1 Temperature Sensors
 - .1 All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of -30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.
 - .2 Standard space sensors shall be available in an off white enclosure for mounting on a standard electrical box.
 - .3 Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
 - .4 Where a local display is specified, the sensor shall incorporate either an LED or LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.
 - .5 Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors are useable in air handling applications where the coil or duct area is less than 14 square feet.
 - .6 Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.
 - .7 Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Thermal

wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.

.8 A pneumatic signal shall not be allowed for sensing temperature.

.2 Current and KW Sensors

2.6 DAMPERS

.1 Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers are to be installed by the Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.

.2 Damper frames are to be constructed of 13 gauge galvanized sheet steel mechanically joined with linkage concealed in the side channel to eliminate noise as friction. Compressible spring stainless steel side seals, and acetal or bronze bearings shall also be provided.

.3 Damper blade width shall not exceed eight inches. Seals and 3/8 inch square steel zinc plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.

.4 For high performance applications, control dampers will meet or exceed the UL Class I leakage rating.

.5 Provide opposed blade dampers for modulating applications and parallel blade for two position control.

2.7 DAMPER ACTUATORS

.1 Electronic Actuators – the actuator shall be direct coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

Part 3 EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

.1 General: Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installation shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

- .2 Access to Site: Unless notified otherwise, entrance to building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.
- .3 Code Compliance: All wiring shall be installed in accordance with all applicable electrical codes and will comply with equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 25 and Division 26, wiring requirements of Division 25 will prevail for work specified in Division 26.
- .4 Cleanup: At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 WIRING, CONDUIT, AND CABLE

- .1 All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr.	Per Mfr.

- .2 Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.
- .3 Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code
- .4 Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit sealoff fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.
- .5 Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration producing equipment. Liquid-tight flexible conduit shall be use in exterior locations and interior locations subject to moisture.
- .6 Junction boxes shall be provided at all cable splices, equipment termination, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers..
- .7 Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.
- .8 Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
- .9 Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140. Only glass fiber is acceptable, no plastic.

- .10 Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

3.3 **HARDWARE INSTALLATION**

.1 Installation Practices for Wiring

1. All controllers are to be mounted vertically and per the manufacturer's installation documentation.
2. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
3. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.
4. Conduit in finished areas, will be concealed in ceiling cavity spaces, plenums, furred spaces and wall construction. Exception; metallic surface raceway may be used in finished areas on masonry walls. All surface raceway in finished areas must be color matched to the existing finish within the limitations of standard manufactured colors.
5. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.
6. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.
7. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

..2 Installation Practices for Field Devices

1. Well-mounted sensors will include thermal conducting compound within the well to insure good heat transfer to the sensor.
2. Actuators will be firmly mounted to give positive movement and linkage will be adjusted to give smooth continuous movement throughout 100 percent of the stroke.
3. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

.3 Enclosures

1. For all I/O requiring field interface devices, these devices where practical will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure which protects the device(s) from dust, moisture, conceals integral wiring and moving parts.
2. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

4. All wiring to and from the FIP will be to screw type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.
 5. All outside mounted enclosures shall meet the NEMA-4 rating.
 6. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.
- .4 Identification
1. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.
 2. All field enclosures, other than controllers, shall be identified with a bakelite nameplate. The lettering shall be in white against a black or blue background.
 3. Junction box covers will be marked to indicate that they are a part of the BAS system.
 4. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.
 5. All I/O field devices inside FIP's shall be labeled.
- .5 Location
1. The location of sensors is per mechanical and architectural drawings.
 2. Space temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
 3. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.4 SOFTWARE INSTALLATION

- .1 General.
- .1 Existing Software will be reused and modified to suit changes made.
- .2 Database Configuration.
- .1 The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.
- .3 Color Graphic Slides.
- .1 The Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.
- .4 Reports.
- .1 The Contractor will configure a minimum of 6 reports for the owner as listed below:
 1. Boiler Status Report

2. Cooling Tower Report
- .5 Documentation
 - .1 As built software documentation will include the following:
 1. Descriptive point lists
 2. Application program listing
 3. Application programs with comments.
 4. Printouts of all reports.
 5. Alarm list.
 6. Printouts of all graphics
 - 7.

3.5 COMMISSIONING AND SYSTEM STARTUP

- .1 Point to Point Checkout.
 - .1 Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
- .2 Controller and Workstation Checkout
 - .1 A field checkout of all controllers and front end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
- .3 System Acceptance Testing
 1. All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
 2. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
 3. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
 4. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

3.6 SEQUENCE OF OPERATION

- .1 Cooling Towers # 1 and # 2 (CT-1 and CT-2)
 - .1 General:
 - .1 The BAS contractor to re-establish and reprogram the existing sequence of operations as required. The BAS Contractor shall coordinate with the Contractor once the cooling towers are replaced and assist in the run-up and commissioning of the cooling towers..
 - .2 The following shall be displayed at the OWS:
 - .1 Chill Water Supply and Return temperatures
 - .2 Outdoor air temperature
 - .4 Fan status
 - .9 Run-time total
 - .10 Alarms
 - .11 Trend logs
 - .2 Steam Boilers # 1 and #2 (B-1 and B-2)
 - .1 The BAS contractor shall interconnect the boiler control package to the existing BAS system.
 - .2 The BAS Contractor shall interconnect the dedicated modulating outdoor air dampers for combustion air with boiler control package. An end switch shall be provided on the dampers to assure that they are open thus permitting the firing of the boilers.
 - .3 The BAS Contractor shall work closely with Boiler Manufacturer's representative and the operating personnel of the facility in re-establishing and reprogramming the existing operation conditions and sequencing.
 - .4 The Boilers sequence of operation should be set-up for lead-lag.
 - .5 The BAS shall display:
 - .1 Boiler Status
 - .2 Operating Pressure
 - .3 Supply Temperature
 - .3 Existing Hot Water Hydronic Boilers (3 Natural Draft Boilers)
 - .1 The BAS contractor shall interconnect the existing individual boiler control package of the existing Hot Water Boilers to the existing BAS system.
 - .2 The BAS Contractor shall interconnect the dedicated modulating outdoor air dampers for combustion air with boiler control package. An end switch shall be provided on the dampers to assure that they are open thus permitting the firing of the boilers.
 - .4 Mechanical Room Unit Heaters

- .1 General:
 - .1 The Mechanical Room unit heaters are controlled by the wall mounted thermostat.
 - .2 Outdoor air dampers will open and modulate as required.
- .2 Normal Operation:
 - .1 The BAS will monitor and maintain the space temperature in the mechanical room (set point 70°F) and generate an alarm if temperature drops below 45°F.
- .5 Mechanical Room Ventilation System
 - .1 The BAS Contractor shall energize the de-stratification fans on a rise in temperature over 60°F.
 - .2 The BAS Contractor shall interconnect exhaust fan EF-1 to energize on a rise above 60°F (adjustable) and shall cause the motorized dampers to open for supply and relief dampers. Fails safe closed.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-06, Canadian Electrical Code, Part 1 (20th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 .
 - .3 CAN/CSA-C22.3 No. 1-01(Update March 2005), Overhead Systems.
 - .4 CAN3-C235-83(R2000), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.2 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.3 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English and French.
- .4 Use one nameplate or label for each language.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS.
- .3 Submit for review single line electrical diagrams under plexiglass or in glazed frames and locate as indicated or as directed.

- .1 Electrical distribution system in main electrical room.
- .2 Electrical power generation and distribution systems in power plant rooms.
- .4 Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass or in glazed frames at fire alarm control panel and annunciator.
- .5 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province or Territory of Canada.
 - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .5 Submit 2 number of copies of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction or inspection authorities.
 - .6 If changes are required, notify Engineer of these changes before they are made.
- .6 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction or inspection authorities for special approval before delivery to site.
 - .2 Submit test results of installed electrical systems and instrumentation.
 - .3 Permits and fees: in accordance with General Conditions of contract.
 - .4 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Engineer.
- .7 Manufacturer's Field Reports: submit to Engineer manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.5 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial or Territorial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings:

.4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Engineer with schedule within 2 weeks after award of Contract.

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

1.7 SYSTEM STARTUP

.1 Instruct Engineer and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

1.8 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.3 Safety precautions.

.4 Procedures to be followed in event of equipment failure.

.5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

.3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.

.4 Post instructions where directed.

- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment necessary to complete the work
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from authority having jurisdiction or inspection authorities before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction or inspection authorities Engineer.
- .2 Porcelain enamel decal signs, minimum size 175 x 250 mm.

2.4 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.5 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: plastic laminate lamicoïd 3 mm thick plastic engraving sheet or melamine, black matt finish face, white core, lettering accurately aligned and engraved into core mechanically attached with self-tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Engineer prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. " as directed by Engineer.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

2.6 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.7 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue

up to 15 kV	Prime Yellow	Auxiliary Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.8 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment "equipment green".
 - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

Part 3 Execution

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipe, plastic, sheet metal, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation. Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 300 mm.
 - .5 Wall mounted telephone and interphone outlets: 1500 mm.
 - .6 Fire alarm stations: 1500 mm.
 - .7 Fire alarm bells: 2100 mm.
 - .8 Television outlets: 300 mm.
 - .9 Wall mounted speakers: 2100 mm.
 - .10 Clocks: 2100 mm.
 - .11 Door bell pushbuttons: 1500 mm.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

- .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power generation and distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: Cooling Tower control and communications systems.
 - .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Engineer.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.8 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3-06, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131-M89(R2004), Type TECK 90 Cable.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 - Construction/Demolition Waste Management And Disposal, and with the Waste Reduction Workplan.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

2.2 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper.
- .3 Insulation:
 - .1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.

- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: galvanized steel.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 50 mm centers.
 - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
 - .1 Watertight, approved for TECK cable.

2.3 MINERAL-INSULATED CABLES

- .1 Conductors: solid bare soft-annealed copper, size as indicated.
- .2 Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
- .3 Overall covering: annealed seamless stainless steel sheath, Type M1 rated 600 V, 250EC.
- .4 Outer jacket: PVC applied over sheath.
- .5 Two hour fire rating.

2.4 ARMOURED CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Type: ACWU90 - flame retardant jacket over thermoplastic armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

2.5 CONTROL CABLES

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with PVC insulation type.
- .3 600 V type: stranded annealed copper

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 16.
 - .2 In cabletroughs in accordance with Section 16.
 - .3 In underground ducts in accordance with Section 16.
 - .4 In trenches in accordance with Section 16.
 - .5 In underfloor distribution system in accordance with Section 16.
 - .6 In cellular floor raceways in accordance with Section 16.
 - .7 In surface and lighting fixture raceways in accordance with Section 16.
 - .8 In wireways and auxiliary gutters in accordance with Section 16.
 - .9 Overhead service conductors in accordance with Section 16.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Install cables.
 - .1 Group cables wherever possible on channels.
- .2 Terminate cables in accordance with Section 26 05 20- Wire and Box Connectors - 0 - 1000 V.

3.3 INSTALLATION OF MINERAL-INSULATED CABLES

- .1 Install cable in trenches in accordance with Section 16.
- .2 Run cable concealed, securely supported by straps.
- .3 Support 2 h fire rated cables at 1m intervals.
- .4 Make cable terminations by using factory-made kits.
- .5 At cable terminations use thermoplastic sleeving over bare conductors.
- .6 Install cable in cabletroughs in accordance with Section 16.
- .7 Where cables are buried in cast concrete or masonry, sleeve for entry of cables.
- .8 Do not splice cables.

3.4 INSTALLATION OF ARMoured CABLES

- .1 Group cables wherever possible.
- .2 Install cable in trenches in accordance with Section 16.
- .3 Lay cable in cabletroughs in accordance with Section 16.

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- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.5 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

3.6 INSTALLATION OF NON-METALLIC SHEATHED CABLE

- .1 Install cables.
- .2 Install straps and box connectors to cables as required.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials for moulded-case circuit breakers.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 26 23 00 - Low Voltage Switchgear.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 100 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .2 Collect and separate for disposal paper, plastic, polystyrene and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Separate for reuse and recycling and place in designated containers Steel, Metal and Plastic waste in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers: to CSA C22.2 No. 5

- .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Plug-in moulded case circuit breakers: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .4 Common-trip breakers: with single handle for multi-pole applications.
- .5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .6 Circuit breakers with interchangeable trips as indicated.
- .7 Circuit breakers to have minimum 65 kA symmetrical rms interrupting capacity rating.

2.2 THERMAL MAGNETIC BREAKERS [DESIGN A]

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 MAGNETIC BREAKERS [DESIGN B]

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS [DESIGN C]

- .1 Thermal magnetic breakers with current limiters.
 - .1 Time current limiting characteristics of fuses limiters coordinated with time current tripping characteristics of circuit breaker.
 - .2 Co-ordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker.
- .2 Series rated breakers to be manufacturer tested and listed. Breakers to be applied following manufacturer's guidelines and accepted best practice.
 - .1 Breakers applied following manufacturer's guidelines and accepted best practice.

2.5 OPTIONAL FEATURES

- .1 Include:
 - .1 On-off locking device.
 - .2 Handle mechanism.

2.6 ENCLOSURE

- .1 As indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 74 21 - Construction/Demolition Waste Management And Disposal.

1.2 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 POLYETHYLENE INSULATED CABLES

- .1 Conductors 22 AWG soft copper made into cables as follows:
 - .1 Number of pairs: as indicated on drawings.
 - .2 Polyethylene, electric grade insulation.
 - .3 Non-hygroscopic coloured binders.
 - .4 Sheath:
 - .1 Flat aluminum tape formed longitudinally and lapped with outer jacket of extruded polyethylene.
 - .2 Inner polyethylene jacket, flat aluminum tape and outer polyethylene jacket.
 - .3 Inner polyethylene jacket, corrugated aluminum tape not overlapped, and soldered, with covering of thermoplastic compound and jacket of polyethylene.
 - .4 Inner polyethylene jacket, layer of spirally wound paper tape and extruded lead sheath.
 - .5 Protective covering:
 - .1 Aerial tape armour of galvanized steel tape.

- .2 Buried tape armour of steel tape, asphaltic compound, and two layers of coal tar anthracene oil impregnated jute.
- .3 Light wire armour of galvanized steel armour wire over cutched jute, covered by two successive layers of asphaltic compound and coal tar anthracene oil impregnated jute.
- .4 Single wire armour of two successive layers of asphaltic compound and coal tar anthracene oil impregnated jute, heavy galvanized steel armour wire and outer covering of asphaltic compounds and two layers of coal tar anthracene oil impregnated jute, with overall layer of asphaltic compound.
- .5 Double wire armour of two layers of asphaltic compound and coal tar anthracene oil impregnated jute, two layers of heavy galvanized steel armour wire separated by layer of asphaltic compound and overall covering of two successive layers of asphaltic compound and coal tar anthracene oil impregnated jute.

2.2 TELEPHONE WIRE

- .1 Drop wire: two parallel 0.98 mm, solid, 30% conductivity high strength copper covered steel, lead coated brass plated conductors with styrene butadiene rubber insulation and neoprene jacket, designed for aerial drops from poles to buildings.
- .2 Heavy duty drop wire: two three No. 16 AWG solid hard drawn copper, lead coated, brass plated conductors with styrene butadiene rubber insulation, neoprene jacket twisted in to pair, designed to connect open wire line to cable terminals.
- .3 Multiple drop wire: twelve No.22 AWG solid annealed copper conductors with polyethylene insulation made into six twisted pairs cabled together laid parallel to messenger of 6.16 mm² grade 130 electro galvanized steel wire and jacketed in form of figure 8 with low temperature polyvinyl chloride, for aerial drop from poles to multiple dwellings.
- .4 Service wire: four No. 22 AWG solid annealed copper conductors with polyethylene insulation, spiral four lay-up, inner jacket polyvinyl chloride, close serving of flat galvanized steel wire armour, outer jacket of polyvinyl chloride designed for buried service connections.
- .5 Ground wire: one No. 6 AWG solid annealed copper conductor with polyvinyl chloride insulation designed for ground connections to protect cable terminals and protectors.

Part 3 Execution

3.1 INSTALLATION

- .1 Install to industry standards.

END OF SECTION

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