PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME BPVC-IX-2013, 2013 ASME Boiler and Pressure Vessel Code (BPVC), Section IX: Welding, Brazing, and Fusing Qualifications: Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators.
- .2 ASME B31.1-2012, Power Piping.

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

.3 Canadian Standards Association (CSA International)
- .1 CAN/CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.
- .2 CAN/CSA B149.1-10, Natural Gas and Propane Instalaltion Code.

.4 Green Seal Environmental Standards (GS)
- .1 GS-11-11, Standard for Paints and Coatings.
- .2 GS-36-11, Standard for Commercial Adhesives.

.5 National Fire Code of Canada (NFCC 2005)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Proposed alterations to existing high pressure system are to be reviewed by certified boiler inspector of authorized insurance company under contract with PWGSC. If existing system was registered (and a P# exists), they will prepare a Piping Data Report using the P# of existing system and submit it to Provincial Authority. They may require registration of existing system or a drawing be prepared and stamped by a Professional Engineer showing proposed changes.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

1.5 TSSA

.1 The contractor shall be responsible for contacting the Technical Standards and Safety Authority (TSSA) and comply with all requirement submissions and inspections of the system and pay all associated fees.

.2 The contractor shall be responsible to submit drawings, specifications, and other required material to TSSA and to obtain a registration number for this installation in a timely manner. Where an existing system is being altered the client will provide the existing registration number to the contractor if available.

1.5 TSSA (Cont'd)

.3 The contractor shall contact TSSA to arrange for the inspection of the system prior to putting the system into service. Submit copies of their approval to the Departmental Representative for their records.

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.
- .1 Paints: Paint natural gas pipe in accordance with manufacturer's recommendations for surface conditions and as required by Code.
- .2 Primer: maximum VOC limit 250 g/L to Standard GS-11.
- .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 to SCAQMD Rule 1113.

.2 Sealants: maximum VOC limit to GSES GS-36.

.3 Sealants: maximum VOC limit to GSES GS-36.

.4 Adhesives: maximum VOC limit to GSES GS-36.

.5 Fire Stopping: ULC listed to intended application.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CAN/CSA B149.1.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer & CAN/CSA B149.1 as indicated without interrupting operation of other system, equipment, components.

3.4 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.

3.4 DRAINS (Cont'd)

.3 Pipe each drain valve discharge separately to above floor drain.
.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 DIELECTRIC COUPLINGS

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

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

3.6 PIPEWORK INSTALLATION

.1 Install pipework to CAN/CSA B149.1.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.8 Slope steam piping, except where indicated, in direction of flow for positive drainage and complete removal of condensate.

.9 Install to permit separate thermal insulation of each pipe.

.10 Group piping wherever possible and as indicated.

.11 Ream pipes, remove scale and other foreign material before assembly.

.12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.13 Provide for thermal expansion.

.14 Valves:
.1 Install in accessible locations.
.2 Remove interior parts before soldering.
.3 Install with stems above horizontal position unless indicated.
.4 Valves accessible for maintenance without removing adjacent piping.
.5 Install globe valves in bypass around control valves.

.15 Check Valves:
.1 Install silent check valves on discharge of pumps with downward flow and as indicated.

3.6 PIPEWORK INSTALLATION (Cont'd)

.15 Check Valves:(Cont'd)
.2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.7 SLEEVES

.1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:
.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
.2 Other floors: terminate 25 mm above finished floor.
.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:
.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
.2 Elsewhere:
.1 Provide space for firestopping.
.2 Maintain fire rating integrity.
.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
.4 Ensure no contact between copper pipe or tube and sleeve.

3.8 ESCUTCHEONS

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

.2 Construction: one piece type with set screws.
.1 Chrome or nickel plated brass or type 302 stainless steel..

.3 Sizes: outside diameter to cover opening or sleeve.
.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.9 PREPARATION FOR FIRE STOPPING

.1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with listing requirements.

.2 Uninsulated unheated pipes not subject to movement: no special preparation.

.3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging fires topping material or installation.

.4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.10 FLUSHING OUT OF PIPING SYSTEMS

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

.2 Before start-up, clean and flush interior of piping systems to remove manufacturing residue and debris resulting from installation practices to acceptance of Departmental Representative.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Departmental Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.12 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Departmental Representative.

.2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

3.13 CLEANING

.1 Clean in accordance with Section 01 00 10 - General Instructions.
.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse and recycling where possible and in accordance with Section 01 00 10 - General Instructions.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 17 - Pipe Welding.

.2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

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 and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Manufacturer, model number, line contents, pressure and temperature rating.

.2 Movement handled, axial, lateral, angular and the amounts of each.

.3 Nominal size and dimensions including details of construction and assembly.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance and operation data in accordance with Section 01 00 10 - General Instructions.

.2 .1 Data to include:

.1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 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.

PART 2 - PRODUCTS

2.1 BELLOWS TYPE EXPANSION JOINTS

.1 For axial movements.

.2 Maximum operating pressure: 1380 kPa.

.3 Maximum operating temperature: 180°C.

.4 Type A: controlled flexing, factory tested to 1½ times maximum working pressure. Provide test certificates.

.5 Bellows:

.1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

2.1 BELLOWS TYPE EXPANSION JOINTS (Cont'd)

.6 Reinforcing or control rings:
- .1 2 piece nickel iron.
- .2 Self equalizing.

.7 Ends:
- .1 Flanges to match pipe.

.8 Liner:
- .1 Austenitic stainless steel in direction of flow.

.9 Shroud:
- .1 Carbon steel, painted.

.10 Compression: 125 mm.

2.2 ANCHORS AND GUIDES

.1 Anchors:
- .1 Provide as indicated, attached to building structure to accommodate imposing stresses.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

.2 Alignment guides:
- .1 Provide as indicated and in accordance with expansion joint manufacturer's recommendations.
- .2 To accommodate specified thickness of insulation.
- .3 Vapour barriers, jackets to remain uninterrupted.

2.3 FLEXIBLE CONNECTION

.1 Application: to accommodate differential motion (sinking/lifting) of piping supported off floating slab on grade or post in footings and off building structure.

.2 Minimum length in accordance with manufacturer's recommendations to suit independent movement of supporting elements.

.3 Inner hose: stainless steel corrugated.

.4 Braided wire mesh stainless steel outer jacket.

.5 Diameter and type of end connection: flanged as indicated.

.6 Operating conditions (for steam service):
- .1 Working pressure: 1380 kPa.
- .2 Working temperature: 180°C.

.7 Operating conditions (other systems):
- .1 To match system requirements.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install expansion joints with cold setting, minimum 15°C. Make record of cold settings.

.2 Install expansion joints, guides and anchors in accordance with manufacturer's instructions.

.3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

.4 Do welding in accordance with Section 23 05 17 - Pipe Welding.

3.3 PIPE CLEANING AND START-UP

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

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 17 - Pipe Welding.

.2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

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 and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Manufacturer, model number, line contents, pressure and temperature rating.

.2 Movement handled, axial, lateral, angular and the amounts of each.

.3 Nominal size and dimensions including details of construction and assembly.

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance and operation data in accordance with Section 01 00 10 - General Instructions.

.2 .1 Data to include:

.1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 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.

PART 2 - PRODUCTS

2.1 BELLOWS TYPE EXPANSION JOINTS

.1 For axial movements.

.2 Maximum operating pressure: 1380 kPa.

.3 Maximum operating temperature: 180°C.

.4 Type A: controlled flexing, factory tested to 1½ times maximum working pressure. Provide test certificates.

.5 Bellows:

.1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.

2.1 BELLOWS TYPE EXPANSION JOINTS (Cont'd)

.6 Reinforcing or control rings:
- .1 2 piece nickel iron.
- .2 Self equalizing.

.7 Ends:
- .1 Flanges to match pipe.

.8 Liner:
- .1 Austenitic stainless steel in direction of flow.

.9 Shroud:
- .1 Carbon steel, painted.

.10 Compression: 125 mm.

2.2 ANCHORS AND GUIDES

.1 Anchors:
- .1 Provide as indicated, attached to building structure to accommodate imposing stresses.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

.2 Alignment guides:
- .1 Provide as indicated and in accordance with expansion joint manufacturer's recommendations.
- .2 To accommodate specified thickness of insulation.
- .3 Vapour barriers, jackets to remain uninterrupted.

2.3 FLEXIBLE CONNECTION

.1 Application: to accommodate differential motion (sinking/lifting) of piping supported off floating slab on grade or post in footings and off building structure.

.2 Minimum length in accordance with manufacturer's recommendations to suit independent movement of supporting elements.

.3 Inner hose: stainless steel corrugated.

.4 Braided wire mesh stainless steel outer jacket.

.5 Diameter and type of end connection: flanged as indicated.

.6 Operating conditions (for steam service):
- .1 Working pressure: 1380 kPa.
- .2 Working temperature: 180°C.

.7 Operating conditions (other systems):
- .1 To match system requirements.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install expansion joints with cold setting, minimum 15°C. Make record of cold settings.

.2 Install expansion joints, guides and anchors in accordance with manufacturer's instructions.

.3 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.

.4 Do welding in accordance with Section 23 05 17 - Pipe Welding.

3.3 PIPE CLEANING AND START-UP

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

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B31.1-2012, Power Piping.
- .2 ASME B31.3-2012, Process Piping.
- .3 ASME Boiler and Pressure Vessel Code-2013:
  - .1 BPVC 2013 Section I: Power Boilers.
  - .2 BPVC 2013 Section V: Nondestructive Examination.
  - .3 BPVC 2013 Section IX: Welding and Brazing Qualifications.

.2 American Water Works Association (AWWA)
- .1 AWWA C206-11, Field Welding of Steel Water Pipe.

.3 American Welding Society (AWS)
- .1 AWS C1.1M/C1.1-2000(R2012), Recommended Practices for Resistance Welding.
- .2 AWS B2.1/B2.1M:2009, Welding Procedure and Performance Qualification.

.4 Canadian Standards Association (CSA International)
- .1 CSA W47.2-11, Certification of Companies for Fusion Welding of Aluminum.
- .2 CSA W48-06 (R2011), Filler Metals and Allied Materials for Metal Arc Welding.
- .3 CSA B51-09, Boiler, Pressure Vessel and Pressure Piping Code.
- .4 CSA-W117.2-12, Safety in Welding, Cutting and Allied Processes.
- .5 CSA W178.1-08 (R2013), Certification of Welding Inspection Organizations.
- .6 CSA W178.2-08 (R2013), Certification of Welding Inspectors.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

.1 Qualifications:
- .1 Welders:
  - .1 Welding qualifications in accordance with CSA B51.
  - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
  - .3 Submit welder's qualifications to Departmental Representative.
  - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
  - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
  - .1 Inspectors qualified to CSA W178.2.
- .3 Certifications:
  - .1 Registration of welding procedures in accordance with CSA B51.
  - .2 Copy of welding procedures available for inspection.
  - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.4 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's name, address.

PART 2 - PRODUCTS

2.1 ELECTRODES

.1 Electrodes: in accordance with CSA W48 Series.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 QUALITY OF WORK

.1 Welding: in accordance with ASME B31.1, ASME B31.3, ASME Boiler and Pressure Vessel Code, Sections I and IX and AWWA C206, using procedures conforming to AWS B2.1, AWS C1.1, applicable requirements of provincial authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

.1 Identify each weld with welder's identification symbol.

.2 Backing rings:
- .1 Where used, fit to minimize gaps between ring and pipe bore.
- .2 Do not install at orifice flanges.

.3 Fittings:
- .1 NPS 2 and smaller: install welding type sockets.
- .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

.1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.

.2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.

.3 Do not conceal welds until they have been inspected, tested and approved by inspector.

.4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

.1 General:
- .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
- .2 To ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .3 Inspect and test welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and gamma ray radiographic (hereinafter referred to as "radiography") tests.

.2 Hydrostatically test welds to ASME B31.1 1.5 times max. working pressure and maintain test for minimum 24 hours without loss. Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure. Bear costs for tests, for repairs or replacement, retesting and making good. Insulate or conceal work only following approval or certification of tests.

.3 Visual examinations: 100% of welds include entire circumference of weld externally and wherever possible internally.

.4 Failure of visual examinations:
- .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative of up to 10% of welds, selected at random by Departmental Representative by radiographic tests.

.5 Full radiographic tests for steam and condensate piping systems.
- .1 Full radiography:
  - .1 Conduct radiographic tests of 10% of welds, selected at random by Departmental Representative from welds which would be most difficult to repair in event of failure after system is operational.
- .2 Radiographic film:
  - .1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality.
- .3 Interpretation of radiographic films:
  - .1 By qualified radiographer.
- .4 Failure of radiographic tests:
  - .1 Extend tests to welds by welder responsible when those welds fails tests.

3.6 DEFECTS CAUSING REJECTION

.1 As described in ASME B31.1 and ASME Boiler and Pressure Vessels Code.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

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

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 25 05 01 - EMCS: General Requirements.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
.1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition 1971.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 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.

PART 2 - PRODUCTS

2.1 ACCURACY

.1 Calculate overall accuracy of each installation using following expression: Overall accuracy = (E (accuracy of individual components of system)^2)1/2.

.2 Components to include:
.1 Primary flow measuring elements.
.2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
.3 RTD's.
.4 Signal processors, recorders.
.5 Calibration of signal processors: assume 0.20% per processor.
.6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.

.3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.

.4 Indicate minimum measurable flow rate.

2.2 STEAM METERING

.1 Type of metering:
.1 Vortex flow meter - pressure and temperature compensated.

.2 Design data:
.1 100% Design flow rate: 1040 kPa, 172 degrees C.
.2 Normal design flow rate: 70% of 100% design flow rate.
.3 Minimum flow rate: 3% of maximum.
.4 Design differential pressure at normal design flow rate: 25 kPa.

2.2 STEAM METERING (Cont'd)

.3 Maximum accuracy of complete meter installation at 70% design flow rate: plus or minus 1.5%.

.4 Measuring principle: Karman vortex street.

.5 Primary measuring at separated vortices aid secondary measuring at operating and standard volumetric flow and mass flow.

.6 Flanged with integrated pressure and temperature measurements using remote signal converter and display. Pressure sensor to have valved isolation.

.7 Measuring sensor and process connections to be 316 L stainless steel.

.8 Power: 24 VDC
Signal: pulse output

.9 Must be compatible with existing base building automation system. Refer to Section 25 05 01 - EMCS: General Requirements.

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 PREPARATION

.1 Before final calculations for orifice diameter, and before purchase of orifice plate, nozzle, venturi, measure:
.1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
.2 For concentricity of pipe.

3.3 INSTALLATION OF PRIMARY ELEMENT

.1 Follow manufacturer's instructions. Provide pipe reducers to suit meter size.

3.4 INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF PRIMARY ELEMENT

.1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

3.5 INSTALLATION OF SIGNAL TRANSMISSION CABLE

.1 Ground shielding at one point only.

.2 Protect against RF interference.

.3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

3.6 START-UP .1 Follow manufacturer's recommendations.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B40.100-2005, Pressure Gauges and Gauge Attachments.
- .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 GENERAL

.1 Design point to be at mid-point of scale or range.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length: to CAN/CGSB-14.4 & ASME B40.200.
- .1 Resistance to shock and vibration.

2.3 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: stainless steel.

2.4 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified

.2 Provide:
- .1 Siphon for steam service.
- .2 Snubber for pulsating operation.
- .3 Diaphragm assembly for corrosive service.
- .4 Gasketted pressure relief back with solid front.
- .5 Bronze stop cock.

PART 3 - EXECUTION

3.1 GENERAL .1 Install thermometers and gauges so they can be easily read from floor or platform.
.1 If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS .1 Install in wells on piping. Include heat conductive material inside well.

.2 Install in locations as indicated and on inlet and outlet of:
.1 Feed water reciever.

.3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES1 Install in locations as follows:
.1 Suction and discharge of pumps.
.2 Upstream and downstream of PRV's.
.3 Upstream and downstream of control valves.
.4 Inlet and outlet of coils.
.5 Outlet of boilers.
.6 In other locations as indicated.

.2 Install dual gauge cocks for balancing purposes.

.3 Use extensions where pressure gauges are installed through insulation.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
- .2 ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.

.2 ASTM International
- .1 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
- .1 MSS-SP-80-2013, Bronze Gate Globe, Angle and Check Valves.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for incorporation into manual specified in Section 01 00 10 - General Instructions.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:
- .1 Furnish following spare parts:
  - .1 Valve seats: one for every 10 valves each size, minimum 1.
  - .2 Discs: one for every 10 valves, each size. Minimum 1.
  - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
  - .4 Valve handles: 2 of each size.
  - .5 Gaskets for flanges: one for every 10 flanged joints.
- .2 Tools:
  - .1 Furnish special tools for maintenance of systems and equipment.
  - .2 Include following:
    - .1 Lubricant gun for expansion joints.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Valves:
- .1 Except for specialty valves, to be single manufacturer.
- .2 Products to have CRN registration numbers.

.2 End Connections:
- .1 Connection into adjacent piping/tubing:
  - .1 Steel pipe systems: screwed ends to ASME B1.20.1.
  - .2 Copper tube systems: solder ends to ASME B16.18.

.3 Gate Valves:
- .1 Requirements common to gate valves, unless specified otherwise:
  - .1 Standard specification: MSS SP-80.
  - .2 Bonnet: union with hexagonal shoulders.
  - .3 Connections: screwed with hexagonal shoulders.
  - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic Type 2.
  - .5 Packing: non-asbestos.
  - .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
- .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
  - .1 Body: with long disc guides, union bonnet, integral bronze seat.
  - .2 Operator: handwheel.

.4 Globe Valves:
- .1 Requirements common to globe valves, unless specified otherwise:
  - .1 Standard specification: MSS SP-80.
  - .2 Bonnet: union with hexagonal shoulders.
  - .3 Connections: screwed with hexagonal shoulders.
  - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
  - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
  - .6 Handwheel: non-ferrous.
  - .7 Handwheel Nut: bronze to ASTM B62.
- .2 Angle valve, NPS 2 and under, composition disc, Class 150:
  - .1 Body and bonnet: union bonnet.
  - .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
  - .3 Operator: lockshield or actuator.

.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 NPS 2 and under, swing type, composition disc, Class 200:
  - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
  - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.

.6 Silent Check Valves:
- .1 NPS 2 and under:
  - .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
  - .2 Pressure rating: Class 150.

2.1 MATERIALS (Cont'd)

.6 Silent Check Valves:(Cont'd)
- .1 NPS 2 and under:(Cont'd)
  - .3 Connections: screwed ends to ASME B1.20.1 and with hex. shoulders.
  - .4 Disc and seat: renewable rotating disc.
  - .5 Stainless steel spring, heavy duty.
  - .6 Seat: regrindable.

.7 Ball Valves: Domestic water service only.
- .1 NPS 2 and under:
  - .1 Body and cap: cast high tensile bronze to ASTM B62.
  - .2 Pressure rating: Class 125 2760-kPa CWP, 860 kPa steam.
  - .3 Connections: solder ends to ASME.
  - .4 Stem: tamperproof ball drive.
  - .5 Stem packing nut: external to body.
  - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
  - .7 Stem seal: TFE with external packing nut.
  - .8 Operator: removable lever handle.

PART 3 - EXECUTION

3.1 INSTALLATION

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

.2 Remove internal parts before soldering.

.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.2 CLEANING

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
- .2 ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
- .3 ASME B16.25-2012, Buttwelding Ends.
- .4 ASME B16.34-2013, Valves Flanged, Threaded and Welding End. Includes Supplement (2010).

.2 American Petroleum Institute (API)
- .1 API STD 598-2009, Valve Inspection and Testing.

.3 ASTM International
- .1 ASTM A49-12, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
- .2 ASTM A182/A182M-13, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
- .3 ASTM A193/A193M-12b, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
- .4 ASTM A194/A194M-12a, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
- .5 ASTM A216/A216M-12, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
- .6 ASTM B85/B85M-10e1, Standard Specification for Aluminum-Alloy Die Castings.

.4 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
- .1 MSS SP-25-2008, Standard Marking System for Valves, Fittings, Flanges and Unions.
- .2 MSS SP-61-2013, Pressure Testing of Valves.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 00 10 - General Instructions.

.2 Extra Stock Materials:

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

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Valves:
- .1 To be of single manufacturer.
- .2 Test valves individually.

.2 Requirements common to valves, unless specified otherwise:
- .1 Pressure-temperature ratings: to ASME B16.34.
- .2 Inspections and tests: to API 598.
- .3 Pressure testing: to MSS SP-61.
- .4 Flanged valves:
  - .1 Face-to-face dimensions: to ASME B16.10.
  - .2 Flange dimensions: to ASME B16.5 with 1.6 mm raised face.
- .5 Butt-weld valves:
  - .1 End-to-end dimensions: to ASME B16.10.
  - .2 End dimensions: to ASME B16.25 bored for standard pipe schedule.
- .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
- .7 Markings: to MSS SP-25.
- .8 Identification:
  - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
  - .2 Body markings: manufacturer, size, primary service rating, material symbol.
- .9 CRN registration number required for all products.

2.2 GATE VALVES

.1 NPS 2-1/2 - 12, rising stem, OS&Y, flexible wedge disc, flanged ends, Class 150:
- .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.
- .2 Body/bonnet joint: flat face with corrugated metallic gasket.
- .3 Bonnet studs: to ASTM A193/A193M Type B7.
- .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
- .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
- .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
- .7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.
- .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
- .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
  - .1 NPS 2 1/2 - 6: solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
  - .2 NPS 8 and larger: carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.
- .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: see elsewhere in this Section.

2.3 GLOBE VALVES .1 NPS 2-1/2 - 12, rising stem, OS&Y, flanged ends, Class 150:
- .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.
- .2 Body/bonnet joint: flat face with corrugated metallic gasket.
- .3 Bonnet studs: to ASTM A193/A193M Type B7.
- .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
- .5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.
- .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
- .7 Yoke bushing: Ni-Resist, minimum melting point above 954 degrees C.
- .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
- .9 Disc: plug type with 15 degrees taper seat and bottom guide.
- .10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
- .12 Operator: see elsewhere in this Section.

2.4 VALVE OPERATORS .1 Handwheel: on all valves.

.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.

.3 Motors:
- .1 Application: full open and full close applications.
- .2 Position and precision control.

2.5 BYPASSES FOR GATE AND GLOBE VALVES .1 Locations: on main valve to building.

.2 Size of bypass valve:
- .1 Main valve up to NPS 8: NPS 3/4.
- .2 Main valve NPS 10 and over: NPS 1.

.3 Type of bypass valves:
- .1 On gate valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze.
- .2 On globe valve: globe, with composition disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze.

2.6 CHECK VALVES .1 NPS 2 1/2 and over, flanged ends, Class 150: swing check.
- .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
- .2 Cap studs: to ASTM A193/A193M Type B7.
- .3 Cap nuts: to ASTM A194/A194M Type 2H.
- .4 Body/cap joint: male-female face with corrugated metallic gasket.
- .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
- .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
- .7 Hinge: ASTM A182/A182M.
- .8 Hinge pin: ASTM A182/A182M.
- .9 Hinge pin plugs: ASTM A182/A182M.

2.7 SILENT CHECK VALVES

.1 .Construction:
- .1 Body: cast steel with integral seat.
- .2 Pressure rating: Class 250.
- .3 Connections: flanged ends.
- .4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.
- .5 Stainless steel spring, heavy duty.
- .6 Seat: regrindable.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.2 COMMISSIONING

.1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.3 PROTECTION

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

.2 Repair damage to adjacent materials caused by cast steel valve installation.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B1.20.2M-2006, Pipe Threads, 60 deg. General Purpose (Metric).
- .2 ASME B16.1-2010, Grey Iron Pipe Flanges and Flanged Fittings. Classes 25, 125, and 250.
- .3 ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.

.2 ASTM International
- .1 ASTM A126-04(2009), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.3 Canadian Registration Number (CRN)

.4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
- .1 MSS SP-78-2011, Cast Iron Plug Valves, Flanged and Threaded Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MATERIAL

.1 Valves:
- .1 To be of single manufacturer.
- .2 Ensure products have CRN registration number.

2.2 LUBRICATED PLUG VALVES

.1 Principle of operation:
- .1 Special sealing compound used to effect tight seal. When line pressure applied to valve in closed position, parallel plug forced against downstream side of valve. Metal-to-metal contact and sealing compound ensures leak-tight seal.

.2 Testing: to MSS SP-78 for non-shock pressure as per manufacturer's recommendations.

.3 End connections:
- .1 NPS ½ to 2: screwed ends.
- .2 NPS 2½ to 12: flanged ends.

.4 Valve:
- .1 Body: cast iron to ASTM A126 Class B semi-steel.
- .2 Pressure rating: NPS ½ to 12:
  - .1 Screwed end valves: screwed to NPT standards.

2.2 LUBRICATED PLUG VALVES (Cont'd)

.4 Valve:(Cont'd)
- .2 Pressure rating:(Cont'd)
  - .2 Flanged end valves: flanged to ASME B16.1 Class 125, 125 psig at 232 degrees C. Flanged valves NPS 2-8 face dimensions in accordance with ASME B16.10 short pattern, making them interchangeable with Class 250 flanged cast iron gate valves.
  - .3 Hydrostatic tests: body 300 psig. Seat: 100 psig.
- .3 Plug: cylindrical with regular pattern port - 90 degrees from full open to full closed, complete with PFTE thrust ring: 100% full port.
- .4 Ends: with hexagon shoulders, ends screwed to ASME B1.20.2M.
- .5 Lubrication system, nickel-plated.
- .6 Lubricant: to suit type, temperature and pressure of contained fluid.
- .7 Include sealing compound injection gun designed for use with pre-packed sealing compound cartridges and valve fitted with button head nipples and combination sealing screws.
- .8 Feeding system: lubricant forced into lubrication grooves between seating surfaces of plug and body to form positive seal, leak proof operation, and corrosion preventing film.
  - .1 Ensure lubricant receptacle can hold additional lubricant.
  - .2 Include lubricant screw for lubrication.
  - .3 Include check valve to prevent reverse flow of lubricant.
  - .4 Include O-rings between body and plug.

.5 Operator:
- .1 Up to NPS 5: manual lever.
- .2 NPS 6 - 8: CGA approved gear-operated handwheel.

.6 3-port and 4 port valves:
- .1 Supply with transflow pattern.
- .2 Include limit stops.

PART 3 - EXECUTION

3.1 INSTALLATION OF LUBRICATED PLUG VALVES

.1 Install with line pressure acting to hold plug against body ports.
- .1 Cut off from higher pressure.

3.2 COMMISSIONING OF LUBRICATED PLUG VALVES

.1 Determine type of sealing compound for particular application.

.2 Ensure even distribution of sealing compound and tight shut-off by opening and closing valve 3 times minimum.

.3 Ensure that plug is free to float when operating valve by easing valve off body.

.4 Determine frequency of re-lubrication during commissioning of remainder of system.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 - Cast-in-Place Concrete.

.2 Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B31.1-07, Power Piping.

.2 ASTM International
- .1 ASTM A125-96(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
- .2 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.

.3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
- .1 MSS SP 58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

.4 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

.1 Design Requirements:
- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP 58.
- .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 SP 58.

.2 Performance Requirements:
- .1 Design supports, platforms, catwalks, hangers to withstand seismic events as specified Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.

2.2 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58 and ANSI B31.1.

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

2.3 PIPE HANGERS

.1 Finishes:
- .1 Pipe hangers and supports: galvanized after manufacture.
- .2 Ensure steel hangers in contact with copper piping are copper plated.

.2 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 SP 58.

.3 Shop and field-fabricated assemblies:
- .1 Trapeze hanger assemblies: to be designed by contractor's engineer.
- .2 Steel brackets: to be designed by contractor's engineer.
- .3 Sway braces for seismic restraint systems: in accordance with contractor's seismic engineer requirements.
- .4 Departmental Representative reserves the right to request fabrication drawings and calculations from professional engineer for all shop or field fabricated assemblies.

.4 Hanger rods: threaded rod material to MSS SP 58:
- .1 Ensure that hanger rods are subject to tensile loading only.
- .2 Provide linkages where lateral or axial movement of pipework is anticipated.

.5 Pipe attachments: material to MSS SP 58:
- .1 Attachments for steel piping: carbon steel galvanized.
- .2 Attachments for copper piping: copper plated black steel.
- .3 Use insulation shields for hot pipework.
- .4 Oversize pipe hangers and supports.

.6 Adjustable clevis: material to MSS SP 58 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.

.7 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 58.

.8 U-bolts: carbon steel to MSS SP 58 with 2 nuts at each end to ASTM A563.
- .1 Finishes for steel pipework: galvanized.

.9 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 58.

2.4 RISER CLAMPS

.1 Steel or cast iron pipe: galvanized carbon steel to MSS SP 58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS SP 58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.5 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:
.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP 58, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:
.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP 58.

2.6 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.7 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Div. 05.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 150 mm larger than equipment; chamfer pad edges. Refer to structural drawings for details.

.2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.10 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel meeting requirements of Div. 05.

.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 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.

3.3 HANGER SPACING

.1 Plumbing piping: to Canadian Plumbing Code and authority having jurisdiction.

.2 Fire protection: to applicable fire code.

.3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.

.4 Copper piping: up to NPS 1/2: every 1.5 m.

.5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.

.6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m

3.3 HANGER SPACING (Cont'd)

.6 (Cont'd)

5	4.3 m
6	4.3 m
8	4.3 m
10	4.9 m
12	4.9 m

.7 Pipework greater than NPS 12: to MSS SP 58.

3.4 HANGER INSTALLATION

.1 Install hanger so that rod is vertical under operating conditions.

.2 Adjust hangers to equalize load.

.3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

.1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.

.2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

.1 Adjust hangers and supports:
- .1 Ensure that rod is vertical under operating conditions.
- .2 Equalize loads.

.2 Adjustable clevis:
- .1 Tighten hanger load nut securely to ensure proper hanger performance.
- .2 Tighten upper nut after adjustment.

.3 C-clamps:
- .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.

.4 Beam clamps:
- .1 Hammer jaw firmly against underside of beam.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 - Cast-in-Place Concrete.

.2 Section 23 05 49.01 - Seismic Restraint Systems (SRS) - Type P2 Buildings.

1.2 REFERENCES

.1 National Electric Code - NEC 1996, Section 427-23.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

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

1.4 QUALITY ASSURANCE

.1 Health and Safety:

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

1.5 ELECTRICAL

.1 Electrical work to conform to Division 26 including the following:

.1 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Div. 21, 22, 23 & 25. Refer to Division 26 for quality of materials and workmanship.

PART 2 - PRODUCTS

2.1 PIPE TRACING HEATING CABLES

.1 General:

.1 Furnish and install a complete ULC Listed and CSA Certified system of heating cables, components, and controls to prevent pipes from freezing.

.2 Products:

.1 The self-regulating heating cable shall consist of two (2) 14 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, fluoropolymer dielectric jacket. To provide a ground path and to enhance the heating cable's ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of high temperature fluoropolymer section 427-23 of the NEC.

.2 In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90%. The self-regulating factor is defined as the percentage reduction, without thermostatic control, of the heating cable output going from 4.4°C pipe temperature operation to 65.6°C pipe temperature operation.

.3 The heating cable shall operate on line voltages of 120 volts without the use of transformers.

2.1 PIPE TRACING HEATING CABLES (Cont'd) (Cont'd)

.2 Products:(Cont'd)

.4 The heating cable for metal pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in watts per metre at 10°C.

Pipe Size (NPS)	Minimum Ambient Temperature -17°C (0°F)	-29°C (-20°F)
3 or less	16 watts	16 watts
4	16 watts	16 watts
6	26 watts	26 watts
8	26 watts	2 strips - 16 watts
10	2 strips - 16 watts	2 strips - 26 watts

.5 Heating-cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC.

.3 Components:

.1 All heating-cable components snail be UL Listed and CSA Certified, for use as part of the system to provide pipe freeze protection. Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires, or that use crimps or terminal blocks, shall not be acceptable. All components that make an electrical connection shall be re-enterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

.4 System Control:

.1 Thermostatic Control - Ambient Sensing: The system shall be controlled by an ambient sensing thermostat set at 4.4°C (40°F).

.5 Power connection, end seal, splice, outer jacket repair kits shall be applied in the field.

.6 Thermostat:

.1 The system shall be controlled by a thermostat either directly or through an appropriate contactor.

.7 Circuit Breaker:

.1 The system shall be protected by a ground fault circuit breaker with a 30 milliamp trip.

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 System must be installed per manufacturer's recommendations.

.2 Apply the heating cable linearly on the pipe after piping has been successfully pressure-tested. Secure the heating cable to piping with cable ties or fibreglass tape.

.3 Apply "Electric Traced" labels to the outside of the thermal insulation.

3.2 INSTALLATION (Cont'd)

.4 Distribute and fasten cable evenly on pipe using pipe strap or tape at maximum spacing 0.5 m. Ensure that heating cables do not touch or cross each other at any point. Run only cold leads in conduit and ensure sensing bulb does not touch cable. Ground shield to building ground. Coordinate cable installation with insulation application. Loop additional cable at fittings, valves, and flanges.

.5 Make power and control connections.

3.3 TESTS

.1 After insulation and before and after installing the thermal insulation, subject heating cable to testing using a 2500 Vdc Megger. Minimum insulation resistance shall be 20 megohms or greater.

.2 Where resistance of 50 megohms or less is measured, stop work and advise Departmental Representative.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 National Research Council Canada (NRCC)
- .1 NRCC NBCC-2010, National Building Code of Canada 2010.

1.2 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.

1.3 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 Ontario.

1.4 ACTION AND INFORMATIONAL 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 design data including:
- .1 Full details of design criteria.
- .2 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).
- .3 Separate shop drawings for each SRS and devices for each system, equipment.
- .4 Identification of location of devices.
- .5 Schedules of types of SRS equipment and devices.
- .6 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
- .7 Installation procedures and instructions.

1.5 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 SRS MANUFACTURER

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

2.2 GENERAL

.1 SRS to provide gentle and steady cushioning action and avoid high impact loads.

.2 SRS to restrain seismic forces in every direction.

.3 Fasteners and attachment points to resist same load as seismic restraints.

.4 SRS of Piping systems compatible with:
- .1 Expansion, anchoring and guiding requirements.
- .2 Equipment vibration isolation and equipment SRS.

.5 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.

.6 Attachments to RC structure:
- .1 Use high strength mechanical expansion anchors.
- .2 Drilled or power driven anchors not permitted.

.7 Seismic control measures not to interfere with integrity of firestopping.

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 Departmental 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.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT (Cont'd)

.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.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Attachment points and fasteners:
- .1 To withstand same maximum load that seismic restraint is to resist and in every direction.

.2 Slack Cable Systems (SCS):
- .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
- .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
- .3 Piping systems: provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
- .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
- .5 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
- .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
- .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.

.3 Install SRS at least 25 mm from equipment, systems, services.

.4 Miscellaneous equipment not vibration-isolated:
- .1 Bolt through house-keeping pad to structure.

.5 Co-ordinate connections with other disciplines.

.6 Vertical tanks:
- .1 Anchor through house-keeping pad to structure.
- .2 Provide steel bands above centre of gravity.

3.2 INSTALLATION (Cont'd)

.7 Horizontal tanks:
.1 Provide at least two straps with anchor bolts fastened to structure.

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 Departmental Representative with certificate of compliance.

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

END

PART 1 - GENERAL

1.1 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CSA B149.1-10, Natural Gas and Propane Installation Code.

.2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-24.3-92, Identification of Piping Systems.

.3 National Fire Protection Association (NFPA)
- .1 NFPA (Fire) 13, Standard for the Installation of Sprinkler Systems, 2013 Edition.
- .2 NFPA (Fire) 14, Standard for the Installation of Standpipe and Hose Systems, 2013 Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:
- .1 Equipment: manufacturer's name, model, size, serial number, capacity.
- .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

.4 Where nameplates are buried by insulation, provide duplicate nameplate on insulation.

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.

2.2 SYSTEM NAMEPLATES (Cont'd)

.3 Sizes:
.1 Conform to following table:

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

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

.4 Identification for PWGSC Preventive Maintenance Support System (PMSS):
.1 Use arrangement of Main identifier, Source identifier, Destination identifier.
.2 Equipment in Mechanical Room:
.1 Main identifier: size #9.
.2 Source and Destination identifiers: size #6.
.3 Terminal cabinets, control panels: size #5.
.3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

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

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

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:
.1 Natural gas: to CSA B149.1 and authority having jurisdiction.
.2 Sprinklers: to NFPA (Fire) 13.
.3 Standpipe and hose systems: to NFPA (Fire) 14.

2.5 IDENTIFICATION OF PIPING SYSTEMS

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

2.5 IDENTIFICATION OF PIPING SYSTEMS (Cont'd)

.4 Arrows showing direction of flow:(Cont'd)
- .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 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 Departmental Representative.
- .2 Colours for legends, arrows: to following table:

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

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

Contents	Background colour marking	Legend
Treated water	Green	TREATED WATER
Brine	Green	BRINE
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
Steam [_____] kPa	Yellow	[_____] kPa STEAM
Steam condensate (gravity)	Yellow	ST.COND.RET (GRAVITY)
Steam condensate (pumped)	Yellow	ST.COND.RET (PUMPED)
Safety valve vent	Yellow	STEAM VENT
Intermittent blow-off	Yellow	INT. BLOW-OFF
Continuous blow-off	Yellow	CONT. BLOW-OFF
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Natural gas	to Codes painted Yellow	
Gas regulator vents	to Codes painted yellow	

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

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

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

2.9 LANGUAGE
.1 Identification in English.

PART 3 - EXECUTION

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

3.2 TIMING
.1 Provide identification only after painting has been completed.

3.3 INSTALLATION
.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
.2 Provide ULC and CSA registration plates as required by respective agency.
.3 Identify systems, equipment to conform to PWGSC PMSS.

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

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 VALVES, CONTROLLERS

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

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

.3 Number valves in each system consecutively.

END

PART 1 - GENERAL

1.1 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.2 EXCEPTIONS

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

1.3 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.

1.4 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.5 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.

1.6 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

1.7 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

1.7 START OF TAB (Cont'd)

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
- .1 Proper thermal overload protection in place for electrical equipment.
- .2 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.

1.8 ACCURACY TOLERANCES

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

1.9 INSTRUMENTS

.1 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.2 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative if requested.

1.10 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, 10 days prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB.

1.11 PRELIMINARY TAB REPORT

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

1.12 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30% of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.13 SETTINGS

.1 After TAB is completed to satisfaction of Departmental 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.

1.14 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.15 SYSTEMS

.1 Steam systems: Include both specified and measured data.
- .1 Boilers
- .2 Condensate pumps
- .3 Feed water pumps and associated controls
- .4 Water treatment system
- .5 Level controllers
- .6 Blowdown controllers
- .7 SRV's (existing and new)
- .8 PRV's (existing and new)

.2 Air systems:
- .1 Take predemolition readings on affected air handling unit including airflows on branches being removed.
- .2 Rebalance fans (allow for belt and sheave replacement) to airflow at remaining branches.

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 ASTM International Inc.
- .1 ASTM B209M-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- .2 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
- .3 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .4 ASTM C553-11, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .5 ASTM C612-10, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .6 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.2 Green Seal Environmental Standards (GSES)
- .1 Standard GS-36-11, Commercial Adhesives.

.3 Thermal Insulation Association of Canada (TIAC)
- .1 National Insulation Standards 2005.

.4 Underwriters Laboratories of Canada (ULC)
- .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:
- .1 Maximum flame spread rating: 25.
- .2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
- .1 Mineral fibre: ASTM C547.
- .2 Maximum "k" factor: ASTM C547.

.4 TIAC Code C-1: rigid mineral fibre board, unfaced.
- .1 Mineral fibre: ASTM C612.
- .2 Maximum "k" factor: ASTM C612.

2.3 CEMENT

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

2.4 JACKETS

.1 Canvas:
- .1 220 and 120 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.

.2 Aluminum:
- .1 To ASTM B209.
- .2 Thickness: 0.50 mm sheet.
- .3 Finish: stucco embossed.
- .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, reinforced, 75 mm wide minimum.

.2 Contact adhesive: quick setting.
- .1 Maximum VOC limit 80 g/L GSES GS-36.

.3 Tie wire: 1.5 mm diameter stainless steel.

.4 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.5 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation.

.6 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards
- .1 Hot equipment: To TIAC code 1503-H.

.2 Elastomeric Insulation:to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

.5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
- .1 Hangers, supports outside vapour retarder jacket.

.7 Supports, Hangers:
- .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

.2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Hot Equipment:
- .1 TIAC code A-1 with bands and 13 mm cement reinforced with one layer of reinforcing mesh.
- .2 TIAC code C-2 unfaced with bands and 13 mm cement precede by one layer of reinforcing mesh.

3.5 EQUIPMENT INSULATION SCHEDULES (Cont'd)

.2 Hot Equipment:(Cont'd)
.3 Thicknesses:
.1 Flash tank: 50 mm
.2 Steam condensate receivers: 50 mm

.3 Finishes:
.1 Equipment in mechanical rooms: TIAC code CEF/1 with aluminum jacket.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM B209M-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
- .2 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
- .3 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .4 ASTM C921-10, 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 Manufacturer's Trade Associations
- .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.4 Underwriters' Laboratories of Canada (ULC)
- .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S702-09, Thermal Insulation, Mineral Fibre, for Buildings.

1.2 DEFINITIONS

.1 For purposes of this section:
- .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
- .2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:
- .1 CRF: Code Rectangular Finish.
- .2 CPF: Code Piping Finish.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
- .1 Mineral fibre: to CAN/ULC-S702.
- .2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
- .1 Mineral fibre: to CAN/ULC-S702.
- .2 Jacket: to CGSB 51-GP-52Ma.
- .3 Maximum "k" factor: to CAN/ULC-S702.

.5 TIAC Code C-2: mineral fibre blanket faced with or without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
- .1 Mineral fibre: to CAN/ULC-S702.
- .2 Jacket: to CGSB 51-GP-52Ma.
- .3 Maximum "k" factor: to CAN/ULC-S702.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:
- .1 Hydraulic setting or air drying on mineral wool, to ASTM C449.

2.5 VAPOUR RETARDER LAP ADHESIVE

1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.8 JACKETS

.1 Canvas:
- .1 220 and 120 gm/m^2 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.

.2 Aluminum:
- .1 To ASTM B209.
- .2 Thickness: 0.50 mm sheet.
- .3 Finish: smooth.
- .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

.3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
- .1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:
- .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Insulation:
- .1 Insulation, fastenings and finishes: same as system.
- .2 Jacket: aluminum.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.
- .1 Securements: SS bands at 300 mm on centre.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code 1501-H.

.3 TIAC Code: C-2 with vapour retarder jacket.
- .1 Insulation securements: band.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.

.4 Thickness of insulation as listed in following table.
- .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
- .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1¼ to 2	2½ to 4	5 to 6	8 & over
Steam	up to 175	A-1	38	50	65	75	90	90
Steam, Saturated and Super heated	over 175	A-1	38	65	65	75	90	90
Condensate Return	60 - 94	A-1	25	38	38	38	38	38
Pumped Condensate return	up to 94	A-1	25	38	38	38	38	38
Boiler Feed		A-1	25	25	25	25	25	25

3.6 PIPING INSULATION SCHEDULES (Cont'd)

.4 (Cont'd)
.2 (Cont'd)

Water Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38
Domestic HWS		A-1	25	25	25	38	38	38

.5 Finishes:
.1 Exposed indoors: canvas.
.2 Exposed in mechanical rooms: aluminum jacket.
.3 Concealed, indoors: canvas on valves, fittings. No further finish.
.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
.5 Outdoors: aluminum jacket.
.6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.3 STEAM SYSTEMS

.1 Performance verification:
- .1 When systems are operational, perform complete tests of steam and condensate return systems to verify operation of boilers.
- .2 Verify operation of components of steam system including:
  - .1 Steam traps by:
    - .1 Measuring temperature of condensate return and/or
    - .2 Using audio-sensing devices.
    - .3 Use of other approved methods.
  - .2 Flash tanks.
  - .3 Thermostatic vents.
  - .4 Water treatment.
  - .5 Blowdown.
  - .6 Drain coolers.
  - .7 Pressure regulators.
  - .8 Safety relief valve.
  - .9 Feed water control.
  - .10 Level control.
  - .11 System capacity control.
- .3 Verify performance of condensation units, including:
  - .1 Pump capacity at design temperature.
  - .2 Controls.
- .4 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.
- .5 Adjust piping system as required to eliminate water hammer.

.2 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.3 Monitor system continuously until acceptance for proper operation of components including steam traps, thermostatic vents, flash tanks and condensate pumping units.

1.4 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

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

PART 2 - PRODUCTS

2.1 NOT USED .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not Used.

END

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:
- .1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.

.4 Cleaning procedures:
- .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
  - .1 Cleaning procedures, flow rates, elapsed time.
  - .2 Chemicals and concentrations used.
  - .3 Inhibitors and concentrations.
  - .4 Specific requirements for completion of work.
  - .5 Special precautions for protecting piping system materials and components.
  - .6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:
- .1 Systems: free from construction debris, dirt and other foreign material.
- .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
- .3 Strainers: clean prior to initial fill.
- .4 Install temporary filters on pumps not equipped with permanent filters.
- .5 Install pressure gauges on strainers to detect plugging.

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS (Cont'd)

.6 Report on Completion of Cleaning:
- .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:
- .1 Fill system with water, ensure air is vented from system.
- .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
- .3 Use water metre to record volume of water in system to +/- 0.5%.
- .4 Add chemicals under direct supervision of chemical treatment supplier.
- .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
- .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
- .7 Add chemical solution to system.
- .8 Establish circulation, raise temperature slowly to maximum design 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.8 Steam Systems: in addition to general requirements as specified above, perform following:
- .1 Remove internal components of steam traps until flushing and warm-up have been completed.
- .2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.
- .3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.
- .4 Water hammer: determine source and eliminate cause.

.9 Steam boilers: In accordance with manufacturer's recommdentations.
- .1 Isolate boilers from piping system.
- .2 Fill to normal operating level. Add cleaner. Fire to 50% of design operating steam pressure. Maintain for 24 h, during which blow down boiler every 4 h including water columns, controls, skimmer lines and valves, test cocks, blowdown valves. Add water to return to operating level.
- .3 Allow boiler to cool, then drain, flush and inspect.
- .4 Reconnect to piping system.
- .5 Refill boiler with clean softened water and immediately add chemical inhibitors.
- .6 Apply heat slowly and raise to normal design operating steam pressure. Maintain for 4 h.
- .7 Discharge condensate from steam system to sewer for 96 h after initial operation. During this period continue chemical treatment of boilers with inhibitors to ensure complete removal of oils, grease and millscale from steam and condensate return piping steam.
- .8 Drain steam condensate until it is clean and free from suspended matter. Ensure proper operation of steam traps.
- .9 Allow boiler to cool, drain, open inspection ports and wash out with clean water.
- .10 If boiler is not used immediately, refill with softened water, add sodium sulphite, bring up to pressure. Test for residual sulphite.
- .11 After cleaning is completed and system is filled, perform relevant start-up procedures as specified for hydronic systems:

3.3 START-UP OF SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and tank level, set pressure controls.
.2 Ensure air is removed.
.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
.5 Clean out strainers repeatedly until system is clean.
.6 Commission water treatment systems.
.7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
.8 Repeat with water at design temperature.
.9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
.10 Bring system up to design temperature and pressure slowly over a 48 hour period.
.11 Perform TAB as specified.
.12 Adjust pipe supports, hangers, springs as necessary.
.13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
.14 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
.15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
.16 Check operation of drain valves.
.17 Adjust valve stem packings as systems settle down.
.18 Fully open balancing valves (except those that are factory-set).
.19 Check operation of over-temperature protection devices on circulating pumps.
.20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 05 - Installation of Pipework.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.5-2013, Pipe Flanges and Flanged Fittings.
- .2 ASME B18.2.1-2012, Square and Hex Bolts and Screws Inch Series.

.2 American Society for Testing and Materials International (ASTM)
- .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 Canadian Standards Association (CSA International)
- .1 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel.
- .2 CSA B149.1-10, Natural Gas and Propane Installation Code Handbook.
- .3 CSA B149.2-10, Propane Storage and Handling Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.1 PIPE

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

2.2 JOINTING MATERIAL

.1 Screwed fittings: pulverized lead paste.

.2 Welded fittings: to CSA W47.1.

.3 Flange gaskets: nonmetallic flat.

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

2.4 VALVES .1 Local gas distributor approved, lubricated plug type lockable on exterior.

PART 3 - EXECUTION

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

3.2 PIPING .1 Install in accordance with Section 23 05 05 - Installation of Pipework, applicable Provincial Codes, CSA B149.1 & CSA B149.2.

.2 Install drip points:
- .1 At low points in piping system.
- .2 At connections to equipment.

.3 Paint yellow all indoor piping with two coats. Exterior piping to have f our (4) coats minimum.

.4 Provide gas venting from PRV's and pressure switches supplied by boiler manufacturer. Size piping in accordance with manufacturer's instructions.

3.3 VALVES .1 Install valves with stems upright or horizontal unless otherwise approved by Departmental Representative.

.2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL .1 Site Tests/Inspection:
- .1 Test system in accordance with CSA B149.1, CSA B149.2 and requirements of authorities having jurisdiction.

.2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.

.3 PV procedures:
- .1 Test performance of components.

3.5 ADJUSTING

.1 Purging: purge after pressure test in accordance with CSA B149.1 & CSA B149.2.

.2 Pre-Start-Up Inspections:

.1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

.2 Check gas trains, entire installation is approved by authority having jurisdiction.

3.6 CLEANING

.1 Cleaning: in accordance with CSA B149.1.

.2 Perform cleaning operations 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

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 21 05 01 - Common Work Results for Mechanical.

.2 Section 23 05 05 - Installation of Pipework.

.3 Section 23 05 23.01 - Valves-Bronze.

.4 Section 23 05 23.03 - Valves - Cast Steel.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.3-2011, Malleable Iron Threaded Fittings: Classes 150 and 300.
- .2 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS ½ through 24.
- .3 ASME B16.9-2012, Factory-Made Wrought Steel Buttwelding Fittings.
- .2 ASME B16.25-2012, Buttwelding Ends.
- .4 ASME B18.2.1-2012, Square and Hex Bolts and Screws (Inch Series).
- .5 ASME B18.2.2-2010, Square and Hex Nuts (Inch Series).

.2 American Water Works Association (AWWA)
- .1 AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.3 ASTM International Inc.
- .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .2 ASTM A105/A105M-13, Standard Specification for Carbon Steel Forgings for Piping Applications.
- .3 ASTM A234/A234M-13e1, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

.4 Canadian Standards Association (CSA International)
- .1 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section01 61 00 - Common Product Requirements.

PART 2 - PRODUCTS

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
- .1 Steam;
  - .1 NPS 1/2 to 1-1/2: Schedule 80, seamless.
  - .2 NPS 2 to NPS 6: Schedule 40-ERW, bend ends.
  - .3 NPS 8 and over: 10 mm wall, ERW.
- .2 Condensate: Schedule 80, ERW, plain ends.

2.2 PIPE JOINTS

.1 NPS 2 and under: screwed fittings with PTFE tape or lead-free dope.

.2 NPS 2-1/2 and over: welding fittings and flanges to CSA W48.

.3 Flanges: plain or raised face. Flange gaskets to AWWA C111/A21.11.

.4 Pipe thread: taper.

.5 Bolts and nuts: carbon steel, to ASME B18.2.1 and ASME B18.2.2.

.6 Buttwelding ends: to ASME B16.25.

2.3 FITTINGS

.1 Pipe flanges:
- .1 NPS 1/2 to 1-1/2: Class 150, full faced welded, to ASTM A105/A105M.
- .2 NPS 2 and over: Class 150, full faced, weld neck, bored to suit pipe, to ASTM A105/A105M.

.2 Screwed fittings: Class 3000, 20 MPa, forged steel to ASTM A105/A105M.

.3 Bend ends: Schedule 40 to ASTM A234/A234AM Grade WPB.

.4 Steel pipe gaskets, flanges and flanged fittings: to ASME B16.5.

.5 Buttwelding fittings: steel to ASME B16.9.

.6 Unions: Class 3000, steel to steel, to ASTM A105/A105M and ASME B16.3.

2.4 VALVES

.1 Connections:
- .1 NPS 2 and smaller: screwed ends.
- .2 NPS 2-1/2 and larger:
  - .1 Equipment: Flanged ends.
  - .2 Elsewhere: Welded ends.

.2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines.
- .1 NPS 2 and under:
  - .1 Class 150, rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2-1/2 -8:
  - .1 Class 150, rising stem, flexible wedge disc, cast iron, steel trim, as specified Section 23 05 23.03 - Valves - Cast Steel.

2.4 VALVES (Cont'd)

.2 Gate valves:(Cont'd)
.3 NPS 10 and over:
.1 Mechanical Rooms: Class 300, rising stem, flexible wedge disc, cast steel with steel trim, as specified Section 23 05 23.03 - Valves - Cast Steel.

.3 Globe valves: Application: Steam service, throttling, flow control, emergency bypass.
.1 NPS 2 and under:
.1 Class 150 with PFTE disc as specified Section 23 05 23.01 - Valves - Bronze.

.4 Gate valves: Application: pumped and gravity condensate return service, steam drip point assemblies.
.1 NPS 2 and under:
.1 Class 150, rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze
.2 NPS 2-1/2 and over:
.1 Class 150, rising stem, solid wedge disc, cast steel, steel trim, as specified Section 23 05 23.03 - Valves - Cast Steel.

.5 Drain valves: Gate, Class 150, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

.6 Bypass valves around large size gate and globe valves: as specified Section 23 05 23.03 - Valves - Cast Steel.

.7 Lift check valves:
.1 NPS 2 and under: lift, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
.2 NPS 2-1/2 and over: as specified Section 23 05 23.03 - Valves - Cast Steel.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 PIPING

.1 Install pipework in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified below.

.2 Connect branch lines into top of mains.

.3 Install piping in direction of flow with slopes as follows, unless indicated:
.1 Steam: 1:240.
.2 Condensate return: 1:70.

.4 Make provision for thermal expansion as indicated.

.5 Drip pocket: line size.

3.3 VALVES

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

3.4 TESTING

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

.2 Test pressure: 1-1/2 times maximum system operating pressure or 1034 kPa whichever is greater.

3.5 SYSTEM START-UP

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

3.6 PERFORMANCE VERIFICATION (PV)

.1 General:
- .1 Verify performance in accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems supplemented as specified herein.

.2 Timing, only after:
- .1 Pressure tests successfully completed.
- .2 Flushing as specified has been completed.
- .3 Water treatment system has been commissioned.

.3 PV Procedures:
- .1 Verify complete drainage of condensate from steam coils.
- .2 Verify proper operation of system components, including, but not limited to:
  - .1 Steam traps - verify no blow-by.
  - .2 Flash tanks.
  - .3 Thermostatic vents.
- .3 Monitor operation of provisions for controlled pipe movement including expansion joints, loops, guides, anchors.
  - .1 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.4 Condensate pumping units: for commissioning procedures, refer to Section 01 91 13 - General Commissioning (Cx) Requirements.

3.7 CLEANING

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 05 05 - Installation of Pipework.

.2 Section 23 05 19 - Meters and Gauges for HVAC Piping.

.3 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

1.2 REFERENCES

.1 American Society for Mechanical Engineers (ASME International)
- .1 ASME BPVC-VIII-1-2013, 2013 ASME Boiler and Pressure Vessel Code (BPVC), Section VIII, Division 1: Rules for Construction of Pressure Vessels.

.2 ASTM International Inc.
- .1 ASTM A126-04(2009), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .2 ASTM A167-99(2009), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
- .3 ASTM A216/A216M-12, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
- .4 ASTM A240/A240M-13a, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- .5 ASTM A276-13, Standard Specification for Stainless Steel Bars and Shapes.
- .6 ASTM A278/A278M-01(2011), Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).
- .7 ASTM A351/A351M-13a, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- .8 ASTM A564/A564M-13, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
- .9 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 Canadian Standards Association (CSA International)
- .1 CAN/CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section01 61 00 - Common Product Requirements.

PART 2 - PRODUCTS

2.1 GENERAL .1 All components installed must be rated for failure conditions of associated systems.

2.1 MATERIALS .1 Cast steel: to ASTM A216/A216M.

.2 Cast iron: to ASTM A278, Class 300.

.3 Bronze: to ASTM B62.

.4 Stainless steel: to ASTM A351/A351M.

2.2 FLOAT AND THERMOSTATIC STEAM TRAPS 0-110 kPa .1 Application: for modulating steam service as indicated.

.2 Materials: body - cast-steel; valve - stainless steel with stainless steel seat; float and mechanisms - stainless steel; air vent - stainless steel thermostatic type.

.3 Capacity: as indicated.

2.3 INVERTED BUCKET STEAM TRAP 0-1000 kPa .1 Application: for non-modulating steam services on heating coils, end of line drips, distribution main drip points and as indicated.

.2 Materials: body - cast-steel; valve - stainless steel; bucket-stainless steel, with bimetal air vent.

.3 Capacity: as indicated.

2.4 THERMODYNAMIC DISC STEAM TRAPS 70-1000 kPa .1 Application: where inverted buckets are not feasible.

.2 Material: body - stainless steel carbon steel; disc - hardened stainless steel; strainer - stainless steel; seat gasket - monel non-asbestos.

.3 Capacity: as indicated.

2.5 VACUUM BREAKERS 0.85-68 kPa .1 Application: on inlets to steam coils.

.2 Materials: body and cap - stainless steel; spring - stainless steel; stem and seat - stainless steel.

.3 Capacity: as indicated.

2.6 PRESSURE REDUCING VALVE -EXTERNAL PILOT OPERATED

.1 Location: as indicated.

.2 Self operating, external pilot, single seat, diaphragm operated, dead end shutoff, enclosed spring chamber main and pilot valve.

.3 Connections:
- .1 Under NPS 2: screwed ends.
- .2 NPS 2-1/2 and over: flanged ends.

.4 Main valve:
- .1 Body: cast iron to ASTM A126, Class B.
- .2 Diaphragm: stainless steel to ASTM A167 & ASTM A240/A240M.
- .3 Seat rings: stainless steel to ASTM A276.
- .4 Disc: stainless steel to ASTM A564/A564M & ASTM A276.
- .5 Stem: stainless steel to ASTM A276.
- .6 Spring: carbon steel.
- .7 Bolting: carbon steel.

.5 Pilot valve:
- .1 Body: cast iron to ASTM A126, Class B.
- .2 Diaphragm: stainless steel to ASTM A167 & ASTM A240/A240M.

.6 Noise criteria: 35.

.7 Capacity:
- .1 As indicated.

2.7 SAFETY AND RELIEF VALVES

.1 Spring loaded type of cast iron with high capacity and semi-nozzle and to ASME code.

.2 Material: body -cast iron; valve - housing malleable iron; spring - steel, cadmium plated; bronze/brass trim.

.3 Capacity: as indicated.

2.8 DRIP PAN ELBOWS

.1 Application: on discharge of steam safety relief valves.

.2 Cast iron or steel with screwed or flanged inlet and threaded drain connections.

2.9 PIPE LINE STRAINERS UP TO NPS 2

.1 Application: ahead of condensate pumps, steam traps, control valves and elsewhere as indicated.

.2 Working pressure: 1034 kPa.

.3 Body: cast iron.

.4 Connections: screwed.

.5 Screen: stainless steel with 0.8 mm perforations.

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

.1 Application: ahead of condensate pumps, steam traps, control valves as indicated.

.2 Working pressure: 1034 kPa.

.3 Body: cast iron.

.4 Connections: flanged.

.5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.

.6 Screen: stainless steel with 3.2 mm perforations.

PART 3 - EXECUTION

3.1 APPLICATION

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

.2 Maintain proper clearance around equipment to permit maintenance.

3.2 STRAINERS

.1 Install as indicated.

.2 Ensure clearance for removal of basket.

.3 Install valved blow-down as indicated.

3.3 SAFETY RELIEF VALVE

.1 Pipe to atmosphere independent of other vents and in accordance with applicable code.

.2 Support discharge pipe against reaction forces and to take up thermal movement.

.3 Drain pipe from drip pan elbow to terminate over floor drain.

3.4 STEAM TRAPS

.1 Install unions on inlet and outlet in accordance with Section 23 05 05 - Installation of Pipework and Section 23 05 19 - Meters and Gauges for HVAC Piping.

3.5 PRESSURE REDUCING VALVES

.1 Install on 3-valve bypass with strainer on inlet.

.2 Pipe as indicated. Follow manufacturer's installation instructions.

3.7 PERFORMANCE VERIFICATION

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

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 22 13 - Steam and Condensate Heating Piping.

.2 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCES

.1 National Electrical Manufacturers' Association (NEMA)
- .1 NEMA MG 1-2011, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:
- .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
  - .1 Pump curves with point of operation.
  - .2 Required NPSH at specified maximum condensate temperature.
  - .3 Tank capacity.
  - .4 Manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
- .2 Indicate control equipment, piping, valves and fittings shipped loose by packaged equipment supplier, showing their final location in field assembly.
- .3 Indicate seismic restraint system incorporated into support system.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Section01 61 00 - Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

PART 2 - PRODUCTS

2.1 VERTICAL MULTISTAGE

.1 General: stainless steel vertical multistage pumps.

.2 Impeller: Oval - 304 stainless steel. Radial impeller - 4 stages.

.3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: Carbon/Silicon Carbide/Viton.

.5 Coupling: rigid self-aligning.

.6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing. NEMA 56C frame, TEFC.

.7 Threaded oval counter flanges made of stainless steel ANSI flanges.

2.1 VERTICAL MULTISTAGE (Cont'd)

.8 Capacity: as indicated.

.9 Design pressure: 1200 kPa.

.10 Design temperature: 100°C.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Place level, shim unit and grout.

.2 Pipe up to system as indicated.

.3 Run tank vent separately to exterior of building as indicated.

.4 Run drain line and overflow to terminate over floor drain.

.5 Check rotation prior to start-up.

.6 Check bearings for oil level and lubrication.

3.3 SYSTEM START-UP AND PERFORMANCE VERIFICATION (PV)

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

.2 Start-up:
- .1 Check strainers and clean as often as necessary until system is clean.
- .2 Tighten as necessary glands of valves, pumps.
- .3 Check lubrication and add as necessary.
- .4 Determine source of loss and rectify deficiencies.

.3 Performance Verification (PV):
- .1 Test unit for capacity, NPSH at design temperatures.
- .2 Discharge condensate to sewer until system is clean.

.4 Reports:
- .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports supplemented as specified herein.
- .2 Include:
  - .1 Report forms as specified Section 01 91 13 - General Commissioning (Cx) Requirements: report forms and schematics.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 22 14 - Steam Specialties.

.2 Section 23 52 00 - Packaged Boiler Plant.

.3 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCES

.1 ASME
- .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

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 water treatment systems and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

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

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 00 10 - General Instructions.

.2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systems for incorporation into manual.

.3 Include following:
- .1 Log sheets as recommended by manufacturer.
- .2 Water quality testing certificate.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MANUFACTURER .1 Equipment, chemicals, and service provided by one supplier, hired by boiler manufacturer to provide coordinated package.

2.2 GENERAL .1 Chemical application rates shall be able to maintain water quality guidelines established by OEM boiler manufacturer and standard industry guidelines. A suitable start-up quantity of chemical shall be shipped along with system equipment for start-up purposes and commissioning.

.2 Water treatment systems as described in Section 23 52 00 - Packaged Boiler Plant of this specification are included in service and quality control requirements specified in this section.

2.3 DUPLEX WATER SOFTENER .1 Duplex water softener to remove hardness to not more than 0.1 ppm as calcium carbonate as determined by ASTM standard method, when operated in accordance with the operating instructions. Each unit shall be designed to provide 31,000 grains per tank maximum capacity of hardness reduction between regenerations to maximum salt dosage of 6.8 kg salt with a continuous flow rate of 0.315 L/s with a pressure drop of 103 kPa and a peak flow rate of 1.26 L/s with a pressure drop of 170 kPa.

.2 The softener tanks (quantity of 2) shall be designed for a working pressure of 1034 kPa and a temperature of 48°C. A minimum freeboard volume of 50% shall be provided to assure adequate bed expansion during backwash. Tanks shall be manufactured of fiberglass reinforced polyester with a 65 mm top opening. The exterior side shall be reinforced by a continuous roving glass filament overwrap of the same color as the tank shell. The tank shall be supported by a molded polypropylene structural base. Each vessel shall have the dimensions of 250 mm diameter x 1120 mm height plus the height of the base.

.3 The backwash distributor and soft water collector shall be single point.

.4 The combination salt storage and brine measuring tank with cover shall be sized to hold 180 kg of salt and have the dimensions of 250 mm diameter x 1000 mm tall. The tank shall be of 10 mm rotationally molded rigid polyethylene. The brine tank shall be equipped with an elevated salt plate for the collection of brine and shall have a chamber to house a brine valve assembly. The brine valve assembly shall include an automatic air eliminator and float safety shut-off valve. It shall open automatically to educt brine, close to prevent the entrance of air after the brine has been drawn, and permit refill of the tank with the correct amount of water. Brine dosage shall be controlled by the softener control valve through an adjustment on the clock timer. The system shall be designed to allow proper refilling regardless of the salt level in the tank.

.5 The control valve shall have 25 mm inlet and outlet connections. It shall be of the mechanically actuated, four position type to accomplish the regeneration steps of backwash, brine draw/slow rinse, fast rinse, and refill. The valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The main control body, second tank adaptor, and connector yoke shall be made of brass with plastic couplings, and copper connector pipes provided. The second tank, meter, and bypass if provided, shall be of the quick disconnect style. Regeneration and alternation shall be actuated by a mechanical drive.

2.3 DUPLEX WATER SOFTENER (Cont'd)

.6 The control shall have adjustable duration of the various steps in regenerations, shall allow for "push-button" start and also provide complete manual operation. Regeneration shall be initiated by volumetric meter. An arrow on the control valve shall indicate which position the control valve is in during regeneration. All steps of the regeneration cycle shall be accomplished using soft water.

.7 The regeneration control microprocessor shall operate the control valve through each regeneration step. The microprocessor shall activate a motor drive which will shift the stand-by tank to the service position, perform the regeneration functions on the exhausted tank and leave it in the stand-by position. The microprocessor shall allow individual adjustment for the length of the backwash, brine rinse and refill cycles as well as the service volume (regeneration) setpoint through the keypad interface.

.8 The control microprocessor shall have an LED display to indicate the status of the tank. Instantaneous flowrate, total service volume, and service volume remaining can also be scrolled through on the display. The keypad shall allow manual activation of the regeneration cycle. The control microprocessor shall have a power failure back-up system that will preserve the regeneration program and all other data delaying regeneration until power is restored.

.9 This softener shall be provided with (Ion exchange resin) 0.028 m^3 of high-capacity sulfonated styrene/divinylbenzene copolymer resin per tank having a minimum exchange of capacity of 31,000 grains per cubic foot when regenerated with 6.8 kg of salt per cubic foot. The media shall be solid, of the proper particle size (not more than 4% through 40 mesh standard screen, wet screening) and shall contain no plates, shells, agglomerates or other shapes which might interfere with the normal function of the water softener.

.10 The supplier shall supply copies of the system specific service manual. This manual shall contain a complete electrical schematic and exploded parts diagrams with all parts listed by part number. The service manual shall also explain complete system operation and include a basic troubleshooting guide.

.11 The water softening equipment shall be warranted against failure due to faulty materials, workmanship, or corrosion for a period of one year.

2.4 SINGLE TANK WATER POLISHER

.1 Single tank water polisher to remove hardness to not more than 0.1 ppm as calcium carbonate as determined by ASTM standard method, when operated in accordance with the operating instructions. Each unit shall be designed to provide 31,000 grains per tank maximum capacity of hardness reduction between regenerations to maximum salt dosage of 6.8 kg salt with a continuous flow rate of 0.315 L/s with a pressure drop of 103 kPa and a peak flow rate of 1.26 L/s with a pressure drop of 170 kPa.

.2 The polisher tank (quantity of 1) shall be designed for a working pressure of 1034 kPa and a temperature of 48°C. A minimum freeboard volume of 50% shall be provided to assure adequate bed expansion during backwash. Tanks shall be manufactured of fiberglass reinforced polyester with a 65 mm top opening. The exterior side shall be reinforced by a continuous roving glass filament overwrap of the same color as the tank shell. The tank shall be supported by a molded polypropylene structural base. Each vessel shall have the dimensions of 250 mm diameter x 1120 mm height plus the height of the base.

.3 The backwash distributor and soft water collector shall be single point.

.4 The combination salt storage and brine measuring tank with cover shall be sized to hold 180 kg of salt and have the dimensions of 450 mm diameter x 1000 mm tall. The tank shall be of 10 mm rotationally molded rigid polyethylene. The brine tank shall be

2.4 SINGLE TANK WATER POLISHER (Cont'd)

.4 (Cont'd)
equipped with an elevated salt plate for the collection of brine and shall have a chamber to house a brine valve assembly. The brine valve assembly shall include an automatic air eliminator and float safety shut-off valve. It shall open automatically to educt brine, close to prevent the entrance of air after the brine has been drawn, and permit refill of the tank with the correct amount of water. Brine dosage shall be controlled by the softener control valve through an adjustment on the clock timer. The system shall be designed to allow proper refilling regardless of the salt level in the tank.

.5 The control valve shall have 25 mm inlet and outlet connections. It shall be of the mechanically actuated, four position type to accomplish the regeneration steps of backwash, brine draw/slow rinse, fast rinse, and refill. The valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The main control body shall be made of brass. Regeneration shall be actuated by a mechanical drive.

.6 The regeneration control microprocessor shall operate the control valve through each regeneration step. The microprocessor shall activate a motor drive which will perform the regeneration functions. The microprocessor shall allow individual adjustment for the length of the backwash, brine rinse and refill cycles as well as the service volume (regeneration) setpoint through the keypad interface.

.7 The control microprocessor shall have an LED display to indicate the status of the tank. Instantaneous flowrate, total service volume, and service volume remaining can also be scrolled through on the display. The keypad shall allow manual activation of the regeneration cycle. The control microprocessor shall have a power failure back-up system that will preserve the regeneration program and all other data delaying regeneration until power is restored.

.8 This polisher shall be provided with (ion exchange resin) 0.028 m^3 of high-capacity sulfonated styrene/divinylbenzene copolymer resin per tank having a minimum exchange of capacity of 31,000 grains per cubic foot when regenerated with 6.8 kg of salt per cubic foot. The media shall be solid, of the proper particle size (not more than 4% through 40 mesh standard screen, wet screening) and shall contain no plates, shells, agglomerates or other shapes which might interfere with the normal function of the water softener.

.9 The supplier shall supply copies of the system specific service manual. This manual shall contain a complete electrical schematic and exploded parts diagrams with all parts listed by part number. The service manual shall also explain complete system operation and include a basic troubleshooting guide.

.10 The water polishing equipment shall be warranted against failure due to faulty materials, workmanship, or corrosion for a period of one year.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC water treatment systems 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.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

.1 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.4 CLEANING OF MECHANICAL SYSTEM

.1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.

.2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.

.3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.

.4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.

.5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.5 WATER TREATMENT SERVICES

.1 Provide water treatment monitoring and consulting services for period of 1 year after system start-up. Service to include:
- .1 Initial water analysis and treatment recommendations.
- .2 System start-up assistance.
- .3 Operating staff training.
- .4 Visit plant every week during period first two (2) months of operation in heating season and until system stabilizes, and advise on treatment system performance. Follow up visits to be performed a monthly basis thereafter.
- .5 Provide necessary recording charts and log sheets for 1 year operation.
- .6 Provide necessary laboratory and technical assistance.
- .7 Provide clear, concise, written instructions and advice to operating staff.

3.6 WATER SOFTENER .1 Install in accordance with manufacturer's instructions.

3.7 FIELD QUALITY CONTROL

.1 Start-up:
- .1 Start up water treatment systems in accordance with manufacturer's instructions.

.2 Commissioning:
- .1 Commissioning Agency: to be water treatment supplier.
- .2 Timing:
  - .1 After start-up deficiencies rectified.
  - .2 After start-up and before TAB of connected systems.
- .3 Pre-commissioning Inspections: verify:
  - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
  - .2 Suitability of log book.
  - .3 Currency and accuracy of initial water analysis.
  - .4 Required quality of treated water.
- .4 Commissioning procedures - Water Softeners:
  - .1 Demonstrate compliance with specifications by chemical analyses of raw water and treated water.
  - .2 Determine, demonstrate actual softening capacity between regenerations.
  - .3 Establish regeneration intervals and procedures.
  - .4 Train O&M personnel in regeneration procedures.
- .5 Training:
  - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O&M personnel.
  - .2 Train O&M personnel in softener regeneration procedures.
- .6 Certificates:
  - .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .7 Commissioning Reports:
  - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- .8 Commissioning activities during Warranty Period:
  - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

END

PART 1 - GENERAL

1.1 REFERENCES

.1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

.2 Underwriters' Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Indicate following, specific to application, including site verification at dimensions:

.1 Methods of sealing sections.
.2 Methods of expansion.
.3 Details of thimbles.
.4 Bases/Foundations.
.5 Supports.
.6 Guy details.
.7 Rain caps.
.8 Listing details.
.9 Compelte asembly drawing.
.10 Submit draft calculations specific to boiler requirements. Show draft is within boiler maximum allowable draft at high fire and single boiler low fire.

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

1.3 QUALITY ASSURANCE

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

.2 Certifications:

.1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 FUELS: PRESSURE CHIMNEY AND BREECHING

.1 ULC labelled, 760 degrees C rated suitable to boiler manufacturer and gas code.

.2 Sectional, prefabricated, double wall with 50 mm insulation with mated fittings and couplings.
- .1 Liner: type 304 stainless steel.
- .2 Shell: type 304 stainless steel.
- .3 Outer seals between sections: to suit application.
- .4 Inner seals between sections: to suit application.

.3 Free standing height: maximum height of unguyed stack above root/last rigid support must be minimum 3900 mm.

2.2 ACCESSORIES

.1 Cleanouts: bolted, gasketted type, full size of breeching, at end of common line.

.2 Barometric dampers: single acting, 70% of full size of breeching area, if required.

.3 Hangers and supports: in accordance with recommendations and gas code.

.4 Rain cap.

.5 Expansion sleeves with heat resistant caulking, held in place as indicated.

.6 Support plate assembly and guides. Refer to structural drawings for site specific lateral guide and support frame conceptual details. Contractor to modify detail to suit specific product installation requirements and to suit site conditions illustrated.

.7 Drain tee.

.8 Exit cone.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

.1 Follow manufacturer's and requirements of gas code installation recommendations.

.2 Suspend breeching at 1.5 m centres and at each joint.

.3 Support chimneys at bottom, roof and intermediate levels as indicated.

.4 Install thimbles where penetrating roof, floor, ceiling and wall. Install flooring collaralon penetrating to exterior.

.5 Install rain caps and cleanouts, as indicated.

END

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 23 25 00 - HVAC Water Treatment Systems.

.2 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.3 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

.1 ASME
- .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.

.2 CSA Group
- .1 CAN1-3.1-77(R2011), Industrial and Commercial Gas-Fired Package Boilers.
- .2 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.
- .3 CSA B140.7-05(R2010), Oil Burning Equipment: Steam and Hot-Water Boilers.
- .4 CSA B149.1-10, Natural Gas and Propane Installation Code.

.3 TSSA - Technical Standards and Safety Authority.

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 heating boilers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
- .1 Submit drawings stamped and signed by professional engineer(s) registered or licensed in Province of Ontario, Canada.
- .2 Indicate on drawings:
  - .1 General arrangement showing terminal points, instrumentation test connections.
  - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
  - .3 Foundations with loadings, anchor bolt arrangements, hoisting/rigging provisions
  - .4 Piping hook-ups.
  - .5 Equipment electrical drawings, showing normal and emergency power circuits.
  - .6 Burners and controls.
  - .7 All miscellaneous equipment (lighting, auxilliary heating, dampers, etc.).
  - .8 Flame safety control system.
  - .9 Breeching and stack configuration.
  - .10 Stack emission.
  - .11 All auxilliary equipment including feedwater pumps, control valves blowdown tank, make-up water assemblies, etc.
  - .12 Water treatment requirements.
  - .13 CSA/ESA certifications, ASME ratings and TSSA approvals.
  - .14 Electrical wiring diagram showing all switches, panels, transformers, wiring, etc.
  - .15 Piping PID diagram.

1.3 ACTION AND INFORMATIONAL SUBMITTALS (Cont'd)

.3 Shop Drawings:(Cont'd)
- .2 Indicate on drawings:(Cont'd)
  - .16 Controls diagram.
- .3 Engineering data to include:
  - .1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.
  - .2 Radiant heat loss at 100% design capacity.
  - .3 Steam carryover (steam quality) at 25%, 50%, 75%, 100% of design capacity.
  - .4 Structural design (snow load, wind load, seismic) of enclosure and associated systems.
  - .5 Acoustic performance.

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

1.4 QUALITY ASSURANCE

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra materials:
- .1 Submit maintenance materials in accordance with Section 01 00 10 - General Instructions.
  - .1 Special tools for burners, access opening, handholes and Operation and Maintenance.
  - .2 Spare parts for 1 year of operation.
  - .3 Spare gaskets.
  - .4 Spare gauge glass inserts.
  - .5 Probes and sealants for electronic indication.
  - .6 Spare burner tips.
  - .7 Spare burner gun.
  - .8 Safety valve test gauge.

.2 Manufactured and install in accordance with ASME and TSSA requirements for low water volume boilers as per Operating Engineers Act. Contractor to be responsible for and bear costs associated with preparation of necessary documentation and forms required for approval.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Storage and Handling Requirements:
- .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect boiler and equipment from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Protect internal parts against rust and corrosion at all times.

PART 2 - PRODUCTS

2.1 GENERAL .1 Packaged Boiler Plant:

.1 Complete with Deaerator/Condensate tank c/w preheat, duplex feedwater pumps c/w VFD, blowdown tank, flash tank, steam header, chemical treatment package, container heat/ventilation, lighting, power distribution, and necessary accessories, controls, burner, safeties and wiring to meet provincial regulations.

.2 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7, CAN1-3.1, witnessed and certified. Departmental Representative to retain option of witnessing factory testing. Field fabrication of packaged system is not acceptable.

.3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.

.4 Designed and constructed to ASME Boiler and Pressure vessel Code.

.5 CRN (Canadian Registration Number), to CSA B51. Registered with TSSA.

.6 Boiler/burner package to bear ULC label.

.7 Pre-operational alkaline boiler blowout to be performed at factory and test certificate submitted to Departmental Representative, and included in closeout manuals.

.8 Packaged boiler plant to be customized to accommodate available space on site as illustrated on drawings and to maintain adequate clearance for proper service and maintenance. Modifications to site layout, infrastructure and routing of associated services as illustrated on drawings required to accommodate packaged boiler plant is subject to approval of Departmental Representative and the associated costs (including any redesign work) must be beared by Contractor.

.9 Packaged boiler plant must be able to maintain noise levels at or below 65 dBA at 7 metres. Additional sound attenuation measures or modifications to infrastructure (fenced enclosure) design to meet the 65 dBA at 7 metres requirements shall be provided by contractor.

2.2 SIZING REQUIREMENTS .1 Provide two (2) packaged boiler plants in accordance with the drawings and specifications. The boiler plants shall be design according to the following description of general requirements and to meet all provincial regulations:

.1 555 Booth - two (2) boilers to supply 5500 kg/hr. (350 BHP) and 1500 kg/hr. (100 BHP) of 99% dry quality steam at 725 kPa to base building distribution through a single 150 mm flanged connection located on side of unit in location as illustrated on drawings. Accept a minimum of 80% condensate return from the building at minimum temperature of 65°C through a single 50 mm flanged connection located on side of unit in location as illustrated on drawings. Accept a 25 mm dia. softened make-up water location as illustrated on drawings from building at maximum hardness of 0.1 ppm. Accept a 575 V, 3 phase, 60 Hertz power supply through a weatherproof 60 Amp disconnect (powered through base building emergency power source) and wired through internal distribution system to power controls, emergency lighting smaller boiler and a single feedwater pump to accommodate minimum heat requirements in event of power failure. Accept a second 575 V/3 phase, 60 Hertz power supply through a weatherproof 120 Amp disconnect (normal power) to feed remainder of boiler plant power requirements c/w necessary distribution equipment. Accept 50 mm natural gas pipe at pressure between 20.5 kPa and 34.5 kPa and located as illustrated on drawings.

.2 601 Booth - two (2) boilers to supply 7800 kg/hr. (500 BHP) and 2300 kg/hr. (150 BHP) of 99% dry quality steam at 725 kPa to base building distribution through a single 150 mm flanged connection located on side of unit in location as illustrated on drawings. Accept a minimum of 80% condensate return from the building at minimum temperature of 65°C through a single 50 mm flanged connection located on side of unit in location as illustrated on drawings. Accept a

2.2 SIZING REQUIREMENTS (Cont'd)

.1 (Cont'd)

.2 (Cont'd)

25 mm dia. softened make-up water location as illustrated on drawings from building at maximum hardness of 0.1 ppm. Accept a 575 V, 3 phase, 60 Hertz power supply through a weatherproof 60 Amp disconnect (powered through base building emergency power source) and wired through internal distribution system to power controls, emergency lighting smaller boiler and a single feedwater pump to accommodate minimum heat requirements in event of power failure. Accept a second 575 V/3 phase, 60 Hertz power supply through a weatherproof 120 Amp disconnect (normal power) to feed remainder of boiler plant power requirements c/w necessary distribution equipment. Accept 50 mm natural gas pipe at pressure between 20.5 kPa and 34.5 kPa and located as illustrated on drawings.

2.3 ENCLOSURE REQUIREMENTS

.1 Packaged enclosure to be approximately 12.2 metres x 3.5 metres x 3.2 metres high. Entire structure to be structurally designed to meet or exceed OBC requirements for snow load, wind load and seismic. Design to be submitted with shop drawings and stamped by Engineer licensed in province of Ontario.

.2 Galvanized steel structural base frame c/w lifting plates and anchor plates for seismic fastening to concrete slab.

.3 6 mm thick steel checker plate flooring with framing to support installed equipment and insulated to R20.

.4 Wall constructed of 26 gauge prefinished steel liner bonded to 13 mm gypsum, 6 mil polymer barrier, 18 gauge steel stud framing with cross bracing, R12 insulation, 13 mm gypsum and prefinished corrugated steel siding or equivalent to approval of Departmental Representative.

.5 Roof constructed of similar assembly as wall with joists and steel deck sloped 2%, and sized to accommodate snow load. Insulated to R20. Provide additional steel integrated on roof to accommodate support of venting in routing as illustrated on drawings.

.6 All penetrations of service connection sealed and ready for final connections.

.7 Provide motion activated exterior light fixture above double entry doorway on long side as shown on drawings. Provide motion activated exterior light fixture on either end above insulated roll up door.

.8 Provide insulated, STC rated double entrance door with lockset to approval of Departmental Representative. Include deadbolt. Provide insulated roll up doors at either end, sized to accommodate service clearances. Locked with heavy duty hasp.

.9 Provide general service power receptacles within unit to accommodate work lights and general maintenance equipment.

.10 Provide heat trace controller and self regulating heat trace cabling to serve drain piping in lengths as illustrated on drawings.

.11 Provide insulation and jacketing following delivery to site and completion of site pressure testing to ensure integrity of piping system following shipment.

.12 Provide enclosure heat using electric resistance heaters and powered through internal emergency power circuitry to maintain minimum heat. Additional heat requirement for enclosure during operation to be provided via steam unit heaters or coils at intake louvres.

2.3 ENCLOSURE REQUIREMENTS (Cont'd)

.13 Provide enclosure ventilation and heat rejection equipment to maintain enclosure temperature within acceptable ranges as recommended by equipment manufacturers during summer operation.

2.4 COIL TUBE BOILER

.1 The steam generators shall be coil tube recirculating, delivering steam at 725 kPa, with 99% plus quality dry steam, certified for low water volume operation as per TSSA requirements. The maximum design pressure shall be 1720 kPa. The safety relief valve setting shall be 896 kPa.

.2 The steam generator shall be ASME approved and CRN registered for the province of Ontario.

.3 The steam generator shall be of forced recirculating, low volume coil type water tube and skid mounted. Each unit shall be capable of achieving full rated output within five (5) minutes from a cold start without the possibility of thermal shock. Low fire hold controls are not an acceptable alternate.

.4 The steam generator shall incorporate a fully modulating, forced draft burner with 10:1 turndown ratio on natural gas. There shall be no difference in steam quality across the entire operating range of the steam generator.

.5 The steam generator shall be designed such that water which does not flash to steam in the steam separator shall be recirculated through the steam generator without returning to the deaerator or feedwater source.

.6 The steam generator shall be installed within an air casing pressurized by the combustion air blower. All combustion air shall be preheated by double wall casing running the complete length of the boiler casing.

.7 The steam generator will be equipped with an electronic excess steam pressure control, burner, and automatic ignition. The steam generating sections shall be removable from the back of the unit incorporating all NPT connections. The saturated steam generator, auxiliaries, and controls will be mounted on a common base. All components on the base will be piped and wired. Components furnished include the circulating pump, forced draft blower, fuel oil pump, steam drum, pressure control instruments, temperature control instruments, pressure gauges, motor starters and push-buttons, control transformer, modulating feedwater controls, steam safety valves, thermocouple, and other components required for a complete steam generator.

.8 Components:

.1 Steam Generator:

.1 The steam generator will consist of a water-cooled combustion chamber, the coils, convection type heat transfer section, and steam drum. Section 1 valves will be installed at the steam drum.

.2 The water-cooled combustion chamber shall be a seal welded helical coil that prevents combustion gases from bypassing the convection heat transfer section. The water wall combustion chamber shall have no retractory in its construction.

.3 Tube materials in the heat transfer sections will be in accordance with ASME specifications. Water wall to be factory insulated in addition to combustion air preheat space.

.4 Coils shall be designed such that individual coils may be replaced without the requirements of code welding. Temperature sensors accessible through rear deviated access door for inspection and service.

.5 Finned tubing shall not be utilized. Refractory seal in rear deviated access door is not acceptable.

2.4 COIL TUBE BOILER (Cont'd)

.8 Components:(Cont'd)
- .1 Steam Generator:(Cont'd)
  - .6 Coil shall be of ASME SA 178 Grade A Welded Carbon Steel Boiler tube with a minimum wall of 4.6 mm.
  - .7 Trapping steam separator back to feedwater tank is not acceptable.
- .2 Pressure control:
  - .1 The pressure control will automatically adjust fuel and air to suit steam demand. The accuracy of this control shall be plus or minus one percent (1%) of the pressure adjustment range.
- .3 Steam components:
  - .1 All features of the design will be such as to ensure safe and reliable operation. Installed controls will shut off the fire if temperature, pressure, or both exceed preset limits. The steam generator will fail-safe in the event of power failure. Fuel and combustion air systems will be electrically interlocked to shut fuel to the burner in case of combustion air failure.
  - .2 The steam generator will have an electronic steam temperature control, which requires a manual reset located on the boiler control panel. This steam temperature control will turn off the burner in the steam generator in the event that steam temperature reaches a preset point.
  - .3 Each individual coil in the convection heat transfer section shall have over heat protection. This shall consist of a thermocouple, which, due to its placement, directly monitors the maximum possible outlet temperature of each coil. Each thermocouple must have continuous digital readout on the control panel. This coil temperature control will extinguish the fire in the steam generator in the event that coil temperature reaches a preset point.
  - .4 The steam generator will have an electronic stack temperature control, which requires a manual reset located on the boiler control panel. The stack thermocouple must have continuous digital readout on the control panel. This stack temperature control will extinguish the fire in the steam generator in the event that stack temperature reaches a preset point.
- .4 Piping:
  - .1 All pressure piping will be designed and constructed in accordance with applicable provisions of the ASME Boiler and Pressure Vessel Code for Power Boilers.
  - .2 ASME spool piece from separator steam outlet to non-return valve, non-return valve, intermediate spool piece between non-return and gate valve with free blow drain and butterfly valve.
- .5 Recirculating pump:
  - .1 The pump furnished with the steam generator shall have a pumping capacity of at least three (3) times the maximum steaming rate.
  - .2 Pump must be air cooled design. No cooling water required.
- .6 Combustion air blower:
  - .1 The steam generator shall be equipped with a motor driven centrifugal combustion air blower. The blower will be of the non-overloading, backward curve type and be equipped with variable speed drive (VSD).
  - .2 Combustion air blower to be mounted at rear of the boiler shell at floor level, in easily accessible location.
  - .3 A silencer shall be provided to maintain noise levels below 65 dBA at 7 metres.
- .7 Burners:
  - .1 The steam generator will be equipped with a forced draft burner for natural gas firing. Natural gas to be delivered between 34.5 kPa and 20.5 kPa.
    - .1 The natural gas burner will be multi-nozzle, automatic gas pilot ignited burner, fully modulating. 10:1 modulation. There shall be no loss in steam quality across entire operating range at steam generator. High/low fire burners and burners with less than 10 to 1 turndown are not acceptable.

2.4 COIL TUBE BOILER (Cont'd)

.8 Components:(Cont'd)

.7 Burners:(Cont'd)

.2 Burner control system shall include automatic burner sequencing, flame supervision, status indication, first-out annunciation, and self-diagnosis. Controls to modulate combustion air blower VSD based on flame quality.

.3 Flame safeguard system c/w linkageless combustion control system

.4 A flame detector shall be used to monitor the flame in the combustion chamber of the steam generator.

.5 A sight glass shall also be supplied to view the flame from the front of the unit.

.8 Steam drum:

.1 The steam drum will be constructed in accordance with the latest ASME requirements. The drum will be designed in such a manner as to separate water from steam so that the steam quality will be ninety-nine and one half percent (99.5%) or greater. The drum will be insulated and covered with metal sheathing.

.2 The steam drum shall be sized to maximize steaming space and minimize potential for wet steam carryover during periods of fluctuating loads. Multiple baffle plates shall be incorporated into the steam drum interior to further ensure dry steam.

.9 Safety valves.

.1 The safety valves shall comply with ASME code.

.10 Steam drum blowdown:

.1 The steam drum shall be equipped with automatic drum bottom blowdown and automatic drum surface blowdown, c/w TDS automatic control system.

.2 The steam drum shall be insulated with 50 mm thermal insulation and jacketed with steel wrapper sheets.

.11 Feedwater control valve and water level control:

.1 The water level control shall be a differential level transmitter type and the feedwater control valve shall be a electrically actuated valve assembly, fully modulating.

.12 Water level indication:

.1 Gauge glass to be flat glass type.

.2 Means of level indication shall be independent of any make-up level control device.

.13 Low water level protection:

.1 Low-low water level burner cutoff switch shall be a probe type cutoff switch wired into the burner control circuit preventing burner operation if boiler water falls below designated safe level and will require manual resetting of burner flame safeguard control before allowing restart and further automatic operation.

.2 A secondary high water level burner cutoff switch shall be a probe type high water level cutoff switch wired into the burner control circuit preventing burner operation if boiler water rises above designated safe level and will require manual resetting of burner flame safeguard control before allowing restart and further automatic operation.

.14 Modulating Outlet Damper:

.1 ULC listed draft control outlet damper to maintain ideal draft conditions, and close tight when boiler is on standby integrated with boiler controller.

.15 Controls:

.1 All electrical components shall comply with UL/CSA International.

.2 NEMA 4 high voltage panel will be separate from the low voltage panel and will contain pump starts, overloads and fuses.

.3 Separate low voltage NEMA 4 panel for Flame safeguard controller, control switches, control voltage transformer, control circuit fuse, terminal strips for all entering and/or leaving wiring, operating and alarm lights, single point auxiliary contact for remote alarm indication of combustion safety failure, additional auxilliary contact and analog outputs to be provided to

2.4 COIL TUBE BOILER (Cont'd)

.8 Components:(Cont'd)

.15 Controls:(Cont'd)

.3 (Cont'd)

accommodate direct monitoring points by EMCS as described in Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.16 Combustion safeguard & burner control system:

.1 The combustion safeguard system shall provide complete safety monitoring and control at all boiler operations.

.2 The fully modulating combustion control system shall be microprocessor based and mechanical linkages must not be used. Individual parallel positioning motors shall be supplied for the combustion air blower damper control, gas control valve, oil control valve, and FGR damper control.

.3 The combustion control system shall provide independent fuel/air ratio curves for each fuel and shall be programmable from the panel mounted display module or via laptop/PC.

.4 The system shall have a fuel/air ratio controller. The manufacturer shall provide any software and/or passwords required for programming.

.5 All data from the on board controller and operator touch screen shall be available for monitoring and control from a remote location via Modbus.

.6 The fuel trains are to consist of the following controls and devices at a minimum:

.1 Pilot gas train:

.1 Pilot gas pressure regulator

.2 Pilot gas solenoid valve

.3 Test connection

.2 Main gas train:

.1 Main gas pressure regulator

.2 Double block and bleed valves, fully automatic with proof of closure

.3 High and low gas pressure switches with manual or automatic resets

.4 Manual gas shutoff lubricated plug valve

.5 Fuel metering valve

.17 All control functions at the boiler including burner, water level, blowdown, TDS monitoring, feedwater, fan/pump failure alarms must be capable of being monitored as delivered from the factory, through a single point Modbus connection. Auxiliary direct read points (through terminal strip) must be made available for monitoring points as listed in Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

2.5 FEEDWATER SYSTEM

.1 The boiler feed system complete with feedwater tank, pumps and controls shall be designed and completely installed within container to accept building condensate return, softened make-up water from building, and feedwater return from the boiler. Duplex pumping shall be provided to supply the boiler with its required feedwater flow rate and pressure.

.2 The boiler feed system is to be fully trimmed including the following items:

.1 Softened Water Make-Up Assembly: A differential pressure make-up water control shall be provided to accept incoming water up to a differential pressure of 690 kPa. The make-up valve shall be made of brass or bronze, electric actuated, globe valve with stainless steel section and stem. The valve shall be mounted on the tank below the water line. The make-up valve shall be controlled to maintain minimum water level in feedwater tank.

.2 Condensate Return Water Assembly: A condensate return water inlet control valve shall be provided to accept incoming pumped condensate at a pressure of 35kPa.

2.5 FEEDWATER SYSTEM (Cont'd)

.2 (Cont'd)

.2 (Cont'd)

The valve shall be made of brass, electric actuated, globe valve with stainless steel section and stem. The inlet control valve shall be controlled based on the building's main condensate tank level. Control valve to modulate open proportionally based on building tank level so that high tank level results in fully open control valve, low tank level results in control valve at minimum position. Coordinate acceptance of control signal from EMCS contractor. Provide control valve status signal at terminal strip for monitoring by EMCS.

.3 Misc. Gauges: A temperature gauge shall be supplied and installed by the manufacturer. The gauge shall be sized suitable for the operation and design range of the boiler feed system. A gauge glass shall be supplied and installed to indicate the water level in the tank. The gauge glass shall be protected from objects by metal protectors and have shut off valves on both ends.

.4 The storage tank shall be supported on a structural stand at a height to supply enough net positive suction head required for the pumps plus additional safety factor to avoid cavitation. All exposed metal surfaces shall be protected with a suitable heat and rust resisting paint.

.5 Pump size shall be based on boiler requirements and be able to pump into the boiler at least 3% above the boiler relief valve setting to satisfy the ASME code. The pump shall be a vertical multistage pump with stainless steel impellers and a minimum of 121°C seals. The pump motors shall be 3-phase, TEFC motors.

.6 The pump suction piping shall be flanged with welded joints and include a vortex breaker, gate valve, strainer, and flexible connector for each pump. Pump discharge piping shall include a liquid filled pressure gauge with shut-off valve, pump throttling valve and bypass line back to feedwater tank sized to allow minimum flow for continuous run pumps when boiler feedwater valve is closed.

.7 Feedwater heater to be stainless steel, noiseless, and sized for 50% make-up water at 10°C. Steam control valve to be self operated and installed above highest tank level with capillary tube to thermocouple.

.8 Pump Electrical Components: The pump shall be supplied with a TEFC motor.Each pump shall have a thru-the-door (3-phase) pump disconnect switch and 3-phase protection by Class LPJ fusing or similar fuse. The pump shall also be protected from the following: undervoltage, overvoltage, motor overload, ground fault, and phase to ground short.

.9 An on/off switch and pilot light shall also be provided for each pump. All pump electrical components shall be wired and factory checked before shipment. A fused control circuit transformer shall also be provided to reduce the 3-phase supplied power to 120/1/60 for the control circuit. The complete transfer system will have single point electrical connection located in a UL listed Nema 12 control panel.

2.6 WATER TREATMENT SYSTEM

.1 The following components shall be designed and installed within container

.1 Make-up Water Meter:

.1 One (1) water meter shall be provided for measuring the flow of soft, polished water to the feedwater tank. The meter shall be manufactured from cast bronze and have both a totalizing register and a 10 gpc contacting head. The meter shall have 20 mm male connections and be capable of 0.94 L/s continuous flow with an accuracy of +/- 1.5%. The meter shall be able to withstand a maximum operating pressure of 1034 kPa. The meter shall be capable of direct connection to building automation system for monitoring.

.2 Datalogic Remote Access Boiler Controller:

.1 One (1) boiler water management controller shall be provided to control the total dissolved solids in the boiler. The controller will have a range of 0-10,000 micromhos/cm with a resolution of 1 micromhos/cm and an accuracy of 1% of reading.

2.6 WATER TREATMENT SYSTEM (Cont'd)

.1 (Cont'd)

.2 (Cont'd)

.2 This central controller shall have built in temperature compensation to ensure accurate monitoring with normal fluctuations in boiler operating pressure and temperature. The temperature compensation will cover a range of 0°C 200°C with a resolution of 0.1 degrees and an accuracy of +/- 1% of reading.

.3 316 SS contacting conductivity sensor with a pressure rating of 1724 kPa each for continuous monitoring of conductivity. This controller shall have a 64 x 128 pixel backlit LCD local display to monitor boiler conductivities and to review and program menu driven onboard software. The controller shall have remote access via the internet through an ethernet connection for configuration, data logging and control by service provider. Additional auxiliary relays/terminal strips shall be provided to send signal to EMCS for:

.1 Alarm (general)

.2 low chemical treatment alarm The controller shall also be capable of Modbus communication with EMCS. Refer to Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.4 This controller shall power the steam boiler surface blowdown valve to control the total dissolved based on conductivity level versus programmable setpoints. It shall have the ability to provide notification of alarm conditions via terminal strip.

.5 This controller shall have the ability to receive a water meter input to coordinate chemical feed addition. It shall include additional digital inputs to receive signals from two (2) chemical level switches.

.3 Chemical Feed System:

.1 Two (2) chemical feed pumps shall be provided to dispense liquid water treatment chemicals from storage containment tanks. The pumps shall be an electronic metering diaphragm type, with a high impact polypropylene body, glass fibre reinforced polypropylene liquid end, teflon faced, EPDM backed diaphragm, and must have ceramic ball check valves and chemical resistant fittings. Each pump shall have a rated maximum output capacity of 90 Litres per day with fully adjustable pulse frequency control. Each pump shall have an output pressure of 900 kPa.

.2 One (1) stainless steel injection assembly shall be provided for the addition of two (2) treatment chemicals to the feedwater tank. The assembly will include: 2 stainless steel injection quills, 2 stainless steel isolation valves, 2 stainless steel tees, 2 stainless steel compression fittings and 2 stainless steel check valves with ceramic balls to prevent backflow

.3 Chemical Storage tanks shall be located within container with sufficient quantities of respective chemical for minimum one (1) month supply.

.4 Water treatment services as described in Section 23 25 00 - HVAC Water Treatment Systems. apply to the water treatment system specified herein.

.2 Blowdown tank shall be suitable for use with boiler plant and be able to accept surface and bottom blowdown.

.1 Blowdown tank shall be designed, constructed and tested in accordance with ASME Code Section VIII, Div. I of the Boiler and Pressure Vessel Code and be in full compliance with CSA B51 for a blowoff vessel at the design pressure and temperature. Registered with TSSA and having Ontario CRN number.

.2 Design pressure: 1049.97 kPa

.3 Design temperature: 232 degrees C

.4 Blowdown tank shall have

.1 300 mm x 400 mm handhole for inspection

.2 flanged blowdown inlet

.3 flanged water outlet with syphon

.4 thermometer and pressure gauge

2.6 WATER TREATMENT SYSTEM (Cont'd)

.2 (Cont'd)
.4 (Cont'd)
.5 remote temperature sensor opening
.6 aquastat
.7 threaded 20 mm cold water inlet c/w thermostatically operated (adjustable) cooling water valve
.8 flanged flash steam vent piped to safe location
.9 threaded 40 mm drain with cap and chain
.10 heavy gauge legs for vertical mounting with bolt holes on feet for seismic fastening to structure
.11 Internal baffling to be stainless steel
.12 constructed of heavy gauge high grade carbon steel with temperature resistant paint finish and a 3.175 mm corrosion allowance.

2.7 MOTORS

.1 All motors shall be TEFC, service duty, be premium efficiency type meeting Energy Code and have 1.15 service factor.

.2 All motors served by adjustable frequency A/C drives shall be inverter duty rated, Furnish and install motor shaft grounding rings for all motors with VFD's.

2.8 EMISSION CONTROL

.1 Rate of discharge of air contaminants from boiler not to exceed:
.1 Nitrogen oxides not to exceed 50 ppm (corrected to 3% O_2) when tested at factory with 3rc party calibrated flue gas analyser.
.2 Emission control requirement is subject to factory witnessed test of Departmental Representative's discretion. Factory test readings are to be provided at minimum.

2.9 EFFICIENCY

.1 The boiler must meet or exceed the following efficiency targets (including flue gas losses accounted for using flue gas analyzer):
.1 20% load - 80.5%
.2 50% load - 83%
.3 75% load - 83%
.4 100% load - 81%

.2 The typical radiation and connection losses are to be less than 1% combined.

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 ASME Boiler and Pressure Vessels Code, regulations of Province having jurisdiction (TSSA) and manufacturers' recommendations.

.2 Make required piping connections to inlets and outlets recommended by boiler manufacturer. Make all field assembly, piping and wiring as recommended by manufacturer.

3.2 INSTALLATION (Cont'd)

.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 Customize packaged boiler plant to accommodate site conditions.

.5 Pipe steam relief valve to safe location.

.6 Pipe surface blowdown/bottom blowdown and water column drain to blowdown tank c/w check valves and water tempering device.

.7 Natural gas fired installations: in accordance with CSA B149.1.

3.3 MOUNTINGS AND ACCESSORIES

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

.2 Blowdown valves:
- .1 Run discharge to terminate as indicated.

3.4 FIELD QUALITY CONTROL

.1 Commissioning:
- .1 Manufacturer to:
  - .1 Certify installation.
  - .2 Start up and commission installation.
  - .3 Carry out on-site performance verification tests.
  - .4 Demonstrate operation and maintenance.
  - .5 Prepare paperwork on behalf of Departmental Representative to obtain TSSA approval (and Ontario Hydro if applicable) of installation including the "Application for Field Approval - Appliance and Equipment" and the field approval submission summary. Contractor to bear costs of approval and submittal of documents.
- .2 Provide Departmental Representative at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

.2 Boiler manufacturer's authorized representative shall provide supervision and startup service. Include minimum five (5) days per boiler on site for commissioning and 2 days for comprehensive training.

END