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FISHERIES AND OCEANS CANADA

REAL PROPERTY, SAFETY AND SECURITY

PACIFIC REGION

INSTITUTE OF OCEAN SCIENCE, SIDNEY, BC

HEATING SYSTEM UPGRADES

Requisition No. F1700-150801/A

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END OF SECTION

Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract comprises shall further be identified as "the Work", and shall include the following:
 - .1 Remove the existing boilers comprising the two existing boilers and provide 4 new condensing boilers and all appurtenances as indicated in the contract drawings and specifications.
 - .2 Remove the existing hot water system's expansion tank and provide new expansion tank(s) as indicated in the contract drawings and specifications.
 - .3 Provide new variable frequency drives (VFD) for the 2 existing hot water pumps.
 - .4 Upgrade 45 secondary zone control valves as detailed in the contract drawings.

1.2 WORK SEQUENCE

- .1 Construct Work in phases as indicated in the drawings and as specified in this section.
- .2 Phase 1: **To be completed prior to March 28, 2016.**
 - .1 Remove one of the two existing boiler as specified in the contract drawings.
 - .2 Purchase and "install" the 4 new condensing boilers in place of the removed boiler per the interim central boiler plant drawings (drawing MI508); note that "installation" in this phase will not include connection to existing hydronic hot water system.
 - .3 Complete the purchase of all equipment as indicated in the contract documents.
 - .4 Install the VFD and new power supplies for each pump motor in sequence, and as required by the contract documents.
 - .5 Begin work on the upgrades of the 45 secondary zone upgrades as indicated in the contract documents.
- .3 Phase 2:
 - .1 Continue and complete all remaining work associated with the upgrades of the 45 secondary zone upgrades as indicated in the contract documents.
 - .2 Continue all remaining work associated with the installation of the 4 new condensing boilers in place of the removed boiler per the interim central boiler plant drawings (drawing M-508).
- .4 Phase 3:

- .1 Make all preparation necessary to minimize system down-time during system transition from existing boiler to the new condensing boiler system.
- .2 Perform and complete system transition.
- .3 Complete system commissioning and the testing and balancing (TAB) of the hydronic hot water system as required by the contract documents.
- .4 Substantial completion and project closeout.
- .5 Maintain fire access/control.

1.3 CONTRACTOR USE OF PREMISES

- .1 Unrestricted use of site within the Limit of Construction as indicated to perform the Work.
- .2 Co-ordinate use of premises under direction of DFO Representative.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.

1.4 EXISTING SERVICES

- .1 Prior to commencing work, consult appropriate authorities and identify all existing underground services and utilities and obtain a Master Dig Permit in accordance to Base requirements.
- .2 Notify DFO Representative and utility companies of intended interruption of services and obtain required permission.
- .3 Where Work involves breaking into or connecting to existing services, give DFO Representative a minimum of 5 working days notice for necessary interruption of mechanical or electrical services throughout course of work. Minimize duration of interruptions. Carry out work at times as directed by governing authorities with minimum disturbance to vehicular traffic and Base operations.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify DFO Representative of findings.
- .5 Submit schedule to and obtain approval from DFO 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 adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .7 Where unknown services are encountered, immediately advise DFO Representative and confirm findings in writing.

- .8 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .9 Record locations of maintained, re-routed and abandoned service lines.
- .10 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.5 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.
 - .11 Other documents as specified.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submit to DFO Representative copies of the following documents, including updates issued:
 - .1 Health and Safety Program as indicated in paragraph 1.8, prior to commencement of work on the work site.
 - .2 Reports or directions issued by authorities having jurisdiction, immediately upon issuance from that authority.
 - .3 Accident or Incident Reports, within 24 hrs of occurrence.
- .2 Submit other data, information and documentation upon request by the DFO Representative as stipulated elsewhere in this section.

1.2 COMPLIANCE REQUIREMENTS

- .1 Comply with the latest edition of the British Columbia Occupational Health and Safety Act, and the Regulations made pursuant to the Act.
- .2 Observe and enforce construction safety measures required by:
 - .1 National Building Code of Canada 2010.
 - .2 Provincial Worker's Compensation Board.
 - .3 Municipal statutes and ordinances.
- .3 In event of conflict between any provisions of above authorities the most stringent provision shall apply.
- .4 Provide and maintain Worker's Compensation Board coverage for all employees for the duration of the contract. Prior to commencement of the work, at the time of Interim Completion and prior to final payment, provide to the DFO Representative a letter or a certificate of Clearance from the Workers' Compensation Board indicating that the Contractor's account is in good standing.
 - .1 Should the Contractor be a sole proprietor, provide documented proof in a form acceptable to the DFO Representative, of an alternative means of personal coverage that meets or exceeds the requirements set out above for Worker's Compensation Board coverage.

1.3 RESPONSIBILITY

- .1 The Contractor is responsible for safety of persons and property on the work site and for protection of federal employees and the general public

circulating adjacent to work site operations to extent that they may be affected by conduct of work.

- .2 The Contractor is to enforce compliance by workers and other persons granted access to work site with safety requirements of Contract Documents, applicable federal, provincial, and local statues, regulations, and ordinances, and with the Contractor's Health and Safety Program.
- .3 Should an unforeseen or peculiar safety related hazard or condition become evident during performance of work, immediately take measures to rectify the situation and prevent damage or harm. Advise the DFO Representative verbally and in writing of the hazard or condition.

1.4 SITE CONTROL AND ACCESS

- .1 Control all work site access points and work site activities. Delineate and isolate the work site as indicated from adjacent and surrounding areas by use of appropriate means to maintain control of all work site access points.
- .2 Make provisions for granting permission to access onto work site to all persons who require access. Procedures for granting permission to access are to be in accordance with the British Columbia Occupational Health and Safety Act, and the Regulations made pursuant to the Act and the Contractor's Health and Safety Program.
- .3 Ensure persons granted access to the work site are in possession of and wear the minimum personal protective equipment (PPE) designated by the Contractor's Health and Safety Program. Ensure persons granted access to the work site are provided with, trained in the use of, and wear, appropriate PPE that are required above and beyond the designated minimums previously noted and as specifically related to the work site activity that they are involved in. Be responsible for the efficacy of the PPE that is provided above and beyond the designated minimums.
- .5 Erect signage at access points and at other strategic locations around the work site clearly identifying the work site area(s) as being "off-limits" to non-authorized persons. Signage must be professionally made with well understood graphic symbols and is not to be used as advertising but for the specific use as related to site safety and key contact information.
 - .1 Information to be provided on the signage is as follows:
 - Project Name/Description:
 - Contractor Company Name:
 - Project Superintendent's Name/Phone No.:
 - DFO Point of Contact Name/Phone No.:

- .6 Secure the work site at all times to protect against un-authorized access.

1.5 FILING OF NOTICE

- .1 File Notice of Project and any other required Notices with the Provincial Authorities prior to commencement of the work. Provide the DFO Representative with a copy of the filed Notice(s) prior to commencement of the work.

1.6 PERMITS

- .1 Obtain permits, licenses and compliance certificates at appropriate times and frequencies as required by the authorities having jurisdiction.
- .2 Post all permits, licenses and compliance certificates on work site and provide copies to the DFO Representative.

1.7 MEETINGS

- .1 Prior to commencement of work attend a pre-commencement meeting conducted by DFO Representative. Ensure minimum attendance by contractor's site superintendent and designated site health and safety representative. DFO Representative will advise of time, date and location of the meeting and will be responsible for recording and distributing the minutes.
- .2 Conduct site specific occupational health and safety meetings as required by the British Columbia Occupational Health and Safety Act, and the Regulations made pursuant to the Act.
- .3 Record and post minutes of all meetings in plain view on the work site. Make copies available to DFO Representative upon request.

1.8 HEALTH AND SAFETY PROGRAM

- .1 Contractors are required under British Columbia Occupational Health and Safety Act, and the Regulations made pursuant to the Act to have in place a Health and Safety Program. Compliance requirements for the content, detail and implementation of the program resides with the provincial/territorial authority. For the purpose of this contract the Health and Safety Program shall include a site-specific Health and Safety Plan that acknowledges, assesses and addresses on-going hazard assessments performed during the progress of work identifying and documenting new or potential health risks and safety hazards not previously known and identified.
- .2 Provide one copy of the Health and Safety Program to the DFO Representative prior to commencement of work on the work site. The

copy provided to the DFO Representative is for the purpose of review against the contract requirements related to the known hazardous substances and/or hazardous conditions. The review is not to be construed to imply approval by the DFO Representative that the program is complete, accurate and legislatively compliant with the British Columbia Occupational Health and Safety Act, and the Regulations made pursuant to the Act, and shall not relieve the Contractor of their legal obligations under such legislation.

1.9 ACCIDENT REPORTING

- .1 Investigate and report incidents and accidents as required by British Columbia Occupational Safety and Health Act, and the Regulations made pursuant to the Act.
- .2 For the purpose of this contract immediately investigate and provide a report to the DFO Representative on incidents and accidents that involve:
 - .1 A resulting injury that may or may not require medical aid but involves lost time at work by the injured person(s).
 - .2 Exposure to toxic chemicals or substances.
 - .3 Property damage.
 - .4 Interruption to adjacent and/or integral infrastructure operations with potential loss implications.
- .3 In the investigation and reporting of incidents and accidents, the Contractor is required to respond in a timely fashion to correct the action that was deemed to have caused the incident and/or accident and advise in writing on the action taken to prevent a re-occurrence of the incident and/or accident.

1.10 RECORDS ON SITE

- .1 Maintain on site a copy of the safety documentation as specified in this section and any other safety related reports and documents issued to or received from the authorities having jurisdiction.
- .2 Upon request, make copies available to the DFO Representative.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 35 29.7 – Construction Site Safety Requirements
- .3 Section 01 41 00 - Regulatory Requirements

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 Ontario
 - .1 Occupational Health and Safety Act, R.S.O. 1990 Updated 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.
- .3 Submit 3 copies of Contractor's authorized representative's work site health and safety inspection reports to DFO Representative and authority having jurisdiction.
- .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 Submit WHMIS MSDS - Material Safety Data Sheets.
- .7 DFO Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 15 days after receipt of plan. Revise plan as appropriate and resubmit plan to DFO

Representative within 10 days after receipt of comments from DFO Representative.

- .8 DFO 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.
- .9 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 DFO Representative.
- .10 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 DFO Representative prior to commencement of Work.

1.7 REGULATORY REQUIREMENTS

- .1 Do Work in accordance with Section 01 41 00 - 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 DFO 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 The Workers Compensation Act, Workplace Safety Regulation, Ontario Reg.
- .2 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 DFO 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 associated with construction.
 - .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 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 DFO Representative.

1.14 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by DFO Representative.
- .2 Provide DFO Representative with written report of action taken to correct non-compliance of health and safety issues identified.

- .3 DFO Representative may stop Work if non-compliance of health and safety regulations is not corrected.

1.15 BLASTING

- .1 Blasting or other use of explosives is not permitted.

1.16 POWDER ACTUATED DEVICES

- .1 Use powder actuated devices only after receipt of written permission from DFO Representative.

1.17 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

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Work and conditions common to Division 23

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 35 30 - Health and Safety Requirements
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .4 Section 01 78 00 – Closeout Submittals
- .5 Section 01 91 31 - Commissioning (Cx) Plan
- .6 Section 01 91 33 - Commissioning Forms
- .7 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment

1.3 HEALTH AND SAFETY

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

1.4 WORK INCLUDED

- .1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein, in complete accordance with applicable codes and ordinances.
- .2 Provide materials, equipment and plant, of specified design, performance and quality; and, current models with published certified ratings for which replacement parts are readily available.
- .3 Provide project management and on-site supervision to undertake administration, meet schedules, ensure timely performance, ensure coordination, and establish orderly completion and the delivery of a fully commissioned installation, in compliance with Division 01 – General Requirements.
- .4 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

- .5 The most stringent requirements of this and other mechanical sections shall govern. Should inconsistencies exist such as the drawings disagreeing within themselves or with the specifications, the better quality and/or greater quantity of work or materials shall be estimated upon, performed and furnished unless otherwise ordered by the DFO Representative in writing during the bidding period.
- .6 All work shall be in accordance with the Project Drawings and Specifications and their intent, complete with all necessary components, including those not normally shown or specified, but required for a complete installation.
- .7 Provide seismic restraints for all required equipment, piping and ductwork.
- .8 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories

1.5 SUSTAINABLE REQUIREMENTS

- .1 Follow instructions and initiatives such as pollution preventions and recycling of materials, packaging and debris.
- .2 HVAC & R equipment shall contain zero CFC or HCFC based refrigerants, and zero use of Halons in fire suppression equipment.
- .3 Building Flush Out
 - .1 Just prior to Occupancy, the building shall be flushed out continuously (i.e. 24 hours per day, seven (7) days a week) using maximum tempered outside air (or maximum amount of outside air while achieving reasonable indoor temperature) for at least fourteen (14) calendar days. If interruptions of more than a few hours are required for testing and balancing purposes, extend flush-out period accordingly.
 - .2 Return ventilation system to normal operation following flush-out period to minimize energy consumption.

1.6 INDOOR AIR QUALITY

- .1 General:
 - .1 In the interest of providing an acceptable indoor environment for the occupants of a new building, it is required that the air systems be used to "flush out" chemical fumes that may be present from building products, furniture, carpets, equipment, etc.
- .2 Execution:
 - .1 The Contractor is required to keep the ductwork systems including plenums and equipment debris free and take all necessary measures to minimize dust contamination into systems.

- .2 After all HVAC systems have been cleaned and balanced, the Control Sub-Contractor shall adjust the controls and dampers on all systems for a period of four (4) calendar weeks to achieve the following conditions:
 - .1 Fans to run continuously complete with temporary filters in place.
 - .2 Systems to run on 100% outside air or to the highest percentage that can be tolerated by the system capacity and the freeze protection.
 - .3 Room temperature to be maintained at:
 - .1 Heating to 20°C.
 - .2 Cooling (where installed) to 25°C.
 - .3 Night setback to 15°C.
 - .4 Variations from these standards must be approved by the DFO Representative.
 - .3 At the end of the four (4) week period, the Controls Sub-Contractor shall readjust the controls to return the air systems to the design conditions established by the Contract Documents.
 - .4 The Controls Sub-Contractor shall notify the DFO Representative five (5) days in advance of the beginning and the end of the four week period.
- .3 Report:
 - .1 The Controls Sub-Contractor shall provide a letter to the DFO Representative for inclusion in the Operating and Maintenance Manuals stating the dates of the "flushing" period and the approximate percentage of outside air used.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, corrugated cardboard packaging material for recycling in accordance with Waste Management Plan.
- .4 Unused paint and sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .5 Fold up metal banding, flatten and place in designated area for recycling.

- .6 Divert unused metal materials from landfill to metal recycling facility approved by DFO Representative.

1.8 COORDINATION

- .1 Check drawings of all trades to verify space and headroom limitations for work to be installed.
- .2 Coordinate work with all trades and make changes to facilitate a satisfactory installation.
- .3 The drawings indicate the general location and route to be followed by the piping and ductwork. Where details are not shown on the drawings or only shown diagrammatically, the pipes and ductwork shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines.
- .4 All ducts and pipes in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All pipes and ducts shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.

1.9 HOISTS AND SCAFFOLDS

- .1 Provide all necessary interior movable or roller scaffolds, platforms, lifts and ladders for the installation of the mechanical work.

1.10 INSPECTION OF WORK

- .1 The DFO Representative shall inspect all work prior to it being concealed. All piping below ground must be approved prior to covering.
- .2 All work shall be approved by all authorities having jurisdiction.
- .3 All openings shall be sealed appropriately in particular in fire rated walls and floors. Sealing shall be inspected prior to covering.

1.11 PERMITS

- .1 Obtain all required permits and pay all fees therefore and comply with all Provincial, Municipal, Federal and other legal regulations and bylaws applicable to the work.
- .2 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work, furnish final unconditional certificates of approval by the inspecting authorities.

1.12 CODES, REGULATIONS AND STANDARDS

- .1 Division 21, 22, 23, 25 and 41 work shall conform to the following codes, regulations and standards, and all other codes in effect at the time of award of Contract, and any others having jurisdiction. The latest revision of each code and standard shall apply unless otherwise specified in the contract documents:
 - .1 Canadian Gas Association
 - .1 National Standard of Canada CAN/CGA-B149.1-05. - Natural Gas Installation Code.
 - .2 Canadian Standards Association
 - .1 CSA Standard C22.1- Canadian Electrical Code.
 - .2 CSA Standard B51- Boiler, Pressure Vessel and Pressure Piping Code.
 - .3 National Research Council of Canada
 - .1 NRCC 23174 National Building Code of Canada 2010.
 - .4 SMACNA Publications
 - .1 Guidelines for seismic restraints of mechanical systems.
- .2 Where these specifications specifically indicate requirements more onerous than the aforementioned codes, these specifically indicated requirements shall be incorporated into the work.

1.13 WARRANTY

- .1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the General Conditions.
- .2 Take note of any extended warranties specified.
- .3 Refer to Section 25 08 20 – EMCS: Warranty and Maintenance for Control System warranty requirements.
- .4 Furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period described in Division 01 and General conditions, which shall include one (1) complete summer and one (1) complete winter of uninterrupted operation. Warranty shall include any part of equipment, units or structures furnished hereunder that show defects in the works under normal operating conditions and/or for the purpose of which they were intended.
- .5 This Contractor shall, at their own expense, promptly investigate any mechanical or control malfunction, and repair or replace all such defective work and all other damages thereby which becomes defective during the time of the guaranty-warranty.

1.14 ENERGY CONSUMPTION

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

1.15 WORKMANSHIP

- .1 Workmanship shall be in accordance with well-established practice and standards accepted and recognized by the DFO Representative and the Trade.
- .2 The DFO Representative shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish and appearance.
- .3 Employ only tradesmen holding valid Provincial Trade Qualification Certificates. Tradesmen shall perform only work that their certificate permits. Certificates shall be available for inspection by the DFO Representative.

1.16 PERFORMANCE VERIFICATION OF INSTALLED EQUIPMENT

- .1 Installed mechanical equipment whose performance is questioned by the DFO Representative, may be subject to performance verification as specified herein.
- .2 When performance verification is requested, equipment shall be tested to determine compliance with specified performance requirements.
- .3 The DFO Representative will determine by whom testing shall be carried out. When requested, the contractor shall arrange for services of an independent testing agency.
- .4 Testing procedures shall be reviewed by the DFO Representative.
- .5 Maintain building comfort conditions when equipment is removed from service for testing purposes.
- .6 Promptly provide the DFO Representative with all test reports.
- .7 Should test results reveal that originally installed equipment meets specified performance requirements; the DFO Representative will pay all costs resulting from performance verification procedure.
- .8 Should test results reveal that equipment does not meet specified performance requirements, equipment will be rejected and the following shall apply:
 - .1 Remove rejected equipment. Replace with equipment, which meets requirements of Contract Documents including specified performance requirements.

- .2 Replacement equipment will be subject to performance verification as well; using the same testing procedures on originally installed equipment.
- .3 Contractor shall pay all costs resulting from performance verification procedure.

1.17 SHOP DRAWINGS/PRODUCT DATA

- .1 Process
 - .1 Shop drawings/product data shall be submitted for all H.V.A.C., Plumbing Equipment and materials.
 - .2 Shop drawings/product data shall be submitted, reviewed, signed and processed as described in Section 01 33 00 - Submittal Procedures.
 - .3 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the DFO Representative.
 - .4 Do not order equipment or material until the DFO Representative has reviewed and returned shop drawings.
 - .5 Shop drawings shall be reviewed by the General Contractor and Mechanical Sub-Contractor indicating that the shop drawings have been reviewed, co-ordinated with the work and that the shop drawings are submitted without qualifications. Shop drawings shall bear the 'reviewed' stamp dated and initialled by the General Contractor and Mechanical Sub-Contractor prior to submitting the shop drawings to the DFO Representative. Shop drawings, which do not bear the contractors and sub-trades 'reviewed' stamp, initials and date will be rejected and sent back as 'not reviewed'.
 - .6 Submit samples, in addition to drawings, of all items, which in the DFO Representative's judgment, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.
 - .7 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the DFO Representative shall revert to the product as instructed by the DFO Representative.
- .2 Content
 - .1 Shop drawings submitted title sheet. Identify section and paragraph number.
 - .2 Data shall be specific and technical.
 - .3 Identify each piece of equipment.
 - .4 Information shall include all scheduled data.
 - .5 Material for maintenance and operating manuals is not suitable.
 - .6 Advertising literature will be rejected.

- .7 The project shall be identified on each document.
- .8 Information shall be given in S.I. units (Imperial Units optional, in brackets).
- .9 The shop drawings/product data shall include:
 - .1 Clearly mark submittal material using arrows, underlining or circling to show differences from specified ratings, capabilities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps, seals, material, finish, or painting.
 - .2 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with mounting point loads.
 - .3 Weights of all major equipment for review by the DFO Representative.
 - .4 Mounting arrangements.
 - .5 Detailed drawings of bases, supports and anchor bolts.
 - .6 Capacity and performance characteristics indicated on performance curves for fans and pumps.
 - .7 Sound Power Data, for all noise generating equipment and where requested.
 - .8 Motor efficiencies on motors 1H.P. and larger.
 - .9 List of the manufacturers and figure numbers for all valves, traps and strainers.
 - .10 Control explanation and internal wiring diagrams for packaged equipment.
 - .11 Control system drawings including a written description of control sequences relating to the schematic diagrams.
 - .12 Submit as a shop drawing, an electrical equipment list for any equipment supplied by the mechanical contractor or his subtrades. The list is to be submitted in a timely fashion so that the electrical contractor can utilize the list as a final check prior to ordering motor control centres, starters, or disconnects. The list is to indicate the following:
 - .1 The horsepower size and number of motors.
 - .2 The minimum circuit amps (MCA) for packaged equipment such as heat recovery units, chillers, etc.
 - .3 The voltage and phase of the motors.
 - .4 Whether or not a starter or a disconnect is included as part of the package.
- .3 Format
 - .1 Black line prints 216 mm x 280 mm or 280 mm x 430 mm.

- .2 Larger drawings may be submitted on reproducible sepia with space for stamps and signatures - master set plus one working copy.
- .3 An assembly of related components, e.g. grilles, registers and diffusers or radiation with sheet metal cabinets, etc. between covers with the contents, identified by model number, listed on the front cover with item identification numbers.
- .4 A brochure for plumbing fixtures between covers with the contents named with model numbers listed on the front cover with item identification numbers.
- .4 Number of copies
 - .1 Provide number of copies indicated in Section 01 33 00 - Submittal Procedures.
- .5 Coordination
 - .1 Where mechanical equipment requires electrical connections, power or other services, the shop drawings shall also be circulated through the Electrical Contractor (or other "services" contractor(s)) prior to submission to the DCC Representative.
- .6 Keep one (1) copy of shop drawings and product data, on site, available for reference.

1.18 CONSTRUCTION DETAIL SAMPLES

- .1 Construction Detail Samples shall be submitted, reviewed, signed and processed as described in Section 01 33 00 - Submittal Procedures.
- .2 Samples of repetitive items encountered during the construction of this project are required to establish quality control.
- .3 Samples shall be provided within 30 days of contract award or 21 days prior to installation on site of specific samples.
- .4 Construction details are samples specifically required for this project and are required as follows:
 - .1 Ductwork Fittings - high pressure (including joints and sealer).
 - .2 Pipe sleeve installation - fire rated wall/floor.
 - .3 Pipe sleeve installation - non-fire rated wall.
 - .4 Pipe hangers.
 - .5 Typical seismic restraint details for equipment, and piping.
- .5 Acceptance of the standard of the sample is strictly at the discretion of the DFO Representative.
- .6 Once the quality of the sample has been accepted it shall establish the quality expected throughout the remainder of the project.

1.19 DUCT AND PIPE MOUNTED CONTROL EQUIPMENT

- .1 The following automatic control equipment will be supplied by the Controls Contractor, under Division 25, but installed by the appropriate trade sections of the Mechanical Contract:
 - .1 Automatic control valves.
 - .2 Temperature control wells.
 - .3 Pressure tappings.
 - .4 Flow switches.
 - .5 Static pressure sensors.

1.20 TEMPORARY OR TRIAL USAGE

- .1 Temporary or trial usage of the mechanical equipment supplied under this contract, by the DFO Representative, shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.21 SPARE PARTS

- .1 Provide spare parts as follows:
 - .1 One glass for each gauge glass installed.
 - .2 One set of V-belts for each piece of machinery.
 - .3 One filter cartridge for each filter installed, not including supply and exhaust air filters banks in the Paint Booths and Hangar Bays.

1.22 PROJECT CLOSE-OUT REQUIREMENTS

- .1 Refer to Section 01 78 00 – Closeout Submittals.
- .2 The project closeout requirements are specifically listed in each section of this specification. The following is a summary of those requirements. Refer to detailed specifications in each section for further, detailed requirements. All life safety systems must be operational and tested and demonstrated to the DFO Representative.
 - .1 Controls:
 - .1 Controls system completion report (check sheets).
 - .2 Controls system final electrical approval certificate.
 - .3 As built control drawings.
 - .4 Control training signed off by DFO Representative (Indicate dates of training in letter and attendance).
 - .5 List of control manuals and documents turned over.
 - .6 Printed copy of control program and database (printed to disk in word format is acceptable).

- .7 Disc of control system database.
- .2 Heating
 - .1 Boiler Inspection Branch certificates.
 - .2 Gas fired appliances/gas line/pressure piping certificate.
 - .3 Registration certificates for all pressure vessels.
 - .4 Pressure test reports for heating lines.
 - .5 Vibration isolation report.
 - .6 Seismic inspection report.
 - .7 Valve tag chart.
 - .8 As built drawings.
 - .9 Welding certificate and x-ray reports.
 - .10 Flushing and cleaning of piping report.
- .3 HVAC
 - .1 As built drawings.
 - .2 Identification Schedules.
 - .3 Demonstrations to the DFO Representative signed off by the DFO Representative.
 - .4 List of incomplete or deficient work prepared by each sub trade.
 - .5 Contractor's Letter of Guarantee
 - .6 Signed-off substantial completion inspection report.
 - .7 List of spare parts signed off by the DFO Representative.
- .4 Plumbing
 - .1 Final plumbing acceptance inspection report.
 - .2 Valve tag chart for plumbing system.
 - .3 Pressure test reports for sanitary, storm and domestic water.
 - .4 As built drawings.
 - .5 O&M information.
 - .6 Final gas inspection acceptance inspection.
- .5 Manufacturer's start up and other reports including:
 - .1 Water Balance.
 - .2 Commissioning.
 - .3 Fire stop letter of assurance.
 - .4 Hot water boilers
 - .5 Heating chemical treatment.

1.23 SUBSTANTIAL PERFORMANCE REQUIREMENTS

- .1 Before the DFO Representative is requested to make an inspection for substantial performance of the work:
 - .1 Commission all systems and prove out all components, interlocks and safety devices.

- .2 Submit a letter certifying that all work (including calibration of instruments and balancing of systems) is complete, operational, clean and all required submissions have been completed.
- .3 A complete list of incomplete or deficient items shall be provided. If, in the opinion of the DFO Representative, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.
- .2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:
 - .1 All reported deficiencies have been corrected.
 - .2 Testing and balancing completed.
 - .3 Operating and Maintenance Manuals completed.
 - .4 "As Built" Record Drawing ready for review.
 - .5 System Commissioning has been completed and has been verified by the DFO Representative.
 - .6 All demonstrations to the DFO Representative have been completed.
- .3 The work will not be considered to be substantially complete until the following requirements have been met:
 - .1 All items listed in .1 and .2 above have been completed.
 - .2 Certificate of Penetrations through separations.
 - .3 Gas Inspection - Certificate of inspection.
 - .4 Seismic DFO Representatives letter of Assurance and final inspection report.
 - .5 Certificate of Substantial Performance.
 - .6 Signed off copy of final inspection report.
 - .7 Hangar Bays' fire protection systems have been tested and demonstrated successfully to the DCC Representative and CFFM.
 - .8 Plumbing Inspection report / card.
- .4 Refer to Section 01 78 00 – Closeout Submittals.

1.24 OPERATING AND MAINTENANCE MANUALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 33 00 - Submittal Procedures and Section 01 78 00 – Closeout Submittals. Manuals to be prepared by an approved independent contractor specializing in operating and maintenance manuals.
- .2 Definition: detailed information and records of individual products provided by manufacturer or supplier as part of project requirements, and of systems, describing operation and maintenance of each item.
- .3 Operating data to include:

- .1 Environmental and other control schematics for each system.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operating instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .4 Maintenance data shall include:
- .1 Servicing, maintenance, operating and trouble-shooting instructions for each item of equipment.
 - .2 Equipment manufacturer's performance data sheets.
 - .3 Equipment performance verification test results.
- .5 Approvals:
- .1 Submit (2) drafts of Operating and Maintenance Manual to the DFO Representative for approval. Submission of individual data will not be accepted unless so directed by the DFO Representative.
 - .2 Make any changes in submission as may be required and re-submit as directed.

1.25 RECORD DRAWINGS

- .1 General: To be read in conjunction with Section 01 78 00 - Closeout Submittals.
- .2 Site records:
 - .1 Provide and maintain sets of white prints as required for each phase of the work. Mark thereon all changes as work progresses and as changes occur.
 - .2 On a weekly basis, transfer information to reproducibles using services of skilled draftsman revising reproducibles to show all work as actually installed.
 - .3 Make these drawings available for reference purposes and to inspection at all times.

Part 2 Products

2.1 ACCESS DOORS

- .1 Supply flush mounted access doors, for installation by Building Trades in furred ceilings and walls, to permit servicing of mechanical equipment and accessories, inspection of life safety or operating devices, and where specifically indicated.

- .2 Unless otherwise noted, access doors shall be minimum: 450mm x 450mm for body entry; 300mm x 300mm for hand entry; 200mm x 200mm for cleanout access. Access doors in building surfaces shall be at least as large as duct access panels accessed through them and shall be oversized when necessary. Size to suit masonry modules when located in a masonry wall.
- .3 Locate access doors so that all concealed items are readily accessible for adjustment, operation and maintenance. Locate in service and storage areas wherever possible. Do not locate in panelled, feature or special finish walls, without prior approval of the DFO Representative.
 - .1 Access doors in fire separations of 3/4 hour rating, and higher, and firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, self closing.
- .4 Minimum Requirements:
 - .1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.
 - .2 Plaster or wet wall construction: 14 gauge bonderized steel flush with wall or ceiling type with concealed flange.
 - .3 Masonry or drywall construction: 16 gauge for 400 mm x 400 mm and smaller, 14 gauge for 450 mm x 450 mm and larger bonderized steel face of wall type with exposed flange.
 - .4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 gauge stainless steel flush with wall or ceiling type with concealed flange.
 - .5 Acoustical tile ceiling and similar block materials: 14 gauge bonderized steel recessed ceiling type.
 - .6 Feature wall construction: Recessed wall type that is selected to complement and conform with the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.
 - .7 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label.
- .5 Acceptable Manufacturers: Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.

Part 3 Execution

3.1 CONCEALMENT

- .1 Conceal all piping, ductwork and conduit in partitions, walls, crawlspaces and ceiling spaces, unless otherwise noted.

- .2 Do not install piping and conduit in outside walls or roof slabs unless specifically directed, in which case, install them with the building insulation between them and the outside face of the building.

3.2 ACCESSIBILITY

- .1 Install all work so as to be readily accessible for adjustment, operation and maintenance. Furnish access doors where required in building surfaces for installation by building trades. Refer to item "Access Doors".

3.3 PROTECTION OF WORK

- .1 Protect equipment and materials, stored or in place, from the weather, moisture, dust and physical damage.
- .2 Mask machined surfaces. Secure covers over equipment openings and open ends of piping, ductwork and conduits, as installation work progresses.
- .3 Equipment having operating parts, bearings or machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.
- .4 Refinish damaged or marred factory finish.
- .5 Air systems to have air filters installed before fans are operated. Install new air filters before system acceptance.

3.4 CUTTING, PATCHING, DIGGING, CANNING AND CORING

- .1 Lay out all cutting, patching, digging, canning and coring required to accommodate the mechanical services. Coordinate with other Divisions.
- .2 Refer to structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls. Openings through structural members of the building shall not be made without the approval of the DFO Representative.
- .3 Be responsible for correct location and sizing of all openings required under Division 21, 22, 23 and 25, including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.
- .4 Verify the location of existing service runs and steel reinforcing within existing concrete floor and walls prior to core drilling and/or cutting. Repairs to existing services and structural components damaged as a result of core drilling and cutting is included in this section of the work.
- .5 Be responsible for all cutting, patching, digging, canning and coring required to accommodate the mechanical services.

- .6 All openings shall be core drilled or diamond saw cut.

3.5 FASTENING TO BUILDING STRUCTURE

.1 General:

- .1 Do not use inserts in base material with a compressive strength less than 13.79 MPa (refer to structural drawings).
- .2 All inserts supporting piping shall have a factor of safety of 5. All other inserts shall have a factor of safety of 4.

.2 Types:

.1 Cast-in-place type:

- .1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.
- .2 Wedge type galvanized steel concrete insert, rated for the duty, for up to 200 mm pipe size.
- .3 Universal type malleable iron body insert, rated for the duty, for up to 200 mm pipe size.
- .4 Screw concrete insert, rated for the duty, for up to 300 mm pipe size.

.2 Drilled, mechanical expansion type:

- .1 Heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa.
- .2 Stud anchor for concrete. (Do not use in seismic restraint applications).
- .3 Drop-in anchor for concrete.
- .4 Sleeve Anchor (medium and light duty) for concrete and masonry.
- .5 Pin bolt (light duty) for concrete and masonry.

.3 Drilled, adhesive type:

- .1 Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.
- .2 Anchor rod with a 2 part adhesive system.
- .3 For use in concrete housekeeping bases (in vertical downward position) where the distance to the edge of the concrete base could cause weakness if a mechanical expansion type anchor were used.
- .4 Rod assemblies shall extend a minimum of 50 mm into the concrete slab below the housekeeping bases.

.3 Note:

- .1 All drilling for inserts shall be performed using the appropriate tool specifically designed for the particular insert. The diameter and

depth of each drilled hole shall be to the exact dimensions as specified by the insert manufacturer.

- .2 Refer to manufacturer's recommendations for tightening torques to be applied to inserts.

3.6 SERVICE PENETRATIONS IN RATED FIRE SEPARATIONS

- .1 Fire stopping shall be done under Section 07 84 00 – Firestopping.

3.7 SERVICE PENETRATIONS IN NON-RATED SEPARATIONS

- .1 All piping, tubing, ducts, wiring, conduits, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent the passage of smoke and/or transmission of sound. Refer to "pipe sleeve" clause in this section for packing and sealing of pipe sleeves.

3.8 PIPE SLEEVES

- .1 Provide pipe sleeves for all piping passing through rated walls and floors. Sleeves to be concentric with pipe.
- .2 Pipes and ducts passing through fire rated separations that have no fire resistance (non-rated separations) do not require a sleeve, but the insulation at the separation should be wrapped with 0.61mm thick galvanized sheet steel band to which to apply the flexible caulking compound to.
- .3 Pipe sleeves for floors and interior walls shall be minimum 0.61mm thick galvanized sheet steel with lock seam joints.
- .4 Pipe sleeves for perimeter walls and foundation walls shall be cast iron sleeve or Schedule 40 steel pipe with annular fin continuously welded at midpoint and protruding 150 mm beyond sleeve diameter. Annular fin shall be embedded into centre of wall.
- .5 Pipe sleeves for wet or washdown floor areas such as washrooms, janitors rooms and mechanical equipment rooms shall be Schedule 40 steel pipe.
- .6 Except as otherwise noted pipe sleeves are not required for holes formed or cored in interior concrete walls or floors.
- .7 Pipe sleeves shall extend 50 mm above floors in unfinished areas and wet areas and 6 mm above floors in finished areas.
- .8 Pipe sleeves shall extend 25 mm on each side of walls in unfinished areas and 6 mm in finished areas.
- .9 Pipe sleeves shall extend 25mm beyond exterior face of building. Caulk with flexible caulking compound.

- .10 Sleeve Size: 12 mm clearance all around, between sleeve and pipe or between sleeve and pipe insulation.
- .11 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.
- .12 Packing of Sleeves:
 - .1 Where sleeves pass through foundation walls and perimeter walls the space between sleeve and pipe or between sleeve and pipe insulation shall be caulked with waterproof fire retardant non-hardening mastic.
 - .2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.9 ESCUTCHEONS AND PLATES

- .1 Provide on pipes and conduits passing through finished walls, partitions, floors and ceilings.
- .2 Plates shall be stamped steel, split type, chrome plated, or stainless steel, concealed hinge, complete with springs, suitable for external dimensions of piping/insulation. Secure to pipe or finished surface. For all pipes passing through suspended ceilings and uninsulated piping passing through walls. Outside diameter shall cover opening or sleeve.
- .3 Where pipe sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.
- .4 Do not install escutcheons and plates in concealed locations.

3.10 EQUIPMENT SUPPORTS

- .1 Provide stands and supports for equipment and materials supplied.
- .2 Lay out concrete bases and curbs required under Division 21, 22, 23 and 25. Coordinate with Section 03 30 00 - Cast-in-Place Concrete. All concrete work is under Section 03 30 00 - Cast-in-Place Concrete.
- .3 Concrete bases shall be a minimum of 100 mm thick, or as noted and shall project at least 150 mm outside the bedplate, unless otherwise directed. Bases and curbs shall be keyed to the floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases at 45 degrees.
- .4 Equipment with bedplates shall have metal wedges placed under the edges of the bedplates to raise those 25 above the base after levelling. The wedges shall be left permanently in place. Fill the space between the bedplate and the base with non-shrink grout - Embeco or In-Pakt.

- .5 Construct equipment supports of structural steel or steel pipe. Securely brace. Employ only welded construction. Bolt mounting plates to the structure.
- .6 Support ceiling hung equipment with rod hangers and/or structural steel.

3.11 EQUIPMENT RESTRAINTS

- .1 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

3.12 EQUIPMENT INSTALLATION

- .1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to piping and duct systems and without interfering with building structure or other equipment.
- .2 Provide means of access for servicing equipment including permanently lubricated bearings.
- .3 Pipe equipment drains to floor drains.
- .4 Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

3.13 ANCHOR BOLTS AND TEMPLATES

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

3.14 MISCELLANEOUS METAL

- .1 Be responsible for all miscellaneous steel work relative to Division 21, 22, 23 and 25 of the Specifications, including but not limited to:
 - .1 Support of equipment
 - .2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork, hot water storage tanks, expansion tanks, fans and mechanical equipment.
 - .3 Earthquake restraint devices - refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 - .4 Access platforms, ladders and catwalks.
 - .5 Pipe anchor and/or support posts.
 - .6 Ceiling ring bolts - secure to structure or steel supports.
- .2 All steel work shall be prime and undercoat painted ready for finish under Painting trade. Refer to drawings for details.

3.15 FLASHING

- .1 Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floors, and roofs.
- .2 Flash, vent and soil pipes projecting 75 mm minimum above finished roof surface with lead worked 25 mm minimum into hub, 200 mm minimum clear on side with minimum 600 x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk.
- .3 Flash floor drains over finished areas with lead 250 mm clear on sides with minimum 900 x 900 mm sheet size. Fasten flashing to drain clamp device.
- .4 Provide curbs for mechanical roof installations 400 mm minimum high above roof insulation. Flash and counterflash with galvanized steel, soldered and made waterproofed.
- .5 Provide continuous lead or neoprene safes for built-up mop sinks, and shower stalls located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

3.16 DELECTRIC COUPLINGS

- .1 On all "OPEN" systems provide wherever pipes of dissimilar metals are joined.
- .2 Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2.
- .3 Provide felt or rubber gaskets to prevent dissimilar metals contact.
- .4 Standard of Acceptance: Capital, Walter Vallet, EPCO.

3.17 PAINTING

- .1 Clean exposed bare metal surfaces supplied under Division 21, 22, 23 and 25 removing all dirt, dust, grease and millscale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.
- .2 Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer, as they are installed.
- .3 Repaint all marred factory finished equipment supplied under Division 21, 22, 23 and 25, which is not scheduled to be repainted, to match the original factory finish.
- .4 Natural gas and fire protection piping shall be painted for identification purposes over their entire lengths throughout all exposed areas and in the mechanical room(s) as follows:

- .1 Gas: Yellow
- .5 Painting of all equipment and materials, supplied under Division 21, 22 and 23, installed in mechanical equipment areas and inside finished areas of the building or exposed outside the building, is included under Painting trade specifications.
- .6 Painting by Painting trade shall be in accordance with the following Colour Schedule for Mechanical Equipment Areas:

Item	Primer (Note **)	Colour Finish
• not galvanized	1. Damp-proof Red 2. Zinc Chromate	Grey
• galvanized	Clear blue undercoat	White (2 coats)
• plenum access doors and 200 mm around doors	Clear blue undercoat	Grey
Exposed Misc. Metal (supplied under this contract)	1. Damp-proof Red 2. Zinc Chromate	To be determined on site
Guards – Belt and Coupling	1. Damp-proof Red 2. Zinc Chromate	To match equipment
Handrails	Red Primer	Aluminum
Insulation Covering (on piping, tanks, heat exchangers, breeching, etc.)	White Primer	White
Motors (electric)		To match associated equipment
Piping (uninsulated)		
• gas (natural)	Red Primer	Yellow
• services other than above	Red Primer	White
Pot Feeders (Chemical)	Red Primer	Aluminum
Tanks (steel), Air Receivers and Supports	1. Damp-proof Red 2. Zinc Chromate	White
Valve Bodies (uninsulated)		
• hot water heating, antifreeze heating	Red Primer	Aluminum (high temp.)
• services other than above	Red Primer	To match associated piping

Note ** 1. Denotes first primer coat and 2. Denotes second primer coat.

3.18 EQUIPMENT PROTECTION AND CLEAN-UP

- .1 Protect equipment and material in storage, on site and after installation until final acceptance. Leave factory covers in place. Take special

- precautions to prevent entry of foreign material into working parts of piping systems.
- .2 All mechanical equipment stored on site shall be kept in a dry, heated and ventilated storage area.
 - .3 Thoroughly clean piping, ducts and equipment of dirt, cuttings, and other foreign material.
 - .4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
 - .5 Provide, install and maintain 30% efficient temporary filters to return and exhaust air openings from ceiling spaces to prevent air born dust from entering ducts, plenums and coils. Install filters to return air grilles when fans are operated and building is not at a clean condition.

3.19 START-UP

- .1 Before starting the plant, provide a certificate stating that the plant is ready for start-up and the following conditions have been met.
 - .1 All safety controls installed and fully operational.
 - .2 Qualified personnel available to operate the plant.
 - .3 Permanent electrical connections made to all equipment.
 - .4 Boiler(s) started up and adjusted by manufacturer's representatives.
 - .5 All air filters installed.
 - .6 All mechanical equipment rooms, including plenums, vacuum cleaned.

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 21 - 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 B40.100-05, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-01, Thermometers, Direct Reading and Remote Reading.
- .2 American National Standard Institute (ANSI)
 - .1 ANSI B40.1, Gauges – Pressure Indicating Dial Type – Elastic Element.
- .3 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 for following items:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Stop cocks.
 - .4 Syphons.
 - .5 Wells.

1.5 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 GENERAL

- .1 Select thermometers and pressure gauges so that their operating range falls in the middle half of the scale range.

2.2 DIRECT READING THERMOMETERS

- .1 Minimum Requirements:
 - .1 All thermometers to be in accordance with Canadian General Standards Board CGSB 14.4 - M88.
 - .2 Pipe mounted stem type - mercury actuated, adjustable angle type.
 - .3 Refer to flow schematics for location of pipe mounted thermometers and wells.
 - .4 Industrial, variable angle type, liquid filled.
- .2 Case:
 - .1 Stem type - cast aluminum alloy, either anodized or coated with baked enamel. The case shall be provided with a clear glass or heat resistant plastic window.
- .3 Scale:
 - .1 Stem type - 225 mm scale length.
 - .2 White background with temperature range in black.
 - .3 Dual Celsius and Fahrenheit scale.
- .4 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.

2.3 THERMOMETER WELLS

- .1 For copper pipe use copper or bronze. For steel pipe use brass or stainless steel, separable socket, 3/4 NPT.
- .2 Thermowell to be registered with Provincial Boiler and Pressure Vessels Safety Branch with CRN number.

2.4 PRESSURE GAUGES

- .1 Minimum Requirements:

- .1 All gauges to be in accordance with ANSI B40.1 Grade "2A" level.
 - .2 115 mm cast aluminum, black steel or stainless steel case, with stainless steel or chrome plated face ring.
 - .3 White background with pressure range in black.
 - .4 Dual kilopascal and psig scale.
 - .5 Phosphor bronze bourdon tube, silver brazed tip and socket 1/4" NPT lower connection.
 - .6 Rotary type bushed movement, silicone dampened to prevent pointer oscillation.
 - .7 Gauges to be registered with Provincial Boiler and Pressure Vessel Safety Branches with CRN number.
 - .8 ULC listed for use on fire protection systems.
 - .9 Accuracy shall be 1% off full scale over the middle half of the scale.
- .2 Accessories:
- .1 Install a bronze needle valve ahead of each gauge.
 - .2 Install an anti-syphon loop (suitable for steam pressure) ahead of each gauge on steam systems.
- .3 Acceptable Manufacturers:
- .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.

Part 3 Execution

3.1 GENERAL

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

3.2 THERMOMETERS

- .1 Install in wells on all piping. Provide heat conductive material inside wells.
- .2 Install the separable well so as to minimize the restriction to flow and, if necessary, install in a section of oversized pipe.
- .3 Install wells where indicated for use with test thermometers.
- .4 Install in locations as indicated and on inlet and outlet of:
 - .1 Water heating coils (excluding terminal reheat coils)
 - .2 Water boilers.
 - .3 Where indicated elsewhere and shown on drawings.

- .5 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.
 - .2 Inlet and outlet of waterside of coils (excluding terminal unit coils)
 - .3 Inlet and outlet of hot water boilers.
 - .4 Where indicated elsewhere and shown on drawings.
- .2 Use extensions where pressure gauges are installed through insulation.
- .3 Where a single gauge is used to measure multiple points provide needle valves to isolate each point, including pressure gauge.

3.4 NAMEPLATES

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of bronze valves.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals

1.3 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 (R2005), Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
 - .2 ASTM B283-08, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .3 ASTM B505/B505M-08, Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Valves specified in this section.
 - .2 Indicate the proposed system where each valve type will be used.
- .3 Closeout Submittals:

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

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 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 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 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: screwed.
 - .3 Connections: soldered or 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, screwed:
 - .1 Rising stem, solid wedge disc, Class 125:
 - .2 Body: bronze with long disc guides.
 - .3 Disc: solid wedge, bronze to ASTM B283, loosely secured to stem.
 - .4 Operator: Handwheel.
 - .3 NPS 2 and under, soldered:
 - .1 Rising stem, solid wedge disc, Class 125.
 - .2 Body: bronze with long disc guides.

- .3 Operator: Handwheel.
- .4 Acceptable Manufacturers:
 - .1 Crane, Grinnell, Kitz, Newman Hattersley, Nibco, Toyo.
- .4 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: screwed.
 - .3 Connections: soldered or 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, screwed, Class 125:
 - .1 Bronze body and bonnet: screwed bonnet.
 - .2 Rising stem
 - .3 Disc and seat: renewable composition or bronze disc (composition to suit service conditions), re-grindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .4 Operator: Handwheel.
 - .3 NPS 2 and under, soldered, Class 125:
 - .1 Bronze body and bonnet: union bonnet.
 - .2 Disc and seat: renewable composition or bronze disc in easily removable disc holder, re-grindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: Handwheel.
 - .4 Acceptable Manufacturers:
 - .1 Crane, Grinnell, Kitz, Newman Hattersley, Nibco, Toyo.
- .5 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 Swing Check Valves:
 - .1 NPS 2 and under, screwed
 - .1 Bronze swing disc, Class 125:
 - .2 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .3 Seat: re-grindable.
 - .2 NPS 2 and under, soldered:

- .1 Bronze swing disc, Class 125:
 - .2 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .3 Seat: re-grindable.
 - .3 Acceptable Manufacturers:
 - .1 Crane, Grinnell, Kitz, Newman Hattersley, Nibco, Toyo.
- .6 Ball Valves:
- .1 NPS 2 and under, screwed to ANSI B1.20.1 with hexagonal shoulders:
 - .1 Class 125
 - .2 Forged brass body and cap, threaded cap, chrome plated ball, PTFE seats, blow out proof stem.
 - .3 Ball valves for isolation service shall have a large/full port.
 - .4 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.
 - .5 Stem seal: TFE with external packing nut.
 - .6 Operator: removable lever handle.
 - .7 Acceptable Manufacturers:
 - .1 Crane, Grinnell, Kitz, Newman Hattersley, Nibco, Toyo, Victaulic.
 - .2 NPS 2 and under, soldered:
 - .1 Class 125
 - .2 Forged brass body and cap, threaded cap, chrome plated ball, PTFE seats.
 - .3 Ball valves for isolation service shall have a large/full port.
 - .4 Ball valves for balancing service shall have a reduced port and valve handle shall have a memory stop.
 - .5 Stem seal: TFE with external packing nut.
 - .6 Operator: removable lever handle.
 - .7 Acceptable Manufacturers:
 - .1 Crane, Grinnell, Kitz, Newman Hattersley, Nibco, Toyo, Victaulic.
- .7 Circuit Balancing Valves:
- .1 NPS 2 and under: copper alloy body, screwed, 'Y' pattern globe.
 - .2 NPS 2-1/2 and over: cast iron body, flanged or grooved, 'Y' pattern globe.
 - .3 Maximum pressure 1715 kPa and maximum temperature 121°C.
 - .4 Calibrated balancing valve with memory, positive shut-off, inlet and outlet pressure measuring connections with integral shut-offs and drains.

- .5 Calibration charts and adjustment tools to be included.
- .6 Provide 1 differential pressure meter kit suitable for direct readout c/w connection hoses suitable for the system pressure.
- .7 Acceptable Products:
 - .1 Bell and Gossett - Circuit Setter
 - .2 ESBE - Circuit Setter
 - .3 Tour & Anderssen - STAD
 - .4 Armstrong - CBV
 - .5 Wheatley - GS
 - .6 Nexus
- .8 Drain Valves
 - .1 Globe type, bronze body with bronze trim and composition disc.
 - .2 Acceptable Manufacturers:
 - .1 Crane, Dahl, Kitz, Newman Hattersley, Nibco, Toyo.

Part 3 Execution

3.1 VALVES

- .1 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.
- .2 Remove internal parts before soldering.
- .3 Install valves with stems upright or angled 45° above horizontal unless approved otherwise.
- .4 Use gate valves or (ball valves NPS 2 and under) to shut off branch takeoffs and to isolate equipment.
- .5 Use globe valves to control flow in circuits; except, where balancing cocks are specifically specified.
- .6 Use plug type globe valves in control valve bypass connections.
- .7 Install circuit balancing valves in the return piping connections to each terminal heating and cooling unit - eg. unit heaters, heating and cooling coils, etc.
- .8 Provide isolation valves in all systems such that large branch pipes can be isolated.
- .9 Provide valves upstream of all meters, gauges, automatic air vents, etc. for isolation purposes.

- .10 Use swing check valves, in horizontal and vertical upflow pipes and on the discharge of pumps. Spring loaded water check valves shall be located 8 pipe diameters downstream of pumps or elbows.
- .11 Use silent check valves where specifically shown in vertical pipes with downward flow.

3.2 DRAIN VALVES AND HOSE BIBBS

- .1 Install drain valves at each low point in the piping system and at specific drain locations shown on the drawings.
- .2 Install NPS 1-1/2 or NPS 3/4 on line sizes less than NPS 1-1/2 drain valves at all low points in the piping systems to facilitate draining.
- .3 Install drain valves for systems operating at over 93°C.
- .4 Install a hose end adaptor on the discharge side of each drain valve or pipe to drain, where indicated.
- .5 Install caps, with chains, on hose end adaptors, in public areas.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of cast iron valves.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals

1.3 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 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-70-2006, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS SP-71-2005, 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.
- .3 American Society of Testing and Materials (ASTM)
 - .1 ASTM A49, Specification for Heat-Treated Carbon Steel.
 - .2 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
 - .3 ASTM B61, Specification for Steam or Valve Bronze Castings.
 - .4 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
 - .5 ASTM B85, Specification for Aluminium-Alloy Die Castings.
 - .6 ASTM209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

1.4 SUBMITTALS

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

- .2 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Valves specified in this section.
 - .2 Indicate the proposed system where each valve type will be used.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 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 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 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 ½ and over, outside screw and yoke (OS&Y), bronze trim, solid wedge disc:
 - .1 Cast iron body, 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.
 - .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 Acceptable Manufacturers:
 - .1 Crane, Grinnell, Kitz, Newman Hattersley, Nibco, Toyo.

2.3 GLOBE VALVES

- .1 NPS 2 1/2 and over, OSY:
 - .1 Body: with multiple-bolted bonnet.
 - .2 WP: 860 kPa steam, 1.4 MPa CWP.
 - .3 Bonnet-yoke gasket: non-asbestos.
 - .4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - .5 Seat ring: renewable, re-grindable, and screwed into body.
 - .6 Stem: bronze to ASTM B62.
 - .7 Operator: Handwheel.
 - .8 Bypass: complete with union and NPS ¾ globe valve as Section 23 05 22 - Valves – Bronze.

2.4 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.

2.5 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 Ratings:
 - .1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 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.

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 SECTION INCLUDES**

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 61 00 - Common Product Requirements
- .3 Section 01 78 00 - Closeout Submittals
- .4 Section 03 30 00 - Cast-in-Place Concrete
- .5 Section 05 12 23 - Structural Steel for Buildings
- .6 Section 05 50 00 - Metal Fabrications
- .7 Section 23 05 49 – Seismic Restraint

1.3 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2007, Power Piping.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A125-1996(R2007), Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-07b, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Specification for Carbon and Alloy Steel Nuts.
- .3 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.

- .4 Canadian Gas Association (CGA)
 - .1 CAN/CGA-B149.1-05, Natural Gas and Propane Installation.
- .5 National Research Council (NRC)/Institute for Research in Construction.
 - .1 NRCC 38728, National Plumbing Code of Canada (NPC) - 2005.

1.4 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 MSS SP58 and ASME B31.1.
 - .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
 - .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
 - .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
- .2 Performance Requirements:
 - .1 Design supports, platforms, catwalks, hangers, to withstand seismic events as specified Section 23 05 49 – Seismic Restraint.

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 Ontario, Canada.
- .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 DCC Representative 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.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 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 GENERAL

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, protect appropriate against damage from earthquake, maintain grade, provide for expansion and contraction and accommodate insulation.
- .2 Provide insulation protection saddles on all insulated piping.
- .3 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.
- .4 Set inserts in position in advance of concrete work. Use grid system in equipment rooms.
- .5 Support from (top of) structural members. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members, as necessary.
- .6 Do not suspend from metal deck.

2.2 PIPE HANGERS

- .1 Finishes:

- .1 Ensure steel hangers in contact with copper piping are copper plated or 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.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-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 to MSS SP69.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate, UL listed to MSS SP69.
- .5 Steel Joist:
 - .1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
- .6 Steel Channel or Angle (bottom):
 - .1 Cold piping NPS 2 and under; malleable iron C clamp.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping; universal channel clamp.
- .7 Steel Channel or Angle (top):
 - .1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer.
- .8 Hanger rods: threaded rod material to MSS SP58:
 - .1 Carbon steel black continuous threaded rod (electro-galvanized in mechanical rooms).
 - .2 Ensure that hanger rods are subject to tensile loading only.

- .3 Provide linkages where lateral or axial movement of pipework is anticipated.
- .4 Do not use 22 mm or 28 mm rod.
- .9 Pipe attachments: material to MSS SP58:
 - .1 Cold piping, steel or cast iron: hot piping steel, with less than 25 mm horizontal movement; hot piping, steel, with more than 300 mm rod length: adjustable clevis.
 - .2 Cold copper piping; hot copper piping with less than 25 mm horizontal movement; hot copper piping with more than 300 mm rod length: adjustable clevis copper plated.
 - .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25 mm; hot steel piping with middle attachment (rod) 300 mm or less; pipe roller.
 - .4 Bottom supported hot piping, steel and copper: pipe roller stand.
 - .5 Spring hangers; where required to offset expansion on horizontal runs which follow long vertical risers.
 - .6 Use insulation shields for hot pipework.
 - .7 Oversize pipe hangers and supports.
- .10 Adjustable clevis: material to MSS SP69, UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .11 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .12 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black.
 - .2 Finishes for copper pipework: black, with formed portion plastic coated or epoxy coated.
- .13 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: black carbon steel to MSS SP58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.4 SADDLES AND INSULATION PROTECTION SHIELDS

- .1 Cold piping NPS 2 and under: protection shield with pipe insulation under shield with uninterrupted vapour barrier – high density insulation
- .2 Cold piping NPS 2-1/2 and over: protection shield with high density insulation under shield with uninterrupted vapour barrier – high density insulation.
- .3 Hot piping NPS 3 and under: insulation over pipe hanger.
- .4 Hot piping NPS 4 and over: protective saddle with insulation under saddle.

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.
- .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 WALL SUPPORTS

- .1 Horizontal pipe adjacent to wall:
 - .1 Angle iron wall brackets with specified hangers.
- .2 Vertical pipe adjacent to wall.
 - .1 Exposed pipe wall support for lateral movement restraint.
 - .2 Channel type support - Burndy, Canadian Strut, Cantruss or Unistrut, type support.

2.8 FLOOR SUPPORTS

- .1 Horizontal pipe.
 - .1 Do not support piping from the floor unless specifically indicated.
- .2 Vertical pipe.
 - .1 Mid-point of risers between floor slabs - adjustable fabricated steel supports. Refer to Section 23 05 49 - Seismic Restraints.

2.9 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

2.10 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.11 PLATFORMS AND CATWALKS

- .1 To Section 05 50 00 - Metal Fabrications.

2.12 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.

2.13 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .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 HANGAR SPACING

- .1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
 - .1 Plumbing piping: to National Plumbing Code.

- .2 Fire protection: to applicable fire code; toggle hangers are unacceptable.
- .3 For Gas Piping refer to Gas Code CAN/CGA-B149.1. Up to NPS ½: every 1.8m.
- .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
- .5 Within 300 mm of each horizontal elbow, tee, joints, etc.

.2 Maximum hanger spacing table.

Pipe Size: NPS	Rod Diameter mm	Maximum Spacing Steel Pipe m	Maximum Spacing Copper Pipe m
½	10	1.8	1.5
¾, 1	10	2.4	1.8
1¼, 1½	10	3.0	1.8
2	10	3.0	3.0
2½, 3, 4	12	3.0	3.0
5, 6, 8	16	3.0	
10, 12	22	3.0	

.3 Maximum hanger spacing for flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

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	

3.4 HANGAR INSTALLATION

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

- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Install hanger to provide minimum 12 mm clear space between finished covering and adjacent work.
- .5 Support vertical piping at every other floor.
- .6 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .7 Where practical, support riser piping independently of connected horizontal piping.
- .8 Install plastic inserts between steel studs and piping.
- .9 For beam clamps, extend hanger rod tight to underside of beam with top bolt and washer.

3.5 INSERTS

- .1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.
- .3 Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.
- .4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square plate and nut above slab, in concealed locations.
- .5 Provide inserts for piping/equipment above chillers, pumps and sump pumps to permit equipment servicing. Provide an eyebolt.
- .6 Inserts shall be installed in accordance with manufacturers recommendations and in no case closer than 2.1 m apart.

3.6 HORIZONTAL MOVEMENT

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

3.7 FINAL ADJUSTMENT

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

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Seismic restraint systems (SRS) for all statically supported and vibration isolated mechanical and fire protection equipment and systems.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 61 00 - Common Product Requirements
- .3 Section 01 74 11 – Cleaning
- .4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Section 01 78 00 - Closeout Submittals

1.3 REFERENCES

- .1 National Building Code of Canada (NBC) - 2010

1.4 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.

1.5 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 British Columbia.

1.6 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 British Columbia, 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 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.
 - .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 DFO Representative 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 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 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 reinforced concrete structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.
- .7 Seismic control measures not to interfere with integrity of fire stopping.

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.
 - .2 Vibration isolators and separate snubbers.
 - .3 Built-up snubber system approved by DCC Representative, 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, and 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.

3.3 FIELD QUALITY CONTROL

- .1 Inspection and Certification:

- .1 SRS: inspected and certified by Seismic Engineer upon completion of installation.
- .2 Provide written report to DFO Representative with certificate of compliance.
- .2 Commissioning Documentation:
 - .1 Upon completion and acceptance of certification, hand over to DFO Representative 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 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 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 61 00 - Common Product Requirements
- .3 Section 01 74 11 - Cleaning
- .4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .5 Section 09 91 23 - Interior Painting

1.3 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-24.3-92, Identification of Piping Systems.

1.4 SUBMITTALS

- .1 Submit shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include the following:
 - .1 Legend of proposed identification details for each system.
 - .2 Details of proposed nameplates, labels and tags.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 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 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate, mechanically fastened to each piece of equipment by manufacturer.
- .2 Include ULC, (Underwriters' Laboratories Canada) or CSA, (Canadian Standards Association) registration logos and those of other agencies, as required by the respective agencies.
- .3 Nameplates shall be located so that they are easily read. Do not insulate or paint over nameplates.
- .4 Lettering and numbers raised or recessed.
- .5 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic, 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

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
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.
- .5 Identify all systems and areas or zones of building being serviced.

2.3 PIPING SYSTEMS GOVERNED BY CODES

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

2.4 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 or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

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

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

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Make-up water	Yellow	MAKE-UP WTR
Boiler feed water	Yellow	BLR. FEED WTR
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Domestic hot water recirc.	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Natural gas	to Codes	
Gas regulator vents	to Codes	

2.5 VALVES, CONTROLLERS

- .1 Lamicaid tags with 12 mm stamped identification data filled with black paint.

- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.6 CONTROLS COMPONENTS IDENTIFICATION

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

2.7 TAGGING IDENTIFICATION

- .1 Secure engraved laminated plastic identification tags (black face and white centre) on the following items:
 - .1 Temperature control instruments, gauges and panels, coordinated with control diagrams identification.
 - .2 Electrical switchgear supplied under the Mechanical Division 21, 22, 23.
 - .3 Refer also to the Controls Section 25.

2.8 LANGUAGE

- .1 Identification in English and French.
- .2 Use one nameplate and label for both languages.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TIMING

- .1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 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.

3.4 NAMEPLATES

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

3.5 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, at not more than 15 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 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, 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. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by DFO Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.7 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 Testing, Adjusting and Balancing (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 Employ an established independent TAB agency to test and balance the listed systems. Prior to finalizing contractual arrangements with the TAB agency, submit the names, qualifications and years of direct field TAB experience in the testing and balancing field for all members of the TAB team that is scheduled to carry out the TAB work. The senior site technologist must have a minimum of five years TAB experience of similar projects. Provide a list of a minimum of ten comparable industrial projects successfully completed by all key members of the TAB team.
- .2 Submit names of personnel to perform TAB to the DFO Representative within 90 days of award of contract.
- .3 Provide documentation confirming qualifications, successful experience.
- .4 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.
- .5 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .6 Use TAB Standard provisions, including checklists, and report forms; submit final report at the completion of the project. Include report in the maintenance manual.

- .7 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .8 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .9 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 (simulate filter loading, outdoor air provision, etc).

1.4 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction (such as sprinkler system, fire alarm system, etc.)

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 the DFO Representative the adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to the DFO Representative 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 DFO Representative for verification of TAB reports.

1.9 START OF TAB

- .1 Notify DFO Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, floor finishes and other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23.
 - .4 Provisions for TAB installed and operational.
- .3 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 HVAC systems: plus 5%, minus 5%.
 - .2 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 DFO Representative 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 DFO Representative.

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

- .1 Format in accordance with SMACNA Guidelines.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.

- .3 Submit 6 copies of TAB Report to DFO Representative for verification and approval, in English in D-ring binders, complete with index and index tabs.
- .4 Include final TAB report in maintenance manual.

1.16 VERIFICATION

- .1 Reported results subject to verification by DFO Representative.
- .2 Provide personnel and instrumentation to verify up to 20% of reported results.
- .3 Number and location of verified results as directed by DFO Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of DFO Representative.

1.17 SETTINGS

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

1.18 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by DFO Representative.
- .2 Include final TAB report in the maintenance manual.

1.19 TAB GENERAL

- .1 Standard: TAB to most stringent of this section or TAB standards of SMACNA or ASHRAE.
- .2 Do TAB of following systems, equipment, components, controls:
 - .1 Heating hot water system(s).
- .3 Qualifications: personnel performing TAB shall be qualified to standards of AABC or NEBB.
- .4 The TAB agency shall be responsible to the Contractor but report jointly to the DFO Representative and the Contractor. Report in writing to the DFO Representative any lack of cooperation and any discrepancies or items not installed in accordance with the contract documents.

- .5 Procedures shall be in general accordance with AABC'S National Standards for Field Measurement and Instrumentation and ASHRAE Standards.
- .6 The TAB agency shall agree to perform spot checks, where requested, in the presence of the DFO Representative.
- .7 Work with the TAB agency to:
 - .1 Ensure that all mechanical systems are complete and ready to be balanced and provide sufficient time for testing and balancing prior to substantial performance.
 - .2 Make corrections to achieve system balance without delay, include all corrections made during the balancing procedure on "As Built" Drawings. Mechanical Contractor to provide "As Built" information to the balancing agency before balancing commences.
 - .3 Maintain all systems in full operation during the complete testing and balancing period.
 - .4 Employ control technicians to make adjustments to the control systems to facilitate the balancing process.
- .8 Consult with the DFO Representative to clarify the design intent where necessary or in case there are any problems foreseen as the balancing processes.
- .9 Complete air balance before commencing water balance where heating coils are installed in the air system. Balancing shall not commence until systems have been cleaned and treated and the air removed from within the piping systems.
- .10 This TAB agency shall remove and re-install ceiling tile to provide access to ductwork and piping. The TAB agency will make good any damage or soiling caused by his forces.
- .11 Permanently mark final settings on valves, dampers and other adjustment devices. Set and lock all memory stop balancing devices.
- .12 Seal all holes with snap plugs or approved alternate method, used for flow and pressure measurements.
- .13 The controls contractor and TAB agency are to allow for checking and making adjustments during the 12 month warranty period, when weather conditions provide natural loads and in cases where complaints arise.
- .14 Submit a draft balance report to the DFO Representative for approval and submit approved copies to the agency preparing the O & M manuals for inclusion in each operating and maintenance manual. Provide field notes in the balancing report to clearly identify unusual

conditions, problem areas and report on any cases where the specified flow rates or conditions could not be achieved by adjustment. Identify outstanding problems that cannot be corrected by the balancing team or that will not be corrected by the installing trades (e.g. in cases where additional balancing dampers are required).

- .15 Submit a statutory declaration to the DFO Representative, certifying that the testing and balancing procedures have been completed, that complete factual reports have been distributed and that directions have been given to the Contractor to correct faults and omissions and, finally, that follow-up testing, after correction of faults and omissions, has been completed and recorded. Reports to be signed by the senior member of the TAB agency.
- .16 The Balancing Agency shall include for 3 days of return visits for readjustment of systems after the building is occupied and used.

1.20 LIQUID SYSTEMS TAB

- .1 Set balance valves and balance fittings to provide required or design flow rates for each system component.
- .2 Use installed flow measuring devices to determine flow rates for system balance. Where flow measuring devices are not installed, base flow balance on the air and liquid temperature difference across terminal heating/cooling elements and coils, acknowledging the different design temperature drops/rises used in the design of the systems.
- .3 Effect system balance with automatic control valves fully open to heat transfer elements.
- .4 Trim pump impellers to match pump performance to system characteristics rather than artificially increasing system pressure drops to match pump characteristics as directed by the DFO Representative.
- .5 Check air vents to ensure that they are correctly installed and are operating properly. The mechanical contractor shall ensure that all air is removed from within the piping system and that there is flow throughout all piping systems before the balancing is started.
- .6 Include in the liquid balance report:
 - .1 Date of test, Name and address of building and balancing technician's name.
 - .2 Heating Coils: Tag, service & location. Specified and actual capacity, flow, liquid pressure drop, liquid entering and leaving temperatures, air-side entering and leaving temperatures.
 - .3 Flow measuring devices: Flow rates.

- .4 Terminal heating/cooling elements: Entering and leaving liquid temperatures.
- .5 System schematics: Specified and actual flow rates.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation of thermal insulation for HVAC and plumbing piping.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 07 84 00 – Fire stopping
- .4 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

1.3 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-04, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-05ae1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-05, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449/C449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-07e1, Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-02, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-04e1, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).
- .4 Underwriters Laboratories of Canada (ULC)

- .1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.

1.4 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.

1.5 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit following shop drawing information:
 - .1 Pipe insulation: manufacturer's catalogue literature
 - .2 Installation requirements
 - .3 Schedule of all piping systems and proposed insulation types, thicknesses and finishes.

1.6 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix typewritten label beneath sample indicating service.

1.7 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.

1.8 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, member of TIAC.

1.9 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.

1.10 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 INSULATION

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.

2.2 PREFORMED PIPE COVERING

- .1 Mineral Fibre - Low and Medium Temperature:
 - .1 With integral vapour barrier jacket and longitudinal lap.
 - .2 Thermal conductivity at 24°C - 0.033 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Manson Alley K, Owens Corning SSL-11, Knauf 850 ASJ/SSL, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL.
- .2 Mineral Fibre - High Temperature:
 - .1 With integral vapour barrier jacket and longitudinal lap.
 - .2 Thermal Conductivity at 93°C - 0.040 W/m/deg.C.
 - .3 Acceptable Products:
 - .1 Manson Alley Kapt, Johns Manville Micro-Lok AP-T Plus, Owens Corning 1200 ASJ/SSL, Roxul ASJ/SL.
- .3 Flexible Foamed Elastomeric:
 - .1 Thermal Conductivity at 24°C - 0.040 W/m/deg.C.
 - .2 Acceptable Products:
 - .1 AP Armaflex, Rubatex R-180-FS.
- .4 Flexible Closed Cell:

- .1 Thermal Conductivity at 24°C - 0.036 W/m/deg.C.
- .2 Acceptable Products:
 - .1 Bondtex Polyethylene, Therma-Cel.

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.
- .3 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: or Stucco embossed.
 - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
- .4 Stainless steel:
 - .1 Type: 304.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Smooth.
 - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921, untreated.
- .5 Tape: self-adhesive, aluminum, 50mm wide minimum.
- .6 Contact adhesive: quick-setting
- .7 Canvas adhesive: washable.

- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .10 Fasteners: 2 mm diameter pins with 35 mm diameter square clips, length to suit thickness of insulation.

2.5 PREFORMED FITTING COVERS:

- .1 Aluminum Fitting Covers:
 - .1 0.51 mm thick, die shaped components with factory applied protective liner on interior surface.
 - .1 Childers Ell-Jacs, Perma-Ells or Shield-Ells or other as commercially available.
- .2 PVC Fitting Covers:
 - .1 0.50 mm thick premoulded one piece covers.
 - .1 Certainteed Snapform, Childers, Proto PVC, Speedline PVC, Zeston PVC, Fattal PVC.
- .3 Preformed Insulation fittings:
 - .1 Shur-Fit, Moulded Acoustic Products or from insulation fabricators.

Part 3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure testing of piping systems to be 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 Apply insulation to piping only after all tests have been made and systems accepted by DFO Representative.
- .4 Apply insulation and insulation finish in a workmanlike manner so that the finished product is uniform in diameter, smooth in finish, pleasing to the eye and with the longitudinal seams positioned to be concealed from view. Apply piping insulation materials, accessories and finishes in accordance with manufacturer's recommendations.

- .5 On piping NPS 2-1/2 and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than the length of shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.
- .6 Insulation and vapour barrier shall be continuous through all non-rated separations.

3.3 INSULATION TERMINATION POINTS

- .1 Terminate insulation 75 mm back from all un-insulated fittings to provide working clearance and terminate insulation at 90° and finish with reinforced scrim cloth and vapour barrier mastic system. Cover onto pipe and over the insulation vapour barrier. On concealed hot services terminate insulation 75mm back from all un-insulated fittings, cut off at 90° and apply reinforced scrim cloth and breather mastic system.
- .2 Cut back insulation at 45° and finish with a silicone caulking sealant around the base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .3 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .4 Apply high compressive strength insulation where insulation may be compressed by weight of piping.
- .5 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.4 VERTICAL RISERS

- .1 On vertical pipe over 75 mm provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 4.5 m centres.

3.5 HOT APPLICATION 26.7°C AND OVER

- .1 Piping:
 - .1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling the flap, with spreading staples at 75 mm centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints and secure with spreading staples.
- .2 Fittings:

- .1 Insulate fittings, to thickness of adjacent pipe insulation, with sections of the pipe insulation mitred to fit tightly, or with preformed insulation fittings or from insulation fabricator.
- .3 Valves, Strainers:
 - .1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation or insulate with preformed insulation fittings or from insulation fabricator. Drains, blowoff plugs and caps shall be left uncovered.
- .4 Flanges and Victaulic Fittings:
 - .1 Do not insulate flanges on condenser water piping inside the building.
 - .2 Insulate flanges on condenser water piping outside the building.
 - .3 Insulate flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe insulation. Insulation to overlap adjoining insulation at least 75 mm.

3.6 COLD APPLICATION 10°C AND LESS

- .1 Piping:
 - .1 Install low/medium temperature pipe insulation with integral vapour barrier jacket to pipe and hold in place by securing the jacket flap. Seal all flaps with vapour barrier adhesive. Pipe insulation with integral self-sealing vapour barrier jackets will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50 percent for insulation O.D. 300 mm and above apply strips on 250 mm centres for additional securement.
- .2 Fittings:
 - .1 Insulate fittings to thickness of adjacent pipe insulation with sections of the pipe insulation mitred to fit tightly, or preformed insulation fittings, then apply reinforcing membrane embedded barrier coating and apply finish vapour barrier coating.
 - .2 Alternatively insulate fittings with tightly placed flexible insulation and apply premoulded 25/50 rated PVC fitting covers. Apply vapour-barrier adhesive and tape on all joints and overlaps.
- .3 Valves, Strainers:
 - .1 Insulate valve bodies, bonnets and strainers with fitted pipe insulation, or mitred blocks all to thickness of adjacent pipe insulation, then apply reinforcing membrane embedded in barrier coating. Alternately, insulate with preformed insulation fittings covered with reinforcing membrane, stapled in place and covered

with a barrier coating. Drains, blow-off plugs and caps shall be left uncovered.

- .4 Unions, Flange and Victaulic Fittings:
 - .1 Insulate cold unions and flanges with oversized pipe insulation or mitred blocks to the thickness of the adjacent pipe covering, then apply reinforcing membrane embedded in barrier coating and final coating of vapour barrier mastic.

3.7 ANTI-SWEAT COATING

- .1 Coat the following un-insulated cold surfaces with an anti-sweat coating:
 - .1 Connecting surfaces of thermometers, pressure gauges, flow switches, controllers, etc.
 - .2 The coating thickness shall be as recommended by the coating manufacturer for the system operation conditions.

3.8 SCOPE OF INSULATION

- .1 Heating Pipe, Fittings and Valves:
 - .1 Insulate the following systems, unless otherwise noted:
 - .1 Hot water heating and preheating supply and return piping.
 - .2 Steam and steam condensate piping
 - .3 Glycol heat recovery piping
 - .4 Fluid cooler sump, spray water, drain, overflow and chemical feed piping, outside building.
 - .5 Hot gas piping.
 - .6 Fire pump engines' exhaust piping
 - .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Piping located within perimeter heating enclosures.
 - .2 Relief piping.
 - .3 Drain lines.
 - .3 Insulate the following valves and fittings if the pipe is insulated:
 - .1 Elbows, tees, reducers.
 - .2 Valve bodies on valves and check valves, over NPS 2-1/2.
 - .3 Flanges.
 - .4 Strainers.
 - .4 The following hot pipe fittings that operate at 60° C shall be coated with insulation coating to prevent skin burns:
 - .1 Valves, NPS 2-1/2" and smaller.
 - .2 Valve bonnets.
 - .3 Unions.
 - .4 Flexible connections.

- .5 Expansion joints.
- .6 Check valve covers.
- .2 Plumbing pipes, fire protection pipes, fittings, valves:
 - .1 Insulate the following systems, unless otherwise noted:
 - .1 Domestic cold water system including meter body and booster pump bodies and including traps on handicapped lavatories.
 - .2 Domestic hot water supply and recirculation piping.
 - .3 All drains, lines, stacks, fire standpipes and sprinkler mains in unheated areas (insulation shall cover heat tracing cables).
 - .4 Water valves, flanges, PRV's, strainers, check valves.
 - .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Piping used exclusively for fire protection (unless in unheated spaces).
 - .2 Soil stacks, vents, etc.,
 - .3 All special service piping, e.g. gas, compressed air, etc.
 - .4 Unions.
 - .5 Flexible connections or expansion joints (unless noted on the drawings).
 - .6 Check valve covers.
 - .7 Strainer leg and basket covers.
 - .8 Flexible fixture connections.
- .3 Pipe penetrations through walls and floors:
 - .1 All material for the stuffing, sealing and caulking of the pipe penetration shall be supplied and installed under this section.

3.9 PIPING INSULATION SCHEDULE

Service	Design Operating Temperature	NOMINAL PIPE SIZE (NPS)				
		Runouts 2 and less (note 1)	1 and less	1 ¹ / ₄ to 2	2 ¹ / ₂ to 4	5 and larger
Chilled Water	10°C	25	25	25	40	40
Condenser Water Inside Bldg.	30°C	25	25	25	25	25
Condenser Water Outside Bldg.	30°C	N/A	40	40	40	40
Hot Water Heating	50-90°C	25	25	25	40	40

Service	Design Operating Temperature	NOMINAL PIPE SIZE (NPS)				
		Runouts 2 and less (note 1)	1 and less	1 ¹ / ₄ to 2	2 ¹ / ₂ to 4	5 and larger
Glycol heat recovery inside Building	10-30°C	25	25	25	25	25
Glycol heat recovery outside Building	10-30°C	25	25	25	25	25
Refrigerant Suction and Hot Gas	5°C or lower	25	40	40	40	40
Evaporator Drip Pan Drains	12°C and lower	25	25	25	25	25
Domestic Cold Water	5°C	25	25	25	25	25
Domestic Hot & Tempered Water Supply and Recirculation	40-70°C	25	25	25	40	40
Buried & Exterior Rainwater Storm Drainage	5°C	none	none	None	none	none
Above Grade Interior Rainwater Storm Drainage	5°C	25	25	25	25	25
Steam	110 to 827 kPa	40	50	65	65	75
Condensate (gravity)	100°C	25	40	40	50	50
Condensate (pumped)	80°C	25	25	25	40	40
Fire Pump Diesel Engine Exhaust Pipe & Silencer	over 200°C	N/A	75	75	75	75

Note 1: All piping forming part of the HVAC system and located outside the building envelope shall be insulated for the level specified in the Table for steam piping.

3.10 HIGH TEMPERATURE PIPING – OVER 200°C

- .1 Install high temperature preformed pipe insulation, 75 mm thick, on the diesel fire pump generator exhaust piping upstream from the wall thimble, including the silencer. Secure in place with galvanized steel bands or 1.6 mm galvanized wire at 300 mm on centres. DO NOT insulate flexible connection to manifold.

- .2 Where concealed, or exposed insulate fittings with molded 2-piece covers or mitred pipe insulation to cover fittings to the thickness of adjoining insulation.
- .3 Insulate all flanges and unions. Install sections of oversized preformed pipe insulation to overlap adjoining insulation at least 75 mm.
- .4 At insulation termination points, cut back insulation at 45° and finish with a hard coat of insulating cement to match the adjacent insulation.
- .5 Finish:
 - .1 Apply vinyl foil laminate vapour barrier jacket ASJ.
 - .2 Where exposed inside the building cover the vapour barrier jacket with PVC jacket.
 - .3 Where exposed outside the building - apply a 0.41 mm thick aluminum weather protecting jacket with longitudinal seams located to shed water. Overlap all seams 50 mm and secure with metal banding 250 mm centres and at the overlaps.

3.11 REFRIGERATION SUCTION PIPING OUTSIDE BUILDING

- .1 Install flexible foamed elastomeric or flexible closed cell preformed piping insulation. Secure longitudinal and butt joints with adhesive. Insulate all fittings and components. To obtain the specified thickness, apply in layers with staggered joints.
- .2 Finish with flexible elastomeric or flexible closed cell insulation coating.
- .3 Provide aluminum watertight jacket for all outdoor insulated piping.

3.12 PIPE INSULATION FINISHES

- .1 "Concealed" insulation in horizontal and vertical service spaces will require no further finish.
- .2 "Exposed" flexible insulation shall be painted with a heavy brush coating of foam plastic white insulation coating.
- .3 "Exposed" insulation inside the building shall be finished as follows:
 - .1 Over a factory applied integral all-service type jacket on the pipe insulation, apply PVC jacket. PVC shall comply with the maximum flam spread and smoke density rating code requirements listed in Clause 2.1
 - .2 Over insulated fittings apply PVC fitting covers. Over insulated valve bodies, valve bonnets, strainers and flanges apply purchased PVC covers or field fabricate from PVC sheeting secured with solvent bonding cement.
 - .3 Finish fabric with one (1) coat of fabric coating.

- .4 "Exposed" outdoor insulation shall be finished as follows:
 - .1 Insulation shall have a vapour sealed vapour barrier jacket.
 - .2 Over the pipe insulation jacket apply aluminum weather protecting jacket. The longitudinal seam shall be located to shed water. Secure the jacket using necessary metal banding on approximately 250 mm centres and at the overlaps. Screws are not permitted on cold operating systems, since they will penetrate the vapour barrier.
 - .3 Over insulated fittings, valve bodies, valve bonnets, strainers and flanges apply metal jacket or preformed metal fittings to provide a complete jacket system. Secure with necessary fastenings.
 - .4 Seal all outdoor jacketing watertight.

3.13 FIRE STOPPING AND SMOKE SEALS

- .1 Fire stopping shall be done under Section 07 84 00 - Firestopping.
- .2 Maintain insulation around pipes penetrating fire separation only as permitted by Firestop Assembly Listing.

3.14 INSULATION PACKING OF PIPE SLEEVES

- .1 Tightly pack the space between all pipe sleeves and pipe or between pipe sleeve and pipe insulation with mineral wool insulation - Thermal Ceramics "Cerafiber" or Carborundum "Fiberfax" to full depth of sleeve to prevent transmission of sound and/or passage of smoke.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Commissioning of mechanical systems.

1.2 RELATED WORK

- .1 Section 01 79 00 – Demonstration and Training

1.3 QUALITY ASSURANCE

- .1 The commissioning shall be executed in accordance with the intent of ASHRAE Standard 1-1996 "Guideline for Commissioning of HVAC Systems".

1.4 GENERAL

- .1 Be responsible for the performance and commissioning of all equipment supplied under the Sections of Division 21, 22, 23 and 25.
- .2 Commissioning is the process of advancing the installation from the stage of static completion to full working order in accordance with the contract documents and design intent. It is the activation of the completed installation.
- .3 In consultation with the General Contractor, ensure that sufficient time is allowed and fully identified on the construction schedule for the proper commissioning of all mechanical and process systems.

1.5 COMMISSIONING AND DEMOSTRATION

- .1 Provide the services of an approved independent specialist firm to coordinate the commissioning process specified under this division and those items of other Divisions which interact with work of this Division as outlined herein, including the complete life safety and fire protection system.
- .2 The cooperation of all trades is essential for an efficient and planned process. A team comprising the following is recommended:
 - .1 Commissioning Coordinator.
 - .2 General Contractor.
 - .3 Mechanical Contractor's Supervisor.
 - .4 DFO Representative
 - .5 Division 21, 22, 23 and 25 Trades.
 - .6 Division 26 - Electrical.

- .3 Prepare a commissioning statement for each of the four (4) phases that the process is perceived to be worked through. In sequence, the phases are expected to be:
 - .1 PHASE 1 - System readiness.
 - .2 PHASE 2 - System start-up, testing, balancing etc.
 - .3 PHASE 3 - Verification of system performance.
 - .4 PHASE 4 - Demonstration & instruction.
- .4 Each phase is applicable to each major and/or separate system making up the work in Divisions 21, 22, 23 and 25 plus interface with Division 26, as applicable.
- .5 Regular meetings shall be held during the commissioning process. Minutes of the meetings shall be issued to all contractors involved, the DFO Representative and the Owners representative.
- .6 Plan the work to be specific in respect of personnel, schedule, review and laboratory tests.
 - .1 Personnel: Assign direct overall charge of commissioning to a person (the commissioning coordinator) fully qualified through practical experience and a comprehensive knowledge of the interactive nature of building and process systems and their controls to understand the complete system and be available to carry the project through to total completion. This person shall be responsible for: Commissioning, Demonstration to the DFO Representative and Owner and Certifications of Substantial and Total Performance.
 - .2 Schedule: Submit a schedule, as part of the construction schedules, for the commissioning phase of the work. This schedule shall show:
 - .1 Equipment start-up schedule.
 - .2 Submission dates for the various documents required prior to substantial performance.
 - .3 Timing of the various phases of the commissioning, testing, balancing and demonstration process.
 - .3 Review: Within two (2) months of commencing with the project work, the person having direct overall charge of commissioning shall review design intent and intended commissioning procedures with the Consultant. Within three (3) months of commencing with the project, submit a detailed plan that addresses the entire approach to the commissioning process. The plan should be prepared specifically for the project at hand. The plan should include the following components:
 - .1 Name and qualifications of the commissioning coordinator.
 - .2 Itemized check lists for the readiness, start-up and operational verification of all equipment and systems.

- .3 Outline of proposed method of notification and correction of interim operational deficiencies.
- .4 Outline of proposed demonstration and operator training program.
- .4 Troubleshooting: Where problems become apparent during the commissioning process, work at the identification and resolution of these problems. The basic functions in trouble shooting are:
 - .1 What - Identification and definition of the problem.
 - .2 Why - Determination and evaluation of the causes.
 - .3 When - Determine the time available to resolve the problem.
 - .4 Involve the DFO Representative in the review of the problem and proposed resolution.
 - .5 Co-ordinate remedial action with the appropriate parties.
 - .6 Evaluate the effectiveness of the remedial action.
- .5 Laboratory Tests: If the field tests indicate that equipment supplied to the project does not meet specifications, laboratory certification of the potentially deficient equipment may be requested by the DFO Representative. In the event that equipment does not meet specifications, contractor shall be responsible for the costs of:
 - .1 The above laboratory tests, and
 - .2 All subsequent testing and correction required.
- .7 The work included in each of the four phases shall be generally as follows:
 - .1 PHASE 1 System readiness
 - .1 Before starting any of the separate systems, provide a certificate stating that the specific system is ready for start-up and the following conditions have been met.
 - .1 All safety controls installed and fully operational (dry run test).
 - .2 Qualified personnel available to operate the plant.
 - .3 Permanent electrical connections made to all equipment.
 - .2 System readiness shall include, but not necessarily be limited to the following:
 - .1 Checking system physical completion, including all instrumentation.
 - .2 Flushing, chemical cleaning (as required), charging, fluid treating (as required).
 - .3 Equipment lubrication and prestart checks.
 - .4 Rotational checks.
 - .5 Filter systems installed and sealed in place.
 - .6 Adjusting vibration isolation and seismic restraints.
 - .7 Alignment of drives (direct and belt).
 - .8 Control function checks, including all alarms.

- .9 Self diagnostic packaged control items checked.
- .10 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently, corrected before proceeding to PHASE 2.
- .2 PHASE 2 System startup, testing, balancing
 - .1 System commissioning shall include, but not necessarily be limited to:
 - .1 Activation of all equipment and systems.
 - .2 Testing and adjustment of all equipment and systems.
 - .3 All deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency, shall be repeated before proceeding to PHASE 3.
 - .2 Phase 2 is concluded when the installation is in full working order and acceptable for use. The work will include the following:
 - .1 Balancing of the liquid systems as specified in this section.
 - .2 Set up all automatic control valves/dampers and automatic temperature control devices.
 - .3 Plug all air pressure and flow measuring holes.
 - .4 Adjust vibration isolators and seismic restraints as necessary.
 - .5 Verification and certification of the sealing of all pipe penetrations through fire separations (rated & non-rated) and other separations.
 - .6 Verification of water tightness of all roof and exterior wall penetrations.
 - .7 Testing and debugging of E.M.C.S. (Energy Management Control System).
 - .8 Set up and test all alarm protective devices.
 - .3 Fine Tuning
 - .1 Setting up automatic controls for accurate response and precise sequencing.
 - .4 Testing
 - .1 A detailed check by a person having direct overall charge of commissioning. This check to include all items and functions to be later demonstrated to the DFO Representative.
- .3 PHASE 3 Verification of System Performance
 - .1 Verification of system performance by the DFO Representative will not commence until PHASE 2 has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of

the verification procedure. The verification process will include the demonstration of the following:

- .1 The ease of access that has been provided throughout for servicing coils, motors, drives, fusible fire damper links, control dampers and damper operators.
- .2 Location of and opening and closing of all access panels.
- .3 Operation of all automatic temperature control devices.
- .4 Proper response of all systems to temperature space sensors.
- .5 Operation of all equipment and systems, under each mode of operation including:
 - .6 E.M.C.S. control features and all automatic controls.
 - .7 Coils.
 - .8 Hot Water Boilers and associated natural gas system.
 - .9 Water Treatment (Hydronic systems).
 - .10 Tanks - domestic hot water and expansion.
 - .11 Breathing air filters and controls
- .2 At the completion of Phase 3, the Contractor shall submit the following to the DFO Representative:
 - .1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.
 - .2 A commissioning report which should include completed copies of all Phase 2 documentation outlined in the commissioning plan plus copies of start-up reports from specialty contractors and vendors and any other relevant information for inclusion in the operating & maintenance manuals.
 - .3 British Columbia Boiler Inspection Dept. approval of boiler, pressure vessels and pressure piping installations.
 - .4 British Columbia Gas Inspection Dept. approval of boiler on gas firing.
 - .5 Record drawings as specified, update to include changes resulting from commissioning.
 - .6 Identification of equipment and systems complete.
- .4 PHASE 4 Demonstration and Acceptance
 - .1 Demonstration and acceptance shall not commence until the commissioning process PHASE 3 has been successfully completed.
 - .2 The Demonstration process is a planned process requiring a preplan approval before commencement and a signed

- statement of satisfaction from the DFO Representative upon completion.
- .3 For Demonstration and instruction to Operating staff requirements, refer to this section of the specification and also to Section 01 79 00 – Demonstration and Training.
 - .5 Post Substantial Performance Visits
 - .1 Provide follow-up visits to the site at one month, two months and six month after substantial performance for a minimum period of two days, to ensure that the systems are operating correctly and that they are being operated and maintained properly.
 - .2 Submit a report to the DFO Representative which documents any problems that have arisen and correction action required.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 91 13 - General Commissioning Requirements
- .2 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC
- .3 Section 23 08 02 - Cleaning and Start-up

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up.

1.3 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 operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Boiler failure.

1.4 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.

- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning off heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.5 CONDENSER WATER 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.

1.6 NATURAL GAS SYSTEMS

- .1 Operation tests:
 - .1 Measure gas pressure at gas meter outlet and at burner manifold.
 - .2 Verify details of temperature and pressure compensation at meter.
 - .3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.
 - .4 Check terminals of vents for gas pressure regulators.

1.7 REPORTS

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

1.8 TRAINING

- .1 In accordance with Section 01 91 13 - General Commissioning Requirements: Training of O&M Personnel.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials and installation for piping, valves and fittings for gas fired equipment.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 11 - Cleaning
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .4 Section 01 78 00 - Closeout Submittals
- .5 Section 23 05 05 - Installation of Pipework
- .6 Section 23 08 01 - Performance Verification
- .7 Section 23 08 02 - Cleaning and Start-Up

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18-01 (R2005), Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22-01 (R2005), Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1-96 (R2005), 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-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 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-05, Natural Gas and Propane Installation Code Handbook.

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Indicate the following shop drawings:
 - .1 Valves.
 - .2 Pressure reducing valves
 - .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.
 - .6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 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 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS2 1/2 and over, plain end.
- .2 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 type.
- .2 NPS 2 and under, screwed.
- .3 NPS 2-1/2 and over, flanged.
- .4 Suitable for the temperature to which exposed.
- .5 Certified by Canadian Gas Association (CGA).

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 gas piping in accordance with Section 23 05 05 - Installation of Pipework and CAN/CSA B149.1.

- .2 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly.
- .3 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.
- .4 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .5 Slope piping down in direction of flow to low points.
- .6 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .7 Provide clearance for access for maintenance of equipment, valves and fittings.
- .8 Use dielectric type fittings where buried service enters and connects to building piping.
- .9 Joints:
 - .1 Gas service inside building - screw or weld NPS 2 and under. Weld NPS 2-1/2 and over.
 - .2 Gas service in ceiling plenums - weld all sizes.
 - .3 Gas service outside building - weld all sizes below ground.
- .10 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.
- .11 Paint all exposed and exterior gas piping.

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless otherwise approved by DFO Representative.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.
- .3 Install valve on the main gas service entering the building. Valve to have locking lugs.

3.4 CONNECTIONS TO EQUIPMENT

- .1 Install unions or flanges in connections to all equipment and specialty components.

- .2 Arrange piping connections to allow ease of access and for removal of equipment.
- .3 Align and independently support piping connections adjacent to equipment to prevent piping stresses being transferred.

3.5 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.
 - .2 Notify the DFO Representative and the Inspection Authority having jurisdiction, 48 hours in advance of intended test date.
 - .3 Examine piping for leaks. Remake all leaking connections and joints.
 - .4 Submit final gas inspection certificate.
- .5 Performance Verification:
 - .1 Refer to Section 23 08 01 - Performance Verification.

3.6 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.

3.7 CLEANING

- .1 Cleaning: in accordance with Section 23 08 02 - Cleaning and Start-Up, CAN/CSA B149.1, supplemented as specified.
- .2 Perform cleaning operations as specified in Section 01 74 11 - Cleaning 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 SECTION INCLUDES

- .1 Materials and installation of Hydronic Specialties Equipment.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals
- .4 Section 23 08 01 - Performance Verification

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME-04, Boiler and Pressure Vessel Code.
- .2 American Society for Testing and Materials, (ASTM).
 - .1 ASTM A47/A47M-99 (2004), Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A516/A516M-06, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .3 ASTM A536-84(2004), Specification for Ductile Iron Castings.
 - .4 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International).
 - .1 CSA B51-03 (R2007), Boiler, Pressure Vessel, and Pressure Piping Code.

1.4 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 Include the following shop drawings:
 - .1 Expansion tanks
 - .2 Air vents
 - .3 Air separators
 - .4 Valves

- .5 Strainers
- .6 Suction diffusers
- .7 Pressure reducing and relief valves
- .2 Closeout Submittals:
 - .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY STORAGE AND DISPOSAL

- .1 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 DIAPHRAGM TYPE EXPANSION TANK

- .1 Vertical steel pressurized diaphragm type expansion tank.
- .2 EPDM Diaphragm sealed in elastomer suitable for 115 degrees C operating temperature.
 - .1 Tank to be suitable for glycol system
- .3 Working pressure: 860 kPa with ASME stamp and certification.
- .4 Identification plate showing:
 - .1 Manufacturer's name.
 - .2 Capacity in litres.
 - .3 Hydraulic test pressure.
 - .4 Working pressure.
 - .5 Code stamping and ASME registered design.
- .5 Air pre-charged to 84 kPa (initial fill pressure of system).
- .6 Base mount for vertical installation.
- .7 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .8 Renewable diaphragm.
- .9 Capacity and size: Refer to drawing schedules.

2.2 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.
- .2 Float: solid material suitable for 115 degrees C working temperature.

2.3 AIR VENTS AUTOMATIC – HIGH CAPACITY TYPE

- .1 Non-Serviceable Type
 - .1 Casing and internal parts suitable for system operating pressure and temperature.
 - .2 All metal construction with outlet threaded to accept vent tubing connection.
 - .3 Automatic float type.
 - .4 Shrader type venting valve.
 - .5 Acceptable Products:
 - .1 345 kPa maximum operating pressure -Armstrong 11-AV, Dole 75, Maid-O-Mist 7, Taco 423, Watson McDaniel AE1800.

2.4 AIR VENTS MANUAL – HIGH CAPACITY

- .1 Globe Type
 - .1 Bronze body, union bonnet, screwed, 450 brinell hardened stainless steel trim and plug type disc.
- .2 Acceptable Products:
 - .1 Class 125 - Crane 14-1/2 LP, Jenkins 2032, Lunkenheimer 73-PS, Toyo 214.

2.5 AIR SEPARATOR - IN-LINE

- .1 Provide centrifugal type with 860 kPa WSP steel tank, galvanized steel 6 mm perforated strainer, perforated stainless steel air collector tube and drain connection.

2.6 PIPE LINE STRAINER

- .1 NPS 2 and under: bronze body to ASTM B62, screwed connections, Y pattern.
- .2 NPS 2 1/2 and over: cast iron body to ASTM, Class 30, flanged connections.
- .3 NPS 2 and over: Y or T type with ductile iron body to ASTM A536 or malleable iron body to ASTM A47M, grooved ends.
- .4 Blowdown connection: NPS 1.

- .5 Basket Screen: stainless steel or brass with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.
- .7 Acceptable Products:
 - .1 Armstrong, Erwel, Kitz, Mech-Line, Muesco, Spirax/Sarco, Toyo, Victaulic.

2.7 SUCTION DIFFUSER

- .1 Body: cast ductile iron body.
- .2 Strainer: stainless steel with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.
- .3 Connections:
 - .1 NPS 2 and under, screwed.
 - .2 NPS 2-1/2 and over, flanged or grooved.
- .4 Permanent magnet particle trap.
- .5 Full length straightening vanes.
- .6 Pressure gauge tapings.
- .7 Adjustable support leg.
- .8 Integrated long radius elbow, strainer and suction entrance guide vanes.
- .9 Suitable for 1029 kPa and 122°C.
- .10 Select for system flow rate and allowable pressure drop.
- .11 Acceptable Products:
 - .1 Armstrong Suction Guide, Bell & Gossett Suction Diffusers, Mech-Line, Taco Suction Diffuser, Victaulic suction diffuser.

2.8 PRESSURE REDUCING STATION – COLD WATER

- .1 Screwed, bronze or cast iron body, suitable to 1380 kPa, composition seat.
- .2 Each reducing station to include:
 - .1 Gate valve, strainer, union, pressure reducing valve, union, gate valve.
 - .2 Bypass with globe valve.
 - .3 20 mm relief valve.
- .3 Acceptable Products:

.1 Cashco, Watts.

2.9 PRESSURE RELIEF VALVES - WATER

- .1 Screwed, bronze body or cast iron body with expanded outlet.
- .2 ASME rated.
- .3 Coordinate with Heat Exchangers Schedules.

Part 3 Execution

3.1 GENERAL

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Run drain lines and blow off connections to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow DFO Representative's directive.
- .5 Check shop drawings for conformance of all tappings for ancillaries and for equipment operating weights.

3.2 AIR VENTS – AUTOMATIC – HIGH CAPACITY TYPE

- .1 Install automatic high capacity air vents at each high point in the piping systems and where shown on the drawings.
- .2 Install on tees and not on horizontal pipe runs or elbows.
- .3 Install a 12 mm minimum isolating gate valve ahead of each air vent, unless air vent has an integral shut-off valve.
- .4 Fit all vents on top of an air-collecting chamber.
- .5 Pipe all air vent discharge connections separately, to the nearest building drain, using 6 mm hard drawn copper tube. Label ends with permanent labels.
- .6 Pipe all air vent discharge connections, (except for glycol) separately, to a water-tight solder jointed, 1.2 mm copper drain pan, using 6 mm (1/4") hard drawn copper tube where exposed and soft copper where concealed. Label ends with permanent labels.
- .7 Pipe all air vent discharge connections from the glycol circuit, separately back to the glycol mixing tank, using 6 mm hard drawn copper tube.

3.3 AIR VENTS – MANUAL – HIGH CAPACITY

- .1 Install manual air vents at high points in the piping systems where shown on the drawings.
- .2 Install on tees and not on horizontal pipe runs or elbows.
- .3 Install isolating gate valve ahead of each vent valve.
- .4 Pipe air vent discharge connections to nearest building drain.

3.4 AIR SEPARATOR

- .1 Install on suction side of system circulation pump.

3.5 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.
- .5 Provide isolation valves on either side of strainer, to permit cleaning without draining the system.

3.6 EXPANSION TANKS – DIAPHRAGM TYPE

- .1 Adjust expansion tank pressure as indicated.
- .2 Install gate valve in system connection.
- .3 Install globe valve in tank drain connection.

3.7 PRESSURE REDUCING STATIONS – COLD WATER

- .1 Install water make-up stations for each hot water, chilled water and other closed water systems where shown on the drawings.
- .2 Pipe relief valve to drain.

3.8 PRESSURE SAFETY RELIEF VALVES - WATER

- .1 Install pressure relief valve(s) on each heat exchanger to prevent over pressuring.
- .2 Select relief valves to relieve full heat input of the heat supply side.
- .3 Pipe relief valve to drain.

- .4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.9 SUCTION DIFFUSERS

- .1 Install suction guides on the suction of centrifugal pumps, where shown on the drawing and where scheduled in accordance with manufacturer's recommendations.
- .2 "Start up" strainer baskets must be removed prior to commissioning of systems.

3.10 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification, supplemented as specified herein.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 11 - Cleaning
- .3 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .4 Section 01 78 00 - Closeout Submittals
- .5 Section 21 05 01 - Common Work Results - for Mechanical
- .6 Section 23 05 17 - Welding
- .7 Section 23 05 22 – Valves: Bronze
- .8 Section 23 05 23 – Valves: Cast Iron
- .9 Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
- .10 Section 23 08 02 – Cleaning and Start-Up

1.3 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-2005, Cast Iron Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.3-2006, Malleable Iron Threaded Fittings.
 - .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .4 ASME B16.9-2007, Factory-Made Wrought Buttwelding Fittings.
 - .5 ASME B18.2.1-1996 (R2005), Square and Hex Bolts and Screws (Inch Series).
 - .6 ASME B18.2.2-87(2005), Square and Hex Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-2004, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.

- .3 ASTM A536-2004, Standard Specification for Ductile Iron Castings.
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B242-05, Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI B31, Standard of Pressure Piping.

1.4 SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by Professional Engineer registered or licensed in Province of Ontario, Canada.
 - .2 Submit the following shop drawings:
 - .1 Manufacturers literature for piping and fittings.
- .2 Closeout Submittals.
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:

1.5 DELIVERY, STORAGE AND HANDLING

- .1 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 PIPE

- .1 Steel Pipe:
 - .1 Schedule 40 to ASTM A53 Grade B for the following systems:
 - .1 Hot water heating
 - .2 Relief valve vents

- .2 Steel and Stainless Steel Pipe:
 - .1 to NPS 8, Schedule 80 to ASTM A53 Grade B.
 - .2 to NPS 10 and over, 12.7 mm 1/2" wall thickness to ASTM A53 Grade B.
 - .3 All sizes, Schedule 10, 316 stainless steel, roll grooved pipe and fittings.
 - .4 for the following systems:
 - .1 Condenser water - open circuit.

2.2 PIPE JOINTS – STEEL PIPING

- .1 NPS 2 and under: screwed fittings, except where otherwise noted, with teflon tape and rectroseal teflon paste or pipe dope.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W47.1.
- .3 Flanges: raised face, steel weld neck, lap or back-welded slip on type. Use flat face for attachment to cast iron valves.
- .4 Roll grooved mechanical type pipe couplings to CSA B242-M1980 may be used on chilled water, condenser water, glycol heat recovery and heat pump water systems. Use lubricant supplied by manufacturer and coat gasket. Gasket grade "EPDM" gasket for temperature range -34oC to 110oC.
- .5 Bolts and Nuts, carbon steel: to ASME B18.2.1 and ASME B18.2.2.
- .6 Flange gaskets:
 - .1 To AWWA C111.
 - .2 Up to 860 kPa system pressure - non-asbestos gaskets for mating surfaces.
 - .3 Over 860 kPa system pressure - stainless steel spiral wound non-asbestos gaskets.

2.3 PIPE FITTINGS – STEEL PIPE

- .1 Pipe fittings, screwed, flanged or welded:
 - .1 Cast iron pipe flanges: Class 125 to ANSI B16.1.
 - .2 Cast iron screwed fittings: Class 125 to ANSI B16.3.
 - .3 Steel pipe flanges and flanged fittings: to ANSI B16.5.
 - .4 Steel butt-welding fittings: to ANSI B16.9a.
 - .5 Unions, malleable iron ground joint type: Class 150 to ANSI B16.3.
- .2 Fittings for roll grooved piping: malleable iron to ASTM A47M or ductile iron to ASTM 536.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: flanged ends.
- .2 Gate Valves: Application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Class 125, Rising stem, solid wedge disc, as specified Section 23 05 22 – Valves: Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23 – Valves: Cast Iron.
- .3 Butterfly valves: Application: isolating each cell or section of multiple component equipment:
 - .1 NPS 2 1/2 and over: lug type: as specified Section 23 05 17 - Welding.
- .4 Globe valves: Application: throttling, flow control, emergency bypass:
 - .1 NPS 2 and under:
 - .1 Globe, with composition disc, as specified Section 23 05 22 – Valves: Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 With composition disc, bronze trim, as specified Section 23 05 23 – Valves - Cast Iron.
- .5 Balancing, for TAB:
 - .1 Circuit balancing valves, 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 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified Section 23 05 22 – Valves: Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23 – Valves: Cast Iron.
- .8 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified Section 23 05 22 – Valves: Bronze.

- .2 NPS 2 1/2 and over:
 - .1 Flanged ends: as specified Section 23 05 23 – Valves: Cast Iron.
- .9 Ball valves:
 - .1 NPS 2 and under: as specified Section 23 05 22 – Valves: Bronze.

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 INSTALLATION

- .1 Ream pipe ends. Clean scale and dirt, inside and outside before and after assembly. Remove foreign material from piping.
- .2 During construction, protect all openings in piping and equipment, by capping or plugging to prevent entry of dirt.
- .3 Screw or weld (unless otherwise specified) all piping systems up to NPS 2.
- .4 Weld (unless otherwise specified) all piping systems NPS 2-1/2 and over.
- .5 Install piping to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .6 Avoid piping in exterior walls unless otherwise directed. If required, install this piping protected from the outside by the building insulation and vapour barrier.
- .7 Maintain a minimum of 25 mm space between adjacent flanges or pipe insulation, whichever has the larger diameter.
- .8 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .9 Saddle type branch fittings may be used on mains, if branch line is half size or smaller than main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .10 Use long radius elbows.
- .11 Install all thermometer wells and immersion sensor wells specified under the Controls Section. Where wells will restrict flow in small diameter pipes (NPS 1-1/2 and smaller) install a section of oversized pipe at least NPS 2.

- .12 Remake leaking joints using new materials, do not caulk or cement leaking threaded joints.
- .13 Use eccentric reducers at pipe size changes, flush on top side, to permit positive venting and drainage.
- .14 Do not use thread protection couplings, close nipples, running nipples or street elbows.
- .15 Install dielectric type unions or flanges on "OPEN" type systems, where copper piping connects to steel. eg. domestic hot water tanks.
- .16 Avoid locating water and drain piping over electrical equipment. Where this is unavoidable, provide galvanized drip pans under such pipe and weld piping and fittings. Provide drain and piping from drip pans to satisfactory floor drain.
- .17 Bull head tees shall not be used for converging flows.
- .18 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .19 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .20 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .21 Assemble piping using fittings manufactured to ANSI standards.

3.3 PIPE GRADING

- .1 Grade all piping to provide positive drainage and venting. Slope as follows:
 - .1 Supply mains and branches - up in the direction of flow, minimum 1:480.
 - .2 Return mains and branches - down in the direction of flow, minimum 1:480.
 - .3 Reverse return supply and return mains - up in the direction of flow, minimum 1:480 .
 - .4 Grade horizontal drainage and vent piping down in direction of flow, 2% minimum.
 - .5 On closed system, equip low points with 20 mm drain valves. Provide, at high points on lines and on equipment connections, collecting chambers and high capacity float operated air vents.

3.4 SOLDERING AND BRAZING

- .1 Pressure fluid systems - with chemical treatment (heating, chilled and condenser water). BRAZE with silver base brazing alloy, 538°C melting point.
- .2 Pressure fluid systems - without chemical treatment, (heat recovery, domestic water). SOLDER with 95/5 tin-antimony.
- .3 Non-pressure systems, (drains) SOLDER with 95/50 tin-antimony.

3.5 CONNECTIONS TO EQUIPMENT AND TO EXISTING PIPING

- .1 Install union grooved couplings or flanges at connections to all equipment and specialty components and at all connecting points to existing systems which, for reasons of separation for testing, will require to be blank flanged or capped.
- .2 Install removable sections of pipe or 300 mm spool pieces on the suction side of end suction pumps and where required for ease of maintenance.
- .3 Connect to equipment in accordance with manufacturer's instruction unless otherwise noted.
- .4 Arrange piping connections to allow ease of access and for removal of equipment.

3.6 EXPANSION OF PIPING

- .1 Install all piping systems with due regard and provision for expansion avoiding strain or damage to equipment and building. Pay particular attention to piping running horizontal across building expansion joints and provide adequate expansion and contraction for all such piping.
- .2 Only major expansion configuration and fittings have been shown on the drawings. Provide all required additional compensators, loops and swing connections.
- .3 Provide anchors, where shown. Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.
- .4 Expansion loops shall be of all welded construction with long radius elbows.
- .5 Install expansion loops, cold sprung 50% of the calculated expansion.
- .6 Install at least 3 elbows in all branch connections. Where space does not permit 3 elbows, install braided flexible pipe connectors in accordance with manufacturers' recommendations. 3 elbow branch connections

shall have sufficient developed length to ensure that excessive stresses are not generated in the piping and in no case less than 900mm.

3.7 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install butterfly valves on chilled water and condenser water lines only.
- .3 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install globe valves for balancing and in by-pass around control valves as indicated.
- .5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- .6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

3.8 CIRCUIT BALANCING VALVES

- .1 Install circuit balancing valves as indicated.

3.9 FLUSHING AND CLEANING

- .1 Refer to Section 23 08 02 – Cleaning and Start-Up.

3.10 FILLING OF SYSTEM

- .1 Refill system with clean water, adding water treatment as specified.

3.11 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Test system in accordance with Section 21 05 01 - Common Work Results – for Mechanical.
- .2 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.

3.12 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 SECTION INCLUDES

- .1 Materials and installation of hot water heating boilers:

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 23 05 48 - Vibration and Seismic Controls
- .4 Section 23 51 00 – Breeching, Chimneys and Stacks

1.3 REFERENCES

- .1 American Boiler Manufacturer's Association (ABMA)
- .2 American National Standards Institute (ANSI)
 - .1 ANSI Z21.13-2005/CSA 4.9a-2005, 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 (R2006), 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)

1.4 SUBMITTALS

- .1 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit drawings stamped and signed by Professional Engineer registered or licensed in Province of Ontario, Canada.

- .2 Indicate the following:
 - .1 General arrangement showing dimensions, terminal points, instrumentation test connections.
 - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
 - .3 Boiler weight distribution, anchor bolt arrangements.
 - .4 Piping hook-ups.
 - .5 Equipment electrical drawings.
 - .6 Burners and controls.
 - .7 All miscellaneous equipment.
 - .8 Flame safety control system.
 - .9 Breeching and stack configuration.
 - .10 Stack emission continuous monitoring system to measure CO, O₂, NO_x, SO₂, stack temperature and smoke density of flue gases.
- .3 Engineering data to include:
 - .1 Boiler efficiency at 25%, 50%, 75%, and 100% of design capacity.
- .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.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 DFO Representative will make available 1 copy of systems supplier's installation instructions.
- .3 Closeout Submittals:
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 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.

1.7 MAINTENANCE

- .1 Extra materials:
 - .1 Special tools for burners, manholes, handholes and Operation and Maintenance.
 - .2 Spare parts for 1 year of operation.

Part 2 Products

2.1 GENERAL

- .1 Packaged boiler: complete with burner and necessary accessories and controls, and ready for attachment of water supply, return and drain piping, fuel piping, electrical connections, and chimney connection. UL/ULC labelled.
- .2 Designed and constructed in accordance with ASME Code requirements.
- .3 CRN (Canadian Registration Number), to CSA B51.
- .4 Boiler/burner package to bear ULC or CGA label.
- .5 Electrical components CSA approved.
- .6 Approved by Ontario Safety Authority
- .7 Boilers to be test fired before shipment and to be registered with the Provincial Authorities.
- .8 Include erection and wiring diagrams and an operating and maintenance manual with boiler package.
- .9 Check all available drawings and ensure that the boiler proposed will fit in the space allotted and can be maintained and operated in a normal manner without difficulty.
- .10 Performance:
 - .1 In accordance with American Boiler Manufacturers Association (ABMA).
 - .2 Capacity: Refer to equipment schedules.
 - .3 Boiler efficiency: 85 % minimum, at 30% to 100% firing rates.
 - .4 Flue gas temperature leaving boiler:
 - .1 Not to exceed 260 degrees C.
 - .2 Above dew point conditions at minimum firing rate.

- .11 Electrical:
 - .1 Power: 120 V, 1 phase, 60 Hz.
 - .2 Controls: 120 V, 1 phase, 60 Hz.
 - .3 Electrical components: CSA approved.
- .12 Controls: factory wired. Enclosed in Electrical and Electronic Manufacturers' Association of Canada (EEMAC) 1 steel cabinet.
- .13 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.
- .14 Jackets: heavy gauge metal, finished with heat resisting paint.
- .15 Mounting:
 - .1 Structural steel base, lifting lugs.
- .16 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.
- .17 Start-up, instruction, on-site performance tests: 2 days.
- .18 Trial usage:
 - .1 DFO Representative may use boilers for test purposes prior to acceptance and commencement of warranty period.
 - .2 Supply labour, materials and instruments required for tests.
- .19 Temporary use by contractor:
 - .1 Contractor may use boilers only after written approval from DFO Representative.
 - .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 HOT WATER BOILERS – FIRE TUBE

- .1 Construction:
 - .1 Packaged flexible steel fire tube boiler designed to resist thermal shock.
 - .2 Boiler shall be furnished with an adequate number of tappings and inspection openings to facilitate internal boiler inspection and cleaning.

- .3 Boiler shall be complete with a heavy gauge insulated metal jacket, finished with heat resistant enamel paint.
- .4 All exposed boiler components such as down comers and drum ends to be insulated. If not factory insulated, boiler supplier shall include and arrange for field application.
- .5 Provide secure attachment points for seismic anchoring.
- .2 Boiler Accessories:
 - .1 Provide all standard trim items and controls as described in the manufacturer's published product specification including the following:
 - .1 Flue gas thermometer.
 - .2 Thermometer and pressure gauge.
 - .3 Water temperature control operator.
 - .4 High limit safety control with manual reset.
 - .5 Low water cutoff with manual reset (manual reset should not be necessary after electrical power interruption).
 - .6 ASME safety relief valve.
 - .7 Electronic combustion safety control
 - .8 Ignition transformer.
 - .9 Two stage burner unit.
- .3 Gas Burner and Control Equipment
 - .1 Boiler shall be furnished with a forced draft, flame retention gas burner.
 - .2 Burner shall be complete with integral motor and blower for supplying sufficient combustion air.
 - .3 Provide all standard trim items and controls as described in manufacturers published product specification including the following:
 - .1 Flue gas thermometer.
 - .2 Thermometer and pressure gauge.
 - .3 Water temperature control operator.
 - .4 High limit safety control with manual reset.
 - .5 Low water cutoff with manual reset. Manual reset should not be necessary after electrical power interruption. One normally open set of dry contacts for alarm signal to the EMCS.
 - .6 ASME safety relief valve(s) to release entire boiler capacity.
 - .7 Automatic gas valve operator.
 - .8 Auxiliary safety shut-off valve.
 - .9 Pilot solenoid valve.
 - .10 Pilot ignition assembly.

- .11 Ignition transformer.
 - .12 Main manual gas shut-off valve.
 - .13 Pilot cock.
 - .14 Pilot and main gas pressure regulators.
 - .15 Air safety switch.
 - .16 Electronic combustion safety control with UV sensor.
- .4 Accessories:
- .1 Modulating gas burner.
 - .2 Auxiliary low water cutoff.
 - .3 Alarm horn.
 - .4 Indicator lights - as specified.

2.3 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ANSI/ASME requirements.
- .2 Hot water boilers:
- .1 Relief valves: ANSI/ASME rated, set to release entire boiler capacity.
 - .2 Pressure gauge: 90 mm diameter complete with shut-off cock.
 - .3 Thermometer: 115 mm diameter range 10 to 150 degrees C.
 - .4 Low water cut-off: with visual and audible alarms.
 - .5 Auxiliary low water cut-off: with separate cold water connection to boiler.
 - .6 Isolating gate valves: on supply and return connections.
 - .7 Drain valve: NPS 2.
 - .8 Stack thermometer: range 65 to 400 degrees C.
 - .9 Outdoor controller: to reset operating temperature controller.
 - .10 One 1 set of cleaning tools.
- .3 Pot type chemical feeder.

2.4 EMISSION CONTROL

- .1 Rate of discharge of air contaminants from boiler not to exceed:
- .1 For nitrogen oxides expressed as nitrogen dioxide:
 - .1 22 ng/J of heat input when fired with gaseous fuel.
 - .2 For carbon monoxide, 125 ng/J of heat input.

2.5 OTHER REQUIREMENTS

- .1 Shop Tests – Hot Water Boilers:
- .1 The packaged boiler must receive factory tests to check the construction, controls, and operation of the unit. All tests may be witnessed by the purchaser, if desired.

- .2 Start Up Service – Hot Water Boilers:
 - .1 After boiler installation is completed, the manufacturer shall provide the services of a field representative for starting the unit and training the operator. A factory approved and authorized start-up report shall be submitted to the customer/user at the time of start-up.

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.
- .2 Make required piping and electric connections including any control wiring between boiler control panel and oil pump starter.
- .3 Pipe relief valves and air vent on hot water boilers to floor drain.
- .4 Do not deviate from required service and maintenance clearances.
- .5 Mount unit level.
- .6 Natural gas fired installation to CAN1-B149.1-05.
- .7 Manufacturers' representative to:
 - .8 Certify Installation.
 - .9 Provide start-up and burner adjustment service
 - .10 Carry out on-site performance verification tests.
 - .11 Provide maintenance and operating instructions.
 - .12 Test reports to be submitted for review and inclusion in maintenance manuals.

3.2 INSTALLATION

- .1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province of Ontario 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.
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Pipe blowdown/drain to blowdown tank/floor drain.
- .7 Natural gas fired 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.

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 DFO Representative at least 24 hours' notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

END OF SECTION

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END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 20 - Wire And Box Connectors 0-1000 V.
- .2 Section 26 05 21 - Wires and Cables (0-1000 V).
- .3 Section 26 05 22 - Connectors And Terminations.
- .4 Section 26 05 28 - Grounding - Secondary.
- .5 Section 26 05 29 - Hangers and Supports for Electrical Systems.
- .6 Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
- .7 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .8 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .9 Section 26 24 16.01 - Panelboards Breaker Type.
- .10 Section 26 24 19 - Motor Control Centres.
- .11 Section 26 28 23 - Disconnect Switches - Fused and Non-Fused.
- .12 Section 26 29 10 - Motor Starters to 600 V.
- .13 Section 26 28 13.01 - Fuses - Low Voltage.
- .14 Section 26 28 16.02 - Moulded Case Circuit Breakers.

1.2 REFERENCES

- .1 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.
- .2 Reference Standards:
 - .1 CSA Group
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CSA C282-15-Emergency Electrical Power for Buildings.
 - .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

- .2 Product Data:
 - .1 Submit manufacturer's instructions, electronic copy of product literature and data sheets for panelboards, breakers, disconnects, starters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
 - .1 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.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .4 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Certificates:
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .5 Manufacturer's Field Reports: submit to Departmental Representative 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.
- .6 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.

- .2 Recycled Content:
 - .1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer content, and total cost of materials for project.
 - .3 Regional Materials: submit evidence that project incorporates required percentage 75% of regional materials and products, showing their cost, distance from project to furthest site of extraction or manufacture, and total cost of materials for project.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for all electrical equipment supplied by this contractor for incorporation into manual.
 - .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.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect all products from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 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 for control items in English.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.3 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 as shown on mechanical drawings.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and Departmental Representative.
- .2 Decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

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

2.6 EQUIPMENT IDENTIFICATION

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

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 to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate.
- .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 Departmental Representative.
- .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.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, to match existing building wiring.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code box covers.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

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

3.3 NAMEPLATES AND LABELS

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

3.4 FIELD QUALITY CONTROL

- .1 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Circuits originating from branch distribution panels.
- .2 Carry out tests in presence of Departmental Representative.
- .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.5 SYSTEM START-UP

- .1 Instruct Departmental Representative 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.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – Common Work Results - Electrical.

1.2 REFERENCES

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.18, Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No.65, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedure.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wire and box connectors and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for wire and box connectors for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connector] from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for stranded round copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wire and box connectors installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Remove insulation carefully from ends of conductors [cables] and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
 - .3 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.
 - .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Section 26 05 00 - Common Work Results - Electrical.

1.2 PRODUCT DATA

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

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 600V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE.

2.2 CONTROL CABLES

- .1 Generator controls cabling as recommended by generator manufacturer.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

- .1 Install cable in trenches in accordance with Section 33 65 76 – Direct Buried Underground Cable Ducts.
- .2 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).

- .3 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .4 Conductor length for parallel feeders to be identical.
- .5 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

3.3 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
 - .2 In underground ducts in accordance with Section 33 65 76 – Direct Buried Underground Cable Ducts.

3.4 INSTALLATION OF CONTROL CABLES

- .1 Install generator control cables in conduit and underground ducts.
- .2 Ground control cable shield.

3.5 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 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.12012, Canadian electrical Code Part 1.
 - .2 CSA C22.2 No.4113, Grounding and Bonding Equipment.

1.2 PRODUCT DATA

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

1.3 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 CONNECTORS AND TERMINATIONS

- .1 Copper long barrel compression connectors to manufacturer's recommendations and as required sized for conductors.

Part 3 Execution

3.1 INSTALLATION

- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2No.41-13.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)
 - .1 ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

1.2 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 EQUIPMENT

- .1 Grounding conductors: bare stranded copper, tinned, soft annealed, size to CSA-C22.1-2012.
- .2 Insulated grounding conductors: green, copper conductors, size CSA-C22.1-2012.

- .3 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Bolted type conductor connectors.
 - .2 Bonding jumpers, straps.
 - .3 Pressure wire connectors.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Soldered joints not permitted.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, frames of generators, auto-transfer switches, control panels, distribution panels.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General**1.1 WASTE MANAGEMENT AND DISPOSAL**

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

Part 2 Products**2.1 SUPPORT CHANNELS**

- .1 U shape, size 41 x 41mm, 2.5mm thick, surface mounted or suspended.

Part 3 Execution**3.1 INSTALLATION**

- .1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to concrete with expandable inserts.
- .3 Secure equipment to walls or suspended ceilings with toggle bolts or attached to structure.
- .4 Support equipment, conduit using clips, spring loaded bolts designed as accessories to basic channel members.
- .5 Fasten exposed conduit to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits 50 mm and smaller.
 - .2 Two-hole steel straps for conduits larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.

- .6 Suspended support systems.
 - .1 Support individual conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 1500mm on centre spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit.
- .9 Ensure adequate support for raceways dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways.
- .11 Do not use supports or equipment installed for other trades for conduit support except with permission of other trade and approval of Departmental Representative.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 JUNCTION AND PULL BOXES

- .1 Construction: welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on flat covers.

Part 3 Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.2 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name, voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's instructions.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 CONDUIT BOXES

- .1 Cast boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.2 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 3 Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

- .3 Provide correct size of openings in boxes for conduit, mineral insulated connections. Do not install reducing washers.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18- Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-2-07 (R2012), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985 (R2013), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-06 (R2011)], Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-15, Mechanical Protection Tubing (MPT), and fillings (Bi-natural Standard, with UL1696).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .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.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 CONDUITS

- .1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Rigid PVC conduit: to CSA C22.2 No. 211.2.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 53 mm and smaller.
 - .1 Two hole steel straps for conduits larger than 53 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1500 mm on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 27 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

- .1 Polypropylene.

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 datasheets.

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Surface mount or suspend conduits in service room.
- .3 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .4 Use electrical metallic tubing (EMT) inside building.
- .5 Use rigid PVC conduit underground.
- .6 Install conduit sealing fittings in hazardous areas.
 - .1 Fill with compound.
- .7 Minimum conduit size for lighting and power circuits: 21 mm.
- .8 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 21 mm diameter.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.

- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.5 CLEANING

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

- .1 Section 26 05 00 – Common Work Results – Electrical.
- .2 Section 26 28 16.02 – Moulded Case Circuit Breakers.

1.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No.29-15, Panelboards and Enclosed Panelboards.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by the contractor.
 - .2 Include on drawings:
 - .1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

- .2 Store and protect panelboards from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 PANELBOARDS

- .1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .2 600 V panelboards: bus and breakers rated for 42,000 A (symmetrical) interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked enamel

2.2 BREAKERS

- .1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.
- .2 Breakers full rated to interrupting capacity of panel, with thermal and magnetic tripping in panelboards except as indicated otherwise.

- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.3 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplate for each panelboard size 4 engraved.
- .3 Nameplate for each circuit in distribution panelboards size 2 engraved.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for panelboards installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
- .2 Mount panelboards as indicated.
- .3 Connect loads to circuits.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – Common Work Results – Electrical

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide fuse performance data characteristics for each fuse type. Performance data to include: average melting time-current characteristics.
- .3 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in moisture free location.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.4 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Six spare fuses of each type and size installed up to and including 600 A.

Part 2 Products

2.1 FUSES - GENERAL

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

- .1 Class L fuses.
 - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type L2, fast acting.
- .2 Class J fuses.
 - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.
- .3 Class R -R fuses.
 - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
 - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class C fuses.

Part 3 Execution

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
 - .1 Install rejection clips for Class R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
- .5 Install spare fuses in fuse storage cabinet.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 – Common Work Results – Electrical

1.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No. 5-09, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for [circuit breakers] and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates:
 - .1 Prior to installation of circuit breakers in either new or existing installation, Contractor must submit 3 copies of a production certificate of origin from the manufacturer. Production certificate of origin must be duly signed by factory and local manufacturer's representative certifying that circuit breakers come from this manufacturer and are new and meet standards and regulations.
 - .1 Production certificate of origin must be submitted to Departmental Representative for approval.
 - .2 Delay in submitting production of certificate of origin will not justify any extension of contract and additional compensation.
 - .3 Any work of manufacturing, assembly or installation to begin only after acceptance of production certificate of origin by Departmental Representative. Unless complying with this requirement, Departmental Representative reserves the right to mandate manufacturer listed on circuit breakers to authenticate new circuit breakers under the contract, and to Contractor's expense.
 - .4 Production certificate of origin must contain:
 - .1 Manufacturer's name and address and person responsible for authentication. Person responsible must sign and date certificate.

- .2 Licensed dealer's name and address and person of distributor responsible for Contractor's account.
- .3 Contractor's name and address and person responsible for project.
- .4 Local manufacturer's representative name and address. Local manufacturer's representative must sign and date certificate.
- .5 Name and address of building where circuit breakers will be installed:
 - .1 Project title: [_____].
 - .2 End user's reference number: [_____].
 - .3 List of circuit breakers: [_____].

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store circuit breakers indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect circuit breakers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers, 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 10kA symmetrical rms interrupting capacity rating.

2.2 THERMAL MAGNETIC BREAKERS

- .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.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install circuit breakers as indicated.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-04 (R2014), Enclosed and Dead Front Switches.
 - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 WASTE MANAGEMENT AND DISPOSAL

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

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible, horsepower rated disconnect switch in CSA Enclosure Type 1, to CAN/CSA C22.2 No.4 size as indicated.
- .2 Provision for padlocking in off switch position by two locks.

- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 6 28 13.01 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results - Electrical.

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1, Part 4: Electromechanical contactors and motor-starters.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Provide shop drawings for each type of starter to indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
- .3 Extra Materials:
 - .1 Provide listed spare parts for each different size and type of starter.
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.

- .3 1 contacts, auxiliary.
- .4 1 control transformer[s].
- .5 1 operating coil.
- .6 Fuses as indicated

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 MANUAL MOTOR STARTERS

- .1 Single and Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One or Three overload heaters as required, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Pushbutton switch: heavy duty labelled as indicated.
 - .2 Indicating light: heavy duty type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Magnetic of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.

- .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Accessories:
 - .1 Pushbuttons heavy duty labelled as indicated.
 - .2 Indicating lights: heavy duty type and color as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.5 ACCESSORIES

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

2.6 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.7 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 2 engraved as indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION