

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 10 10 General Instructions.
- .2 Section 01 33 00 Submittal Procedures.

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

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

1.3 QUALITY ASSURANCE

- . 1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- . 2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 MAINTENANCE

- . 1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - . 1 One set of packing for each pump.

- . 2 One casing joint gasket for each size pump.
- . 3 One head gasket set for each heat exchanger.
- . 4 One glass for each gauge glass.
- . 5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

. 2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

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

1.5 DELIVERY, STORAGE, AND HANDLING

- . 1 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MATERIALS

- . 1 Not Used.

PART 3 - EXECUTION

3.1 PAINTING REPAIRS AND RESTORATION

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

3.2 CLEANING

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

3.3 FIELD QUALITY CONTROL

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

3.4 DEMONSTRATION

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

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

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

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

. 6 Departmental Representative will record these demonstrations on video tape for future reference.

3.5 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Use of mechanical systems during construction.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 USE OF SYSTEMS

- .1 Use of new and or existing permanent heating and or ventilating systems for supplying temporary heat or ventilation is not permitted only under following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage.
 - .5 Supply ventilation systems are protected by 60 % filters, inspected daily, changed every week 2 weeks or more frequently as required.
 - .6 Return systems have approved filters over openings, inlets, outlets.
 - .7 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
 - .8 Warranties and guarantees are not relaxed.
 - .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
 - .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.
- .2 Filters specified in this Section are over and above those specified in other Sections of this project.
- .3 Exhaust systems are not included in approvals for temporary heating ventilation.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

- .1 This work shall be governed by all the conditions of labour and material incorporated in the General Contract documents, of which these specifications form a part and shall be subject to all clauses contained in the General Conditions of Division 01.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- .1 Commissioning Section 01 91 00
- .2 General Commissioning Requirements Section 01 91 01
- .3 Commissioning: Training Section 01 91 41
- .4 Mechanical Testing Requirements Section 23 05 03
- .5 EMCS: Startup, Verification and Commissioning Section 25 01 11
- .6 EMCS: Training Section 25 01 12
- .7 Electrical Systems Commissioning Section 26 10 01
- .8 Electrical Testing Requirements Section 26 10 02
- .9 Commissioning Plan

1.3 SCOPE/ WORK INCLUDED

- .1 Provide labour tools and supervision to commission systems specified in Division 23 in accordance with this section and those referenced in subsection 1.2 Related Work Specified Elsewhere above.

1.4 RESPONSIBILITIES

- .1 GENERAL – MECHANICAL, CONTROLS AND TAB CONTRACTORS. The commissioning responsibilities applicable to each of the mechanical, controls and TAB contractors of Division 23 and sections 25 01 11 and 25 05 01 are as follows:

- .1 Attend a commissioning information meeting and other meetings necessary to facilitate the Commissioning process.
- .2 Provide the Commissioning Agent (CxA) with normal cut sheets and shop drawing submittals of commissioned equipment.
- .3 Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional testing procedures.
 - .1 This will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any owner-contracted tests, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified.

In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Agent.

1.4 RESPONSIBILITIES – (Cont'd)

.1.3 - (Cont'd)

- .2 The Commissioning Agent may request further documentation necessary for the commissioning process. This data request may be made prior to normal submittals.
 - .3 Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CxA for review and approval.
 - .4 Contractors shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 - .5 Provide limited assistance to the CxA in preparing the specific functional performance test procedures as specified in the Commissioning Plan. Subs shall review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 - .6 Address current A/E punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems.
 - .7 Provide skilled technicians to execute starting of equipment and to execute the functional performance tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
 - .8 Provide skilled technicians to perform functional performance testing under the direction of the CxA for specified equipment in the Commissioning Plan. Assist the CxA in interpreting the monitoring data, as necessary.
 - .9 Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA, CM and A/E and retest the equipment.
 - .10 Execute seasonal or deferred functional performance testing, witnessed by the CxA, according to the specifications.
- .2 Mechanical Contractor(s) of Division 23. The responsibilities of the HVAC mechanical contractor(s), during construction and acceptance phases in addition to those listed in section 1.4.1 above are:
- .1 Provide startup for all HVAC equipment, except for the building automation control system.
 - .2 Prepare a preliminary schedule for Division 23 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start / completion for use by the CxA. Update the schedule as appropriate.
 - .3 Notify the Construction Manager (CM) or CxA depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Notify the CM or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

1.4 RESPONSIBILITIES – (Cont'd)

.3 Controls Contractor. The commissioning responsibilities of the controls contractor (Section 25 05 01) during construction and acceptance phases in addition to those listed in section 1.4.1 above are:

- .1 Assist and cooperate with the TAB contractor in the following manner:
 - .1 Meet with the TAB contractor prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
 - .2 For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the system completed and approved by the CxA prior to TAB.
 - .3 Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
- .2 Assist and cooperate with the CxA in the following manner:
 - .1 Using a skilled technician who is familiar with this building, execute the functional testing of the controls system as specified for the controls contractor in the Commissioning Plan. Assist in the functional testing of all equipment specified in the Commissioning Plan. Provide two-way radios during the testing.
 - .2 Execute all control system trend logs specified in Section 25 05 01 and the Commissioning Plan.

.4 TAB Contractor. The duties of the TAB contractor of Section 23 05 93, in addition to those listed in section 1.4.1 above are:

- .1 A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests to the CxA and CM at least twice a week.
- .2 Communicate in writing to the controls contractor all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
- .3 Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA.
- .4 Provide the CxA with any requested data, gathered, but not shown on the draft reports.
- .5 Provide a final TAB report for the CxA with details, as in the draft.
- .6 Conduct functional performance tests and checks on the original TAB as specified for TAB in the Commissioning Plan.

1.5 TESTING EQUIPMENT

.1 All test equipment necessary to fulfill the testing requirements of this section and/or as required in Division 23 specifications including the commissioning plan shall be provided as part of the work of this section.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 SUBMITTALS

- .1 Division 23 shall provide submittal documentation relative to commissioning as required.

3.2 STARTUP

- .1 The HVAC mechanical and controls contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 01 91 01. Division 23 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Agent or Owner.
- .2 Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CxA and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all pre-functional checklists as soon as possible.

3.3 TAB

- .1 Refer to the TAB responsibilities in Part 1.4.4 above.

3.4 FUNCTIONAL PERFORMANCE TESTS

- .1 Refer to Section 01 91 01 subsection 1.5 for a list of systems to be commissioned and to Section 01 91 01 subsection Part 3 Commissioning Process for a description of the process and to the Commissioning Plan for specific details on the required functional performance tests.

3.5 OPERATION AND MAINTENANCE (O&M) MANUALS

- .1 The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specification.
- .2 Division 23 shall compile and prepare documentation for all equipment and systems covered in Division 23 and deliver this documentation to the GC for inclusion in the O&M manuals, according to this section and Section 01 91 01, prior to the training of owner personnel.
- .3 The CxA shall receive a copy of the O&M manuals for review.

3.6 TRAINING OF OWNER PERSONNEL

- .1 Refer to Section 01 91 41.

3.7 DEFERRED TESTING

- .1 Refer to Section 01 91 01, subsection 3.10.4 for requirements of deferred testing.

3.8 WRITTEN WORK PRODUCTS

- .1 Written work products of Contractors shall consist of the start-up and initial checkout plan described in Section 01 91 01 and the filled out start-up, initial checkout and pre-functional checklists.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL

- .1 This work shall be governed by all the conditions of labour and material incorporated in the General Contract documents, of which these specifications form a part and shall be subject to all clauses contained in the General Conditions of Division 01.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- | | | |
|----|---|------------------|
| .1 | Commissioning | Section 01 91 00 |
| .2 | General Commissioning Requirements | Section 01 91 01 |
| .3 | Commissioning: Training | Section 01 91 41 |
| .4 | Mechanical Systems Commissioning | Section 23 05 02 |
| .5 | EMCS: Startup, Verification and Commissioning | Section 25 01 11 |
| .6 | EMCS: Training | Section 25 01 12 |
| .7 | Electrical Systems Commissioning | Section 26 10 01 |
| .8 | Electrical Testing Requirements | Section 26 10 02 |
| .9 | Commissioning Plan | |

1.3 SCOPE / WORK INCLUDED

- .1 Provide labour tools and supervision to conduct functional testing as described/specified herein and in Section 01 91 01 for the following equipment and systems:
- Air and water testing and balancing (TAB)
 - Steam Boilers
 - Heating Boilers
 - Air Handling Units
 - Energy Recovery Ventilator
 - Exhaust Fans
 - Domestic Water Heaters
 - Heat Exchanger
 - Cabinet Unit Heaters and Baseboards
 - Door Air Curtain
 - Pumps
 - HVAC Zones
 - Heating Loops
 - Energy Management and Control System (EMCS)

Note: Final equipment list to be provided in the Commissioning Plan

1.4 FUNCTIONAL TESTING

- .1 This section specifies the functional testing requirements for Division 23 systems and equipment. The functional testing process, requirements and test method definitions are described in Section 01 91 01 and the Commissioning Plan.
- .2 Prerequisites for functional testing are as follows:
 - .1 All related equipment has been started up and start-up reports and pre-functional checklists submitted and approved ready for functional testing.
 - .2 All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
 - .3 Piping system flushing complete and required report approved.
 - .4 Water treatment system complete and operational.
 - .5 Vibration control report approved (if required).
 - .6 Test and balance (TAB) complete and approved for the air and hydronic systems.
 - .7 All A/E deficiency list items for the equipment specified is corrected.
 - .8 These functional test procedures reviewed and approved by installing contractor.
 - .9 Safeties and operating ranges reviewed by the CxA.
 - .10 Test requirements and sequences of operation provided.
 - .11 Schedules and setpoints provided.
 - .12 False loading equipment, system and procedures ready.
 - .13 Crankcase heaters have been on long enough for startup.
 - .14 Sufficient clearance around equipment for servicing.
 - .15 Record of all values for pre-test setpoints changed to accommodate testing has been made and a check box provided to verify return to original values (control parameters, limits, delays, lockouts, schedules, etc.)
 - .16 Other miscellaneous checks of the pre-functional checklist and start-up reports completed successfully.
- .3 Monitoring is a method of testing as a stand-alone method or to augment manual testing. All points listed in the required monitoring section of the test requirements which are control system monitored points shall be trended by the controls contractor. At the CxA's request, the controls contractor shall trend up to 20% more points than listed herein at no extra charge. Hard copies of monitored data must be in columnar format with time down the left column and at least 5 columns of point values on the same page. Graphical output is desirable, and will be required for all output, if the system can produce it.
- .4 Functional Testing protocols for each component/system involved are provided in the Commissioning Plan.

1.5 TESTING EQUIPMENT

- .1 All test equipment necessary to fulfill the testing requirements of this section and/or as required in Division 23 specifications including the commissioning plan shall be provided as part of the work of this section.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B139-04, Installation Code for Oil Burning Equipment.
- .3 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 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 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.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Primers Paints Coating: in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11 to SCAQMD Rule 1113.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11 to SCAQMD Rule 1113.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.

.4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.

.5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

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 National Fire Code of Canada CSA B139.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer CSA B139 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 Pipe each drain valve discharge separately to above floor drain.
.1 Discharge to be visible.

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

3.5 AIR VENTS

.1 Install manual air vents to CSA B139 at high points in piping systems.

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

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

.2 Locations: where dissimilar metals are joined.

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

.4 Over NPS 2: isolating flanges.

3.7 PIPEWORK

.1 Install pipework to CSA B139.

INSTALLATION

- . 2 Screwed fittings jointed with Teflon tape.
- . 3 Protect openings against entry of foreign material.
- . 4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- . 5 Assemble piping using fittings manufactured to ANSI standards.
- . 6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - . 1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- . 7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- . 8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- . 9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- . 10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- . 11 Group piping wherever possible and as indicated.
- . 12 Ream pipes, remove scale and other foreign material before assembly.
- . 13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- . 14 Provide for thermal expansion as indicated.
- . 15 Valves:
 - . 1 Install in accessible locations.
 - . 2 Remove interior parts before soldering.
 - . 3 Install with stems above horizontal position unless indicated.
 - . 4 Valves accessible for maintenance without removing adjacent piping.
 - . 5 Install globe valves in bypass around control valves.
 - . 6 Use gate ball or butterfly valves at branch take-offs for isolating purposes except where specified.
 - . 7 Install butterfly valves on chilled water and related condenser water systems only.
 - . 8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - . 9 Install plug cocks or ball valves for glycol service.
 - . 10 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- . 16 Check Valves:
 - . 1 Install silent check valves on discharge of pumps and in

- vertical pipes with downward flow and as indicated.
- . 2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

- . 1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- . 2 Material: schedule 40 black steel pipe.
- . 3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- . 4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- . 5 Installation:
 - . 1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - . 2 Other floors: terminate 25 mm above finished floor.
 - . 3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- . 6 Sealing:
 - . 1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - . 2 Elsewhere:
 - . 1 Provide space for 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.

3.9 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.

3.10 PREPARATION FOR FIRE STOPPING

- . 1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- . 2 Uninsulated unheated pipes not subject to movement: no special preparation.
- . 3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- . 4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

**3.11 FLUSHING OUT
OF PIPING SYSTEMS**

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

**3.12 PRESSURE
TESTING OF
EQUIPMENT AND
PIPEWORK**

- . 1 Advise 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.

**3.13 EXISTING
SYSTEMS**

- . 1 Connect into existing piping systems at times approved by Departmental Representative.
- . 2 Request written approval by Departmental Representative 10days minimum, prior to commencement of work.
- . 3 Be responsible for damage to existing plant by this work.

3.14 CLEANING

- . 1 Clean in accordance with Section 01 74 11 - Cleaning.
- . 2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- . 1 Section Includes:
 - . 1 Electrical motors, drives and guards for mechanical equipment and systems.
 - . 2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
 - . 3 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 Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

- . 2 Related Requirements

- . 1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- . 1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - . 1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- . 2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- . 3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - . 1 Material Safety Data Sheets (MSDS).

**1.3 ACTION AND
INFORMATIONAL
SUBMITTALS**

- . 1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- . 2 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - . 1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- . 3 Closeout Submittals
 - . 1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.4 QUALITY
ASSURANCE**

- . 1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- . 2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

**1.5 DELIVERY,
STORAGE, AND**

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

HANDLING

- . 3 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

- . 1 Motors: high efficiency, in accordance with ASHRAE 90.1.

2.2 MOTORS

- . 1 Provide motors for mechanical equipment as specified.
- . 2 Motors under 373 W (1/2 HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- . 3 Motors 373 W (1/2 HP) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, V, unless otherwise indicated.

**2.3 TEMPORARY
MOTORS**

- . 1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Departmental Representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

- . 1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- . 2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- . 3 For motors under 7.5 kW (10 HP): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- . 4 For motors 7.5 kW (10 HP) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- . 5 Correct size of sheave determined during commissioning.
- . 6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- . 7 Motor slide rail adjustment plates to allow for centre line adjustment.
- . 8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

- . 1 Provide guards for unprotected drives.

-

- . 2 Guards for belt drives;
 - . 1 Expanded metal screen welded to steel frame.
 - . 2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - . 3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - . 4 Removable for servicing.
- . 3 Provide means to permit lubrication and use of test instruments with guards in place.
- . 4 Install belt guards to allow movement of motors for adjusting belt tension.
- . 5 Guard for flexible coupling:
 - . 1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - . 2 Securely fasten in place.
 - . 3 Removable for servicing.
- . 6 Unprotected fan inlets or outlets:
 - . 1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - . 2 Net free area of guard: not less than 80% of fan openings.
 - . 3 Securely fasten in place.
 - . 4 Removable for servicing.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- . 1 Fasten securely in place.
- . 2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

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

3.4 CLEANING

- . 1 Proceed in accordance with Section 01 74 11 - Cleaning.
- . 2 Upon completion and verification of performance of installation,

- remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM A 53/A 53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A 105/A 105M-05, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GROOVED END EXPANSION JOINTS

- .1 Packless, Gasketed, Slip, Expansion Joints:
 - .1 2413 kPa maximum working pressure.
 - .2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.
 - .3 PTFE modified polyphenylene sulfide coated slide section.
 - .4 Suitable for axial end movement to 75 mm.
- .2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

2.2 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.
- .3 Inner hose: bronze stainless steel corrugated.
- .4 Braided wire mesh bronze stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.

- .6 Operating conditions:
 - .1 Working pressure: 1034 kPa.
 - .2 Working temperature: To match system requirements.
- .7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

2.3 ANCHORS AND GUIDES

- .1 Anchors:
 - .1 Provide as indicated.
 - .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.
 - .3 Reinforcement: to Section 03 20 00 - Concrete Reinforcing.
- .2 Alignment guides:
 - .1 Provide as indicated by conduit manufacturer.
 - .2 To accommodate specified thickness of insulation.
 - .3 Vapour barriers, jackets to remain uninterrupted.

PART 3 - EXECUTION

3.1 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, as indicated as instructed by Departmental Representative. Make record of cold settings.
- .2 Install expansion joints and flexible connections 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.

3.4 PERFORMANCE VERIFICATION

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

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2007, Power Piping.
 - .2 ANSI/ASME B31.3-2006, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-2007:
 - .1 BPVC 2007 Section I: Power Boilers.
 - .2 BPVC 2007 Section V: Nondestructive Examination.
 - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1-2000(R2006), Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-2005, Safety in Welding, Cutting and Allied Process.
 - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W47.2-M1987(R2008), Certification of Companies for Fusion Welding of Aluminum.
 - .2 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .3 CSA B51-03(R2007), Boiler, Pressure Vessel and Pressure Piping Code.
 - .4 CSA-W117.2-2006, Safety in Welding, Cutting and Allied Processes.
 - .5 CSA W178.1-2008, Certification of Welding Inspection Organizations.
 - .6 CSA W178.2-2008, Certification of Welding Inspectors.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 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 Owner.
 - .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.
- 1.5 DELIVERY, STORAGE AND HANDLING**
- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
 - .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.
- 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 ANSI/ASME B31.1 B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Division 15 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 ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - . 3 Inspect and test % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and magnetic particle (hereinafter referred to as "particle") tests and spot full gamma ray radiographic (hereinafter referred to as "radiography") tests.
- . 2 Hydrostatically test welds to ANSI/ASME B31.1.
- . 3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- . 4 Failure of visual examinations:
 - . 1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative of total of up to 10% of welds, selected at random by Departmental Representative by radiographic particle tests.
- . 5 Full radiographic tests for piping systems.
 - . 1 Spot radiography:
 - . 1 Conduct spot radiographic tests of up to 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.
- . 6 Magnetic particle tests for piping systems.

3.6 DEFECTS CAUSING REJECTION

- . 1 As described in ANSI/ASME B31.1 and ANSI/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.

3.8 CLEANING

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 HEALTH AND SAFETY

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management And Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

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

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB 14.4 ASME B40.200.

2.3 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass or 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 Gasketed pressure relief back with solid front.
- . 5 Bronze stop cock.
- . 6 Oil filled for high vibration applications.

PART 3 - EXECUTION

3.1 GENERAL

- . 1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.

- . 2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

- . 1 Install in wells on piping. Provide heat conductive material inside well.

- . 2 Install in locations as indicated and on inlet and outlet of:

- . 1 Heat exchangers.
- . 2 Water heating and cooling coils.
- . 3 Water boilers.
- . 4 Chillers.
- . 5 DHW tanks.

- . 3 Install wells as indicated only for balancing purposes.

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

3.3 PRESSURE GAUGES

- . 1 Install in following locations:

- . 1 Suction and discharge of pumps.
- . 2 Upstream and downstream of PRV's.
- . 3 Upstream and downstream of control valves.
- . 4 Inlet and outlet of coils.
- . 5 Inlet and outlet of liquid side of heat exchangers.
- . 6 Outlet of boilers.
- . 7 In other locations as indicated.

- . 2 Install gauge cocks for balancing purposes, elsewhere as indicated.

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

3.4 NAMEPLATES

- . 1 Install engraved lamicoïd nameplates as specified in Section 23 05 53.01 - Mechanical Identification, identifying medium.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A 276-08, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B 283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B 505/B 505M-08a, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2008, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

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

1.5 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.

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 Delivery and Acceptance Requirements:

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

- . 3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

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 ANSI/ASME B1.20.1.
 - . 2 Copper tube systems: solder ends grooved ends to ANSI/ASME B16.18.
- . 3 Lockshield Keys:
 - . 1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.
- . 4 Gate Valves:
 - . 1 Requirements common to gate valves, unless specified otherwise:
 - . 1 Standard specification: MSS SP-80.
 - . 2 Bonnet: union with hexagonal shoulders.
 - . 3 Connections: screwed with hexagonal shoulders.
 - . 4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - . 5 Packing: non-asbestos.
 - . 6 Handwheel: non-ferrous.
 - . 7 Handwheel Nut: bronze to ASTM B 62.
 - . 2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - . 1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - . 2 Operator: Handwheel.
 - . 3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - . 1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - . 2 Operator: handwheel.
 - . 4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - . 1 Body: with long disc guides, screwed bonnet.
 - . 2 Disc: split wedge, bronze to ASTM B 283, loosely secured to stem.
 - . 3 Operator: handwheel lockshield.
 - . 5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - . 1 Body: with long disc guides, screwed bonnet.
 - . 2 Operator: handwheel.
 - . 6 NPS 2 and under, rising stem, solid wedge disc, Class 150:

- . 1 Body: with long disc guides, screwed union bonnet.
- . 2 Operator: handwheel.
- . 5 Globe Valves:
 - . 1 Requirements common to globe valves, unless specified otherwise:
 - . 1 Standard specification: MSS SP-80.
 - . 2 Bonnet: union with hexagonal shoulders.
 - . 3 Connections: screwed with hexagonal shoulders.
 - . 4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - . 5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - . 6 Handwheel: non-ferrous.
 - . 7 Handwheel Nut: bronze to ASTM B 62.
 - . 2 NPS 2 and under, composition disc, Class 125:
 - . 1 Body and bonnet: screwed bonnet.
 - . 2 Disc and seat: renewable rotating PTFE disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B 505.
 - . 3 Operator: handwheel lockshield.
 - . 3 NPS 2 and under, composition disc, Class 150:
 - . 1 Body and bonnet: union bonnet.
 - . 2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B 505.
 - . 3 Operator: handwheel lockshield.
 - . 4 NPS 2 and under, plug disc, Class 150, screwed ends:
 - . 1 Body and bonnet: union bonnet.
 - . 2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A 276, loosely secured to stem.
 - . 3 Operator: handwheel.
 - . 5 Angle valve, NPS 2 and under, composition disc, Class 150:
 - . 1 Body and bonnet: union bonnet.
 - . 2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
 - . 3 Operator: handwheel lockshield.
- . 6 Check Valves:
 - . 1 Requirements common to check valves, unless specified otherwise:
 - . 1 Standard specification: MSS SP-80.
 - . 2 Connections: screwed with hexagonal shoulders.
 - . 2 NPS 2 and under, swing type, bronze disc, Class 125:
 - . 1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

- . 2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- . 3 NPS 2 and under, swing type, bronze disc:
 - . 1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - . 2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- . 4 NPS 2 and under, swing type, composition disc, Class 200:
 - . 1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - . 2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
- . 5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - . 1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - . 2 Disc: renewable PTFE no. 6 composition rotating disc in disc holder having guides top and bottom, of bronze to ASTM B 62.
- . 6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - . 1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- . 7 Silent Check Valves:
 - . 1 NPS 2 and under:
 - . 1 Body: cast high tensile bronze to ASTM B 62 with integral seat.
 - . 2 Pressure rating: Class 125.
 - . 3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.
 - . 4 Disc and seat: renewable rotating disc.
 - . 5 Stainless steel spring, heavy duty.
 - . 6 Seat: regrindable.
- . 8 Ball Valves:
 - . 1 NPS 2 and under:
 - . 1 Body and cap: cast high tensile bronze to ASTM B 62.
 - . 2 Pressure rating: Class 125 2760-kPa CWP 4140-kPa CWP, 860 kPa steam.
 - . 3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders solder ends to ANSI.
 - . 4 Stem: tamperproof ball drive.
 - . 5 Stem packing nut: external to body.
 - . 6 Ball and seat: replaceable stainless steel hard chrome solid ball and Teflon seats.
 - . 7 Stem seal: TFE with external packing nut.
 - . 8 Operator: removable lever handle.
- . 9 Butterfly Valves:
 - . 1 NPS 2 1/2 through NPS 6, 2068 kPa with grooved ends.
 - . 1 Body: cast bronze, with copper-tube dimensioned grooved ends.
 - . 2 Disc: elastomer coated ductile iron with integrally cast

- stem.
- . 3 Operator: lever or handwheel.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 CLEANING

- . 1 Clean in accordance with Section 01 74 11 - Cleaning.
- . 2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASTM International Inc.
 - .1 ASTM A 49-01(2006), Standard Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A 126-04, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .3 ASTM A 536-84(2004)e1, Standard Specification for Ductile Iron Castings.
 - .4 ASTM B 61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .5 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .6 ASTM B 85/B 85M-08, Standard Specification for Aluminum-Alloy Die Castings.
 - .7 ASTM B 209-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-03, Pressure Testing of Steel Valves.
 - .2 MSS SP-70-06, Grey Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP-71-05, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP-82-1992, Valve Pressure Testing Methods.
 - .5 MSS SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

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

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 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE

- .1 Furnish following spare parts:

MATERIAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MATERIAL

- . 1 Valves:
 - . 1 Except for specialty valves, to be of single manufacturer.
- . 2 Standard specifications:
 - . 1 Gate valves: MSS SP-70.
 - . 2 Globe valves: MSS SP-85.
 - . 3 Check valves: MSS SP-71.
- . 3 Requirements common to valves, unless specified otherwise:
 - . 1 Body, bonnet: cast iron to ASTM B 209 Class B ductile iron to ASTM A 536 Grade 65-45-12.
 - . 2 Connections: flanged ends plain face with 2 mm raised face with serrated finish grooved ends to ANSI B16.1.
 - . 3 Inspection and pressure testing: to MSS SP-82.
 - . 4 Bonnet gasket: non-asbestos.
 - . 5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
 - . 6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.
 - . 7 Gland packing: non-asbestos.
 - . 8 Handwheel: die-cast aluminum alloy to ASTM B 85/B 85M or malleable iron to ASTM A 49. Nut of bronze to ASTM B 62.
 - . 9 Identification tag: with catalogue number, size, other pertinent data.
- . 4 All products to have CRN registration numbers.

2.2 GATE VALVES

- . 1 NPS 2 1/2 - 8, non rising stem, inside screw, bronze iron trim, solid wedge disc:
 - . 1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, Class 125.
 - . 2 Disc: solid offset taper wedge, bronze to ASTM B 62.
 - . 3 Seat rings: renewable bronze to ASTM B 62, screwed into body.
 - . 4 Stem: bronze to ASTM B 62.
 - . 5 Disc: solid offset taper wedge, cast iron to ASTM A 126 Class B, secured to wrought steel stem.
 - . 6 Seat: integral with body.
 - . 7 Stem: wrought steel.
 - . 8 Operator: handwheel.
 - . 9 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze, paragraph.
- . 2 NPS 10 - 24, non rising stem, inside crew, bronze iron trim, solid wedge disc:

- . 1 Body and multiple-bolted bonnet: cast iron to ASTM A 126 Class B for sizes up to NPS 14, Class C for sizes NPS 16 and over, with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges.
 - . 2 Pressure ratings: Class 125.
 - . 3 Disc: solid offset taper wedge, with bronze rings to ASTM B 62 rolled into cast iron disc, secured to stem.
 - . 4 Seat rings: renewable bronze to ASTM B 62 screwed into body.
 - . 5 Stem: bronze to ASTM B 62.
 - . 6 Disc: solid offset taper wedge, cast iron secured to stem.
 - . 7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
 - . 8 Stem: wrought steel.
 - . 9 Operator: handwheel.
 - . 10 Bypass: complete with union and NPS gate globe valve as Section 23 05 05 - Installation of Pipework, paragraph.
- . 3 NPS 2 1/2-8, outside screw and yoke (OS&Y), bronze iron trim, solid wedge disc:
- . 1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.
 - . 2 Disc: solid offset taper wedge, bronze to ASTM B 62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.
 - . 3 Seat rings: renewable bronze screwed into body.
 - . 4 Stem: nickel-plated steel manganese-bronze.
 - . 5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
 - . 6 Seat rings: integral with body.
 - . 7 Stem: nickel-plated steel.
 - . 8 Pressure-lubricated operating mechanism.
 - . 9 Operator: handwheel.
 - . 10 Bypass: complete with union and NPS gate globe valve as Section 23 05 05 - Installation of Pipework, paragraph.
- . 4 NPS 10 - 24, outside screw and yoke (OS&Y), bronze iron trim, solid wedge disc:
- . 1 Body and multiple-bolted bonnet: NPS 10 - 14: cast iron to ASTM A 126 Class B. With bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, body tie ribs between bonnet and end flanges, yoke, yoke hub, yoke sleeve and nut.
 - . 2 Pressure ratings: Class 125.
 - . 1 NPS 10-12: WP = 1.4 Mpa CWP.
 - . 2 NPS 14-24: WP = 1.03 Mpa CWP.
 - . 3 Disc: solid offset taper wedge, bronze disc rings to ASTM B 62 rolled into cast iron disc, secured to stem through integral forged T-head disc-stem connection.
 - . 4 Seat rings: renewable bronze to ASTM B 62 screwed into body.

- . 5 Stem: nickel-plated steel manganese-bronze.
- . 6 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.
- . 7 Seat: integral with body up to NPS 14, renewable nodular iron on other sizes.
- . 8 Stem: nickel-plated steel.
- . 9 Pressure-lubricated operating mechanism.
- . 10 Operator: handwheel.
- . 11 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze.

**2.3 UNDERWRITERS
APPROVED GATE VALVE**

- . 1 NPS 2 1/2 - 14, OS&Y:
 - . 1 Approvals: UL and FM approved for fire service.
 - . 2 UL and FM Label: on valve yoke.
 - . 3 Body, Bonnet: cast iron to ASTM A 126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B) ductile iron to ASTM A 536 Grade 65-45-12.
 - . 4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.
 - . 5 Packing gland: bronze.
 - . 6 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass, ASTM B 16.
 - . 7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).
 - . 8 Bosses for bypass valve, drain: on NPS 4 and over.
 - . 9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.
 - . 10 Disc seat ring: self-aligning, Milwood undercut on NPS 3 - 12.
 - . 11 Pressure rating:
 - . 1 NPS 2-1/2 - 12: 1.7 Mpa CWP.
 - . 2 NPS 14-1.2: 1.2 MPa CWP.
 - . 12 Operator: handwheel.
 - . 13 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze, paragraph.

2.4 GLOBE VALVES

- . 1 NPS 2 1/2 - 10, OSY:
 - . 1 Body: with multiple-bolted bonnet.
 - . 2 WP: 860 kPa steam, 1.4 MPa CWP.
 - . 3 Bonnet-yoke gasket: non-asbestos.
 - . 4 Disc: bronze to ASTM B 62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.
 - . 5 Seat ring: renewable, regrindable, screwed into body.
 - . 6 Stem: bronze to ASTM B 62.
 - . 7 Operator: handwheel.
 - . 8 Bypass: complete with union and NPS gate globe valve as Section 23 05 23.01 - Valves - Bronze, paragraph.

**2.5 BYPASSES FOR
GATE AND GLOBE
VALVES**

- . 1 Locations: on valves as indicated.
- . 2 Position of bypass valve on main valves:
- . 3 Size of bypass valve:
 - . 1 Main valve up to NPS 8: NPS 3/4.
 - . 2 Main valve NPS 10 and over: NPS 1.

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

2.6 VALVE OPERATORS

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

2.7 CHECK VALVES

- . 1 Swing check valves, Class 125:
 - . 1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Grooved or flanged ends: plain faced with smooth finish.
 - . 1 Up to NPS 16: cast iron to ASTM A 126 Class B ductile iron ASTM A 536 Grade 65-45-12.
 - . 2 NPS 18 and over: cast iron to ASTM A 126 Class C.
 - . 2 Ratings:
 - . 1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.
 - . 2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.
 - . 3 NPS 18 and over: 1.03 MPa CWP.
 - . 3 Disc: rotating for extended life.
 - . 1 Up to NPS 6: bronze to ASTM B 62 stainless steel type 316.
 - . 2 NPS 8 and over: bronze-faced cast iron.
 - . 4 Seat rings: renewable bronze to ASTM B 62 screwed into body.
 - . 5 Hinge pin, bushings: renewable bronze to ASTM B 62 stainless steel.
 - . 6 Disc: A126 Class B, secured to stem, rotating for extended life.
 - . 7 Seat: cast iron, integral with body.
 - . 8 Hinge pin: exelloy; bushings: malleable iron.
 - . 9 Identification tag: fastened to cover.
 - . 10 Hinge: galvanized malleable iron stainless steel.
- . 2 Swing check valves, NPS 2 1/2 - 8 Class 250:
 - . 1 Body and bolted cover: cast iron to ASTM A 126 Class B with tapped and plugged opening on each side for hinge pin.
 - . 2 Flanged ends: 2 mm raised face with serrated finish.
 - . 3 Rating: 250 psi steam; 500 psi CWP.
 - . 4 Disc: rotating for extended life.
 - . 1 Up to NPS 3: bronze to ASTM B 61.
 - . 2 NPS 4 - 8: iron faced with ASTM B 61 bronze.
 - . 5 Seat rings: renewable bronze to ASTM B 61, screwed into body.
 - . 6 Hinge pin, bushings: renewable, bronze to ASTM B 61.
 - . 7 Hinge: galvanized malleable iron.
 - . 8 Identification tag: fastened to cover.

**2.8 SILENT CHECK
VALVES**

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Valves Cast Steel, gate, globe, and check.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.5-2003, Pipe Flanges and Flanged Fittings.
 - .2 ANSI/ASME B16.10-1992, Face-to-Face and End-to-End Dimensions Valves.
 - .3 ANSI/ASME B16.25-1997, Buttwelding Ends.
 - .4 ANSI/ASME B16.34-1996, Valves - Flanged, Threaded and Welding End.
- .2 American Petroleum Institute (API).
 - .1 API 598-1996, Valve Inspection and Testing.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 49-01, Specification for Heat-Treated Carbon Steel Joint Bars.
 - .2 ASTM A 193/A 193M-04, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - .3 ASTM A 194/A 194M-03b, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - .4 ASTM A 216/A 216M-1993(03), Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .5 ASTM B 85-03, Specification for Aluminum-Alloy Die Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
 - .1 MSS SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2003, Pressure Testing of Steel Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.
 - .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit data for valves specified this section.
 - .3 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Closeout Submittals:
 - .1 Submit maintenance data for incorporation into manual

specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE AND DISPOSAL

- .1 Waste Management and Disposal:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management And Disposal.

1.6 MAINTENANCE

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

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .1 Except for specialty valves, to be of single manufacturer.
 - .2 Valves to be individually tested.
- .2 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI 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 ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B 85 or malleable iron to ASTM A 49.
 - .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, solid flexible wedge disc, flanged butt-weld ends, Class 150 300:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A 216/A 216M WCB, with full length disc guides designed to ensure correct re-assembly.

- . 2 Body/bonnet joint: Flat Male-female face with corrugated metallic gasket.
- . 3 Bonnet studs: to ASTM A 193/A 193M Type B7.
- . 4 Bonnet nuts: to ASTM A 194/A 194M 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 this section.

2.3 GLOBE VALVES

- . 1 300: NPS 2 1/2 - 12, rising stem, OS&Y, flanged butt-weld ends, Class 150
 - . 1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A 216/A 216M WCB.
 - . 2 Body/bonnet joint: Flat Male-female face with corrugated metallic gasket.
 - . 3 Bonnet studs: to ASTM A 193/A 193M Type B7.
 - . 4 Bonnet nuts: to ASTM A 194/A 194M 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 ball type with 35 degrees taper seat.
 - . 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 this section.

2.4 VALVE OPERATORS

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

**2.5 BYPASSES FOR
GATE AND GLOBE
VALVES**

- . 1 Locations: on valves as indicated.
- . 2 Position of bypass valve on main valves:.
- . 3 Size of bypass valve:
 - . 1 Main valve up to NPS 8: NPS 3/4.
 - . 2 Main valve NPS 10 and over: NPS 1.
- . 4 Type of bypass valves:
 - . 1 On gate valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze.
 - . 2 On globe valve: globe, with composition bronze disc, bronze trim, to Section 23 05 23.01 - Valves - Bronze.

2.6 CHECK VALVES

- . 1 NPS 2 1/2 and over, flanged butt-weld ends, Class150 300: swing check.
 - . 1 Body and multiple-bolted cap: cast steel to ASTM A 216/A 216M WCB.
 - . 2 Cap studs: to ASTM A 193/A 193M Type B7.
 - . 3 Cap nuts: to ASTM A 194/A 194M 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.

PART 3- EXECUTION

3.1 INSTALLATION

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- . 1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- . 1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - . 1 ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
 - . 2 ASME B16.1-05, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
 - . 3 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings: NPS ½ through 24.
 - . 4 ANSI/ASME B16.11-05, Forged Fittings, Socket-Welding and Threaded.
 - . 5 ANSI/ASME B16.25-07, Buttwelding Ends.
 - . 6 ANSI/ASME B16.34-04, Valves - Flanged, Threaded and Welding Ends.
- . 2 ASTM International Inc.
 - . 1 ASTM A 126-04), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - . 2 ASTM A 536-84(2004)e1, Standard Specification for Ductile Iron Castings.
 - . 3 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - . 4 ASTM B 209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate Metric.
- . 3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - . 1 MSS SP-67-02a, Butterfly Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

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

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 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- . 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.
 - . 4 Valve handles: 2 of each size.

- . 5 Gaskets for flanges: one for every 10 flanged joints.

PART 2 - PRODUCTS

2.1 BUTTERFLY VALVES - RESILIENT SEAT - 200 PSIG

- . 1 Except to specialty valves, to be of single manufacturer.
- . 2 To be suitable for dead-end service.
- . 3 CRN registration number required for products.
- . 4 Sizes:
 - . 1 Wafer Lug type: NPS 2 to 30.
 - . 2 Grooved end type: NPS 2 to 12.
- . 5 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - . 1 NPS 2 - 12: 200 psig.
 - . 2 NPS 14 - 48: 200 psig.
- . 6 Minimum seat temperature ratings to 121 135 degrees C.
- . 7 Application: on-off operation.
- . 8 Full lug body (threaded) Grooved ends.
- . 9 Operators:
 - . 1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel. Standard coating: black laquer.
 - . 2 NPS 8 - 30: manual enclosed gear operator electric pneumatic actuators as specified elsewhere in this section.
- . 10 Designed to comply with MSS SP-67 and API 609.
- . 11 Compatible with ANSI Class 125/Class 150 flanges.
- . 12 Construction:
 - . 1 Body ductile iron ss aluminum bronze.
 - . 2 Disc: aluminum bronze 316 SS plated ductile iron coated ductile iron.
 - . 3 Seat: EPDM Buna-N Viton EPT.
 - . 4 Shaft: 316 416 stainless steel.
 - . 5 Taper pin: 316 SS Monel.
 - . 6 Key: carbon steel stainless.
 - . 7 O-Ring: Buna-N EPDM Fluoroelastomer.
 - . 8 Bushings: luberized bronze Teflon fibreglass with Teflon lining.

2.2 BUTTERFLY VALVES - RESILIENT SEAT - 285 PSIG

- . 1 Sizes:
 - . 1 Lug type: NPS 2 to 48.
 - . 2 Grooved end type: NPS 2 to 12.
- . 2 Pressure rating: 285 psig at 121 135 degrees C.
- . 3 Lug body: 150 ANSI bolt pattern.

- . 4 Full lug body (threaded) Grooved ends..
- . 5 Application: for on-off service.
- . 6 Operators:
 - . 1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.
 - . 2 NPS 8 - 24: manual enclosed gear operator electric pneumatic actuators.
 - . 3 Install parallel or perpendicular to pipeline.
- . 7 Designed to comply with MSS SP-67 and API Std. 609.
- . 8 Compatible with ANSI B16.1 Class 125 (iron) and ANSI B16.5 Class 150 (steel) flanges.
- . 9 Construction:
 - . 1 Body: ductile iron.
 - . 2 Disc: aluminum bronze 316 SS coated ductile iron.
 - . 3 Seat: EPDM Buna-N Viton EPT.
 - . 4 Refer to manufacturer's literature for additional materials.
 - . 5 Shaft: NPS 2 - 12: 416 stainless steel NPS 14 - 48, 316 stainless steel.
 - . 6 Taper pin: 316 SS Monel.
 - . 7 Blowout proof stem.
 - . 8 O-Ring: Buna-N EPDM Fluoroelastomer .
 - . 9 Bushings: Teflon.
 - . 10 Disc shall not be pinned to shaft.
 - . 11 Bubble tight shutoff with downstream flanges removed, class 6 shutoff.

2.3 MOUNTING FLANGES

- . 1 Class 125 cast iron to ANSI B16.1 or Class 150 steel to B16.5 pipe flanges.

PART 3 - EXECUTION

3.1 PREPARATION

- . 1 Valve and mating flange preparation.
 - . 1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - . 2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - . 3 Install butterfly valves with disc in almost closed position.
 - . 4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

- . 1 Install in accordance with manufacturer's instructions.
- . 2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- . 3 Verify suitability of valve for application by inspection of identification

tag.

- . 4 Mount actuator on to valve prior to installation.
- . 5 Handle valve with care so as to prevent damage to disc and seat faces.
- . 6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- . 7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

- . 1 Cycle valve operation from fully closed to fully open then back to fully closed.
- . 2 At same time, check travel stop settings for proper disc alignment.

3.4 CLEANING

- . 1 Clean in accordance with Section 01 74 11 - Cleaning.
- . 2 Clean installed products in accordance to manufacturer's recommendation.
- . 3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International
 - .1 ASTM A 125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A 307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A 563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM) .
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP 58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP 69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP 89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

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.

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- . 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.

2.2 GENERAL

- . 1 Fabricate hangers, supports and sway braces in accordance with MSS SP 58. ANSI B31.1 and
- . 2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- . 1 Finishes:
 - . 1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.
 - . 2 Use electro-plating galvanizing process hot dipped galvanizing process.
 - . 3 Ensure steel hangers in contact with copper piping are copper plated epoxy coated.
- . 2 Upper attachment structural: suspension from lower flange of I-Beam:
 - . 1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - . 1 Rod: 9 mm UL listed 13 mm FM approved.
 - . 2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed FM approved to MSS-SP 58 and MSS-SP 69.
- . 3 Upper attachment structural: suspension from upper flange of I-Beam:
 - . 1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP 69.
 - . 2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
- . 4 Upper attachment to concrete:
 - . 1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - . 2 Concrete inserts: wedge shaped body with knockout protector plate, UL listed or FM approved to MSS SP 69.
- . 5 Shop and field-fabricated assemblies:
 - . 1 Trapeze hanger assemblies:.
 - . 2 Steel brackets:.
 - . 3 Sway braces for seismic restraint systems: to Section.
- . 6 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.

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. 3 Do not use 22 mm or 28 mm rod.

. 7 Pipe attachments: material to MSS SP 58:

- . 1 Attachments for steel piping: carbon steel black galvanized.
- . 2 Attachments for copper piping: copper plated black steel.
- . 3 Use insulation shields for hot pipework.
- . 4 Oversize pipe hangers and supports.

. 8 Adjustable clevis: material to MSS SP 69 UL listed FM approved, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

- . 1 Ensure "U" has hole in bottom for rivetting to insulation shields.

. 9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 69.

. 10 U-bolts: carbon steel to MSS SP 69 with 2 nuts at each end to ASTM A 563.

- . 1 Finishes for steel pipework: black galvanized.
- . 2 Finishes for copper, glass, brass or aluminum pipework: black galvanized, with formed portion plastic coated epoxy coated.

. 11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 69.

2.4 RISER CLAMPS

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

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

. 3 Bolts: to ASTM A 307.

. 4 Nuts: to ASTM A 563.

2.5 INSULATION PROTECTION SHIELDS

. 1 Insulated cold piping:

- . 1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP 69, galvanized sheet. 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 69.

2.6 CONSTANT SUPPORT SPRING HANGERS

. 1 Springs: alloy steel to ASTM A 125, 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 drawings.

2.7 EQUIPMENT SUPPORTS

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

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.9 HOUSE-KEEPING PADS

.1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.

.3 Clamps on riser piping:

.1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.

.2 Bolt-tightening torques to industry standards.

.3 Steel pipes: install below coupling or shear lugs welded to pipe.

.4 Cast iron pipes: install below joint.

.4 Clevis plates:

.1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.6 Use approved constant support type hangers where:

.1 Vertical movement of pipework is 13 mm or more,

.2 Transfer of load to adjacent hangers or connected equipment is not permitted.

.7 Use variable support spring hangers where:

.1 Transfer of load to adjacent piping or to connected equipment is not critical.

.2 Variation in supporting effect does not exceed 25 % of total

load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code Provincial Code authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas 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
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 69.

**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.

**3.7 FIELD QUALITY
CONTROL**

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

3.8 CLEANING

- . 1 Clean in accordance with Section 01 74 11 - Cleaning.
- . 2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
 - .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data to include paint colour chips, other products specified in this section.

1.4 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

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

**2.2 SYSTEM
NAMEPLATES**

- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.
- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.
- .5 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 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/CGA B149.1 authority having jurisdiction.
 - .2 Sprinklers: to NFPA 13.
 - .3 Standpipe and hose systems: to NFPA 14.

2.5 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: to following table:

<u>Background colour:</u>	<u>Legend, arrows:</u>
Yellow	BLACK
Green	WHITE
Red	WHITE

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

	marking	
City water	Green	CITY WATER
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	Green	DOM. HW
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
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	to Codes	
Gas regulator vents	to Codes	
Compressed air (<700kPa)	Green	COMP. AIR kPa
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

**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.
- .2 Use one nameplate and label for each language both languages.

PART 3 - EXECUTION

**3.1 MANUFACTURER'S
INSTRUCTIONS**

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

3.2 TIMING

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

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and or CSA registration plates as required by respective agency.
- .3 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.

3.7 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

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

1.3 PURPOSE OF TAB

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

performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

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

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

. 1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

. 2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

. 1 Review contract documents before project construction is started and confirm in writing to 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.

1.7 START-UP

. 1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

. 2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

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

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

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

. 4 Application of weatherstripping, sealing, and caulking.

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

. 6 Provisions for TAB installed and operational.

. 7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

. 1 Proper thermal overload protection in place for electrical equipment.

. 2 Air systems:

. 1 Filters in place, clean.

. 2 Duct systems clean.

- . 3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - . 4 Correct fan rotation.
 - . 5 Fire, smoke, volume control dampers installed and open.
 - . 6 Coil fins combed, clean.
 - . 7 Access doors, installed, closed.
 - . 8 Outlets installed, volume control dampers open.
 - . 3 Liquid systems:
 - . 1 Flushed, filled, vented.
 - . 2 Correct pump rotation.
 - . 3 Strainers in place, baskets clean.
 - . 4 Isolating and balancing valves installed, open.
 - . 5 Calibrated balancing valves installed, at factory settings.
 - . 6 Chemical treatment systems complete, operational.
- 1.10 APPLICATION TOLERANCES**
- . 1 Do TAB to following tolerances of design values:
 - . 1 HVAC systems: plus 10 %, minus 0 %.
 - . 2 Hydronic systems: plus or minus 10 %.
- 1.11 ACCURACY TOLERANCES**
- . 1 Measured values accurate to within plus or minus 2 % of actual values.
- 1.12 INSTRUMENTS**
- . 1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
 - . 2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
 - . 3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.
- 1.13 ACTION AND INFORMATIONAL SUBMITTALS**
- . 1 Submit, prior to commencement of TAB:
 - . 2 Proposed methodology and procedures for performing TAB if different from referenced standard.
- 1.14 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.
- 1.15 TAB REPORT**
- . 1 Format in accordance with referenced standard.
 - . 2 TAB report to show results in SI units and to include:
 - . 1 Project record drawings.
 - . 2 System schematics.
 - . 3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English French both official languages in D-ring binders, complete with index tabs.

1.16 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.

1.17 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.

1.18 COMPLETION OF TAB

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

1.19 AIR SYSTEMS

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC NEBB SMACNA ASHRAE.
- .2 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB qualified to standards of AABC or NEBB.
- .3 Quality assurance: perform TAB under direction of supervisor qualified by to standards of AABC or NEBB.
- .4 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .5 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .6 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.

1.21 POST-OCCUPANCY TAB

- .1 Participate in systems checks twice during Warranty Period:
 - .1 Approximately 3 months after acceptance, and
 - .2 Within 1 month of termination of Warranty Period.

PART 2 - PRODUCTS

2.1 NOT USED .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED .1 Not used.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and methods for pressure testing ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.
 - .2 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: submit manufacturer's installation instructions.
 - .6 Manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

**2.1 TEST
INSTRUMENTS**

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.
- .4 Test instruments: calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .5 Re-calibrated every six months thereafter.

**2.2 EQUIPMENT
LEAKAGE TOLERANCES**

- .1 Equipment and system components such as VAV boxes, duct heating leakage: %.

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 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
 - .1 Fittings, branch ducts, tap-ins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Small duct systems up to 250 Pa: leakage 2%.
 - .2 VAV box and duct on downstream side of VAV box: leakage 2%.
 - .3 Large low pressure duct systems up to 500 Pa: leakage 2%.
 - .4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1.

. 3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

. 1 Test ducts before installation of insulation or other forms of concealment.

. 2 Test after seals have cured.

. 3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

. 4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

. 1 Manufacturer's Field Services.

. 1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

. 2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

. 3 Schedule site visits, to review Work, at stages listed:

. 1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

. 2 Twice during progress of Work at 25% and 60% complete.

. 3 Upon completion of the Work, after cleaning is carried out.

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

. 2 Performance Verification:

. 1 Departmental Representative to witness tests and to verify reported results.

. 2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ASTM International Inc.
 - .1 ASTM B 209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C 335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C 411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C 449/C 449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C 547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C 553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C 612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C 795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .9 ASTM C 921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment

-
- Thermal Insulation.
 - . 4 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
 - . 5 Underwriters Laboratories of Canada (ULC)
 - . 1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - . 2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE AND HANDLING

- . 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- . 2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- . 3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- . 1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- . 2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
- . 3 TIAC Code C-1: Rigid mineral fibre board to ASTM C 612, with without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- . 4 TIAC Code C-2: Mineral fibre blanket to ASTM C 553 faced with without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - . 1 Mineral fibre: to ASTM C 553.
 - . 2 Jacket: to CGSB 51-GP-52Ma.
 - . 3 Maximum "k" factor: to ASTM C 553.

2.3 JACKETS

- . 1 Canvas:
 - . 1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.

- . 2 Lagging adhesive: compatible with insulation.
 - . 1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.

- . 3 Aluminum:
 - . 1 To ASTM B 209 with and without moisture barrier as scheduled in PART 3 of this section.
 - . 2 Thickness: 0.50 mm sheet.
 - . 3 Finish: Smooth Stucco embossed Corrugated.
 - . 4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

- . 4 Stainless steel:
 - . 1 Type: 316.
 - . 2 Thickness: 0.50 mm sheet.
 - . 3 Finish: Smooth Corrugated Stucco embossed.
 - . 4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

- . 1 Vapour retarder lap adhesive:
 - . 1 Water based, fire retardant type, compatible with insulation.
 - . 1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.

- . 2 Indoor Vapour Retarder Finish:
 - . 1 Vinyl emulsion type acrylic, compatible with insulation.

- . 3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C 449.

- . 4 ULC Listed Canvas Jacket:
 - . 1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921 untreated.

- . 5 Outdoor Vapour Retarder Mastic:
 - . 1 Vinyl emulsion type acrylic, compatible with insulation.
 - . 2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

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

- . 7 Contact adhesive: quick-setting
 - . 1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.

- . 8 Canvas adhesive: washable.
 - . 1 Maximum VOC limit 50 g/L to SCAQMD Rule 1168 GSES GS-36.

- . 9 Tie wire: 1.5 mm stainless steel.

- . 10 Banding: 19 mm wide, 0.5 mm thick stainless steel.

- . 11 Facing: 25 mm stainless hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face.

- . 12 Fasteners: 2 4 mm diameter pins with 35 mm diameter square clips,

length to suit thickness of insulation.

PART 3 - EXECUTION

3.1 APPLICATION

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

**3.2
 PRE-INSTALLATION
 REQUIREMENTS**

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer's instructions and as indicated.

.3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers, and supports are outside vapour retarder jacket.

.5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

**3.4 DUCTWORK
 INSULATION SCHEDULE**

.1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served	none		

—	Outside air ducts to mixing plenum	C-1	yes	25
	Mixing plenum	C-1	yes	25
	Exhaust duct between dampers and louvres	C-1	no	25
	Rectangular ducts outside	C-1	special	50
	Round ducts outside	C-1	special	50
	Acoustically lined ducts	none		

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

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

.1 Finishes: conform to following table:

	<u>TIAC Code</u>	
Indoor, concealed	Rectangular none	Round none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

3.5 CLEANING

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-04-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International Inc.
 - .1 ASTM C 335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C 449/C 449M-07, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C 533-07, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .4 ASTM C 547-07, Standard Specification for Mineral Fiber Pipe Insulation.
 - .5 ASTM C 553-02, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .6 ASTM C 612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .7 ASTM C 795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .8 ASTM C 921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Thermal Insulation Association of Canada (TIAC)
 - .1 National Insulation Standards 2005.
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product

1.4 DELIVERY, STORAGE AND HANDLING

- characteristics, performance criteria, physical size, finish and limitations.
- . 2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
- . 3 Manufacturer's Instructions:
 - . 1 Include procedures to be used and installation standards to be achieved.
- . 4 Qualifications:
 - . 1 Installer to be specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.
- . 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- . 2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- . 3 Store at temperatures and conditions recommended by manufacturer.
- . 4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

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 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C 335.
- . 2 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - . 1 Mineral fibre: ASTM C 547.
 - . 2 Maximum "k" factor: ASTM C 547.
- . 3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - . 1 Mineral fibre: ASTM C 547.
 - . 2 Jacket: to CGSB 51-GP-52MA.
 - . 3 Maximum "k" factor: ASTM C 547.
- . 4 TIAC Code C-1: rigid mineral fibre board, unfaced.
 - . 1 Mineral fibre: ASTM C 612.
 - . 2 Maximum "k" factor: ASTM C 612.
- . 5 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.
 - . 1 Mineral fibre: ASTM C 612.

- . 2 Jacket: to CGSB 51-GP-52MA.
- . 3 Maximum "k" factor: ASTM C 612.
- . 6 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - . 1 Mineral fibre: ASTM C 553.
 - . 2 Jacket: to CGSB 51-GP-52MA.
 - . 3 Maximum "k" factor: ASTM C 553.
- . 7 TIAC Code A.6: flexible unicellular tubular elastomer.
 - . 1 Insulation: with vapour retarder jacket .
 - . 2 Jacket: to CGSB 51-GP-52MA.
 - . 3 Maximum "k" factor.
 - . 4 Certified by manufacturer free of potential stress corrosion cracking corrodents.
- . 8 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - . 1 Insulation: ASTM C 533.
 - . 2 Maximum "k" factor: ASTM C 533.
 - . 3 Design to permit periodic removal and re-installation.

2.3 CEMENT

- . 1 Thermal insulating and finish
 - . 1 To: ASTM C 449/C 449M.
 - . 2 Hydraulic setting or Air drying on mineral wool, to ASTM C 449.

2.4 JACKETS

- . 1 Polyvinyl Chloride (PVC):
 - . 1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.
 - . 2 Colours: to match adjacent finish paint selected by Departmental Representative DCC Representative Consultant.
 - . 3 Minimum service temperatures: -20 degrees C.
 - . 4 Maximum service temperature: 65 degrees C.
 - . 5 Moisture vapour transmission: 0.02 perm.
 - . 6 Thickness: mm.
 - . 7 Fastenings:
 - . 1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - . 2 Tacks.
 - . 3 Pressure sensitive vinyl tape of matching colour.
 - . 8 Special requirements:
 - . 1 Indoor:.
 - . 2 Outdoor: UV rated material at least 0.5 mm thick.
 - . 9 Covering adhesive: compatible with insulation.
 - . 1 Maximum VOC limit 30 80 250 g/L to SCAQMD Rule 1168 GSES GS-36.
- . 2 Canvas:
 - . 1 220 and 120 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
 - . 2 Lagging adhesive: compatible with insulation.
 - . 1 Maximum VOC limit 30 80 250 g/L to SCAQMD Rule

1168 GSES GS-36.

- .3 Aluminum:
 - .1 To ASTM B 209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: smooth stucco embossed corrugated.
 - .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, plain reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
 - .1 Maximum VOC limit 30 80 250 g/L to SCAQMD Rule 1168 GSES GS-36.
- .3 Canvas adhesive: washable.
 - .1 Maximum VOC limit 30 80 250 g/L to SCAQMD Rule 1168 GSES GS-36.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face both faces of insulation on one face of insulation with expanded metal lath on other face.
- .7 Fasteners: 2 4 mm diameter pins with 35 mm diameter square clips. Length of pin to suit thickness of insulation.

**2.6 VAPOUR RETARDER
LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.
 - .1 Maximum VOC limit 30 80 250 g/L to SCAQMD Rule 1168 GSES GS-36.

**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/m².

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**

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

REQUIREMENTS

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

3.3 INSTALLATION

- . 1 Install in accordance with TIAC National Standards
 - . 1 Hot equipment: To TIAC code 1503-H.
 - . 2 Cold equipment: to TIAC code 1503-C.
- . 2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- . 3 Provide vapour retarder as recommended by manufacturer.
- . 4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- . 5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- . 6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - . 1 Hangers, supports outside vapour retarder jacket.
- . 7 Supports, Hangers:
 - . 1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- . 1 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- . 2 Installation to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

3.5 FIRE SUPPRESSION EQUIPMENT INSULATION SCHEDULES

- . 1 Includes valves, valve bonnets, strainers,
- . 2 Hot Equipment:
 - . 1 TIAC code A-1 or C-1 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - . 2 TIAC code C-2 unfaced with wire or bands and 13 mm cement precede by one layer of reinforcing mesh.
 - . 3 Thicknesses:

Heat exchangers	50 mm
Steam condensate receivers	50 mm
Deaerator-feedwater heaters	50 mm
- . 3 Breechings:
 - . 1 TIAC code A-2 with 25 mm air gap, mechanical fastenings or

wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.

- . 4 Cold equipment:
 - . 1 TIAC A-3 or C-4 with mechanical fastenings or wire or bands and 13 mm cement reinforced with one layer of reinforcing mesh.
 - . 2 TIAC C-2 faced with vapour retardant jacket and with wire or bands and 13 mm cement preceded by one layer of reinforcing mesh.
 - . 3 TIAC A-6 or C-4 with mechanical fastenings or wire or bands.
 - . 4 Thicknesses: chillers (except factory insulated) 50 mm.
- . 5 Finishes:
 - . 1 Equipment in mechanical rooms: TIAC code CEF/1 with jacket.
 - . 2 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 CLEANING

- . 1 Clean in accordance with Section 01 74 11 - Cleaning.
- . 2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- . 1 Section Includes:
 - . 1 Thermal insulation for piping and piping accessories in commercial type applications.
- . 2 Related Requirements
 - . 1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- . 1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - . 1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- . 2 American Society for Testing and Materials International (ASTM)
 - . 1 ASTM B 209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - . 2 ASTM C 335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - . 3 ASTM C 411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - . 4 ASTM C 449/C 449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - . 5 ASTM C 533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
 - . 6 ASTM C 547-2003, Mineral Fiber Pipe Insulation.
 - . 7 ASTM C 795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - . 8 ASTM C 921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- . 3 Canadian General Standards Board (CGSB)
 - . 1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - . 2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- . 4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - . 1 Material Safety Data Sheets (MSDS).
- . 5 Manufacturer's Trade Associations
 - . 1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- . 6 Underwriters' Laboratories of Canada (ULC)
 - . 1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - . 2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - . 3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - . 4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for

Buildings, Part 2: Application Guidelines.

1.3 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.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards member of TIAC.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

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 C 335.

- . 3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - . 1 Mineral fibre: to CAN/ULC-S702 ASTM C 547.
 - . 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 ASTM C 547.
 - . 2 Jacket: to CGSB 51-GP-52Ma.
 - . 3 Maximum "k" factor: to CAN/ULC-S702 ASTM C 547.

- . 5 TIAC Code C-2: mineral fibre blanket faced with without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - . 1 Mineral fibre: to CAN/ULC-S702 ASTM C 547.
 - . 2 Jacket: to CGSB 51-GP-52Ma.
 - . 3 Maximum "k" factor: to CAN/ULC-S702 ASTM C 547.

- . 6 TIAC Code A-6: flexible unicellular tubular elastomer.
 - . 1 Insulation: with vapour retarder jacket.
 - . 2 Jacket: to CGSB 51-GP-52Ma.
 - . 3 Maximum "k" factor:
 - . 4 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

- . 7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - . 1 Insulation: to ASTM C 533.
 - . 2 Maximum "k" factor: to.
 - . 3 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

- . 1 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- . 2 Contact adhesive: quick setting.
- . 3 Canvas adhesive: washable.
- . 4 Tie wire: 1.5 mm diameter stainless steel.
- . 5 Bands: stainless steel, 19mm 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 C 449/C 449M.

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.

2.8 JACKETS

- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².
- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint by Departmental Representative DCC Representative Consultant.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Canvas:
 - .1 220 and 120 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
 - .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
 - .1 To ASTM B 209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: smooth stucco embossed corrugated.
 - .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.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking to: Section 07 92 10 - Joint Sealing.

2.10 FACTORY PRE-INSULATED STEEL PIPE FOR DIRECT BURIED PIPE

- .1 Insulation:
 - .1 Rigid polyisocyanurate foam, factory applied.
 - .2 Thickness: 50mm
 - .3 Density: ASTM D 1622, 56kg/m³.
 - .4 Closed cell content: ASTM D 6226 to minimum of 90%.
 - .5 Water absorption: ASTM C 272, 4.0% by volume.
 - .6 Thermal conductivity: ASTM C518 0.020W/m°C.
- .2 Insulation to be bonded to pipe by sand blasting or chemical foam-bonding.
- .3 Polyethylene Jacket
 - .1 Outer jacket shall be black PE, UV inhibited, factory applied according to ASTM D3350, minimum 2% carbon black.
 - .2 PE jacket to be minimum 3.17mm thick.

- . 4 Joints
 - . 1 Joints shall be insulated with field famed in place, hi-temperature polyisocyanurate foam.
 - . 2 Joints shall be heat shrink wrapped with closure seal.
 - . 3 Overlap shall be minimum of 75mm on either side of each joint.
- . 5 End Seals
 - . 1 Heat shrinkable end seals shall be field installed at all pipe insulation exposed ends at building entries.

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 SS PVC ABS high temperature fabric.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

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

**3.6 PIPING
 INSULATION
 SCHEDULES**

- .2 Provide vapour retarder as recommended by manufacturer.
- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS wire bands Tape at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: SS wire bands Tape at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 TIAC Code: A-6.
 - .1 Insulation securements:.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code:.
- .5 TIAC Code: C-2 with without vapour retarder jacket.
 - .1 Insulation securements:.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .6 TIAC Code: A-2.
 - .1 Insulation securements:.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-H.
- .7 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Applica- tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run to 1 out	1 1/4 to 2	2 1/2 to 4	5 to 6	8 & over	
Steam	up to 175	A- 1	38	50	65	75	90	90
Steam,	over 175	A- 1	38	65	65	75	90	90
Saturated and Superheated Condensate	60-94	A- 1	25	38	38	38	38	38
Return Pumped Condensate Return	up to 94	A- 1	25	38	38	38	38	38

Boiler Feed Water		A- 1	25	25	25	25	25	25
Hot Water Water Heating	60-94	A- 1	25	38	38	38	38	38
Hot Water Heating	up to 59	A- 1	25	25	25	25	38	38
Glycol Heating	60-94	A- 1	25	38	38	38	38	38
Glycol Heating	up to 59	A- 1	25	25	25	25	38	38
Domestic HWS		A- 1	25	25	25	38	38	38
Domestic CWS		A- 3	25	25	25	25	25	25
Domestic CWS with vapour retarder		C- 2	25	25	25	25	25	25
Refrigerant Hot gas-liquid suction	4-13	A- 6	25	25	25	25	25	25
Refrigerant hot gas-liquid suction	below 4	A- 6	25	25	38	38	38	38
Buried Pre-Insulated		A- 6	50	50	50	50	50	50

.8 Finishes:

- .1 Exposed indoors: PVC jacket.
- .2 Exposed in mechanical rooms: PVC jacket.
- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .5 Outdoors: water-proof aluminum jacket.
- .6 Finish attachments: SS screws bands, at 150 mm on centre.
- .7 Seals: wing closed.
- .8 Installation: to appropriate TIAC code CRF/1 through CPF/5.
- .9

3.7 CLEANING

- . 1 Proceed in accordance with Section 01 74 11 - Cleaning.
- . 2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- . 3

3.8 PRE-INSULATED PIPE

- . 1 Install underground, pre-insulated in accordance with the manufacturers instructions.
- . 2 Bed piping on clean fill and as indicated on the drawings.
- . 3 Provide tracer tape and location wire as indicated on the drawings.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E 202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

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

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed
 - .2 Verification of operating, limit, safety controls.
 - .3 Verification of primary and secondary pump flow rates.
 - .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to

determine if chemical treatment is correct. Include cost.

- . 6 Heating system capacity test:
 - . 1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - . 1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - . 2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - . 2 Test procedures:
 - . 1 Open fully heat exchanger, heating coil and radiation control valves.
 - . 2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - . 3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.6 GLYCOL SYSTEMS

- . 1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E 202.

1.7 STEAM SYSTEMS

- . 1 Performance verification:
 - . 1 When systems are operational, perform relevant tests of steam and condensate return piping systems as specified under hydronic systems.
 - . 2 Verify operation of components of steam system including:
 - . 1 Steam traps by:
 - . 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.
 - . 3 Verify performance of condensation units, including:
 - . 1 Pump capacity at design temperature.
 - . 2 Controls.
 - . 4 Verify performance of condensate return system to ensure return of maximum quantity of condensate return water at with minimum temperature drop.
 - . 5 Adjust piping system as required to eliminate water hammer.
- . 2 Monitor system continuously until acceptance for proper operation of components including steam traps, thermostatic vents, flash tanks and condensate pumping units.

1.8 POTABLE WATER SYSTEMS

- . 1 When cleaning is completed and system filled:
 - . 1 Verify performance of equipment and systems as specified elsewhere in Division 23.
 - . 2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or

recharge air chambers. Repeat for each outlet and flush valve.

- . 3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

**1.9 WET AND DRY
PIPE SPRINKLER
SYSTEM, STANDPIPE
AND HOSE SYSTEMS**

- . 1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.
- . 2 Verification of controls, detection devices, alarm devices is specified Division 26.
- . 3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.
- . 4 Verify operation of interlocks between HVAC systems and fire alarm systems.

**1.10 SANITARY AND
STORM DRAINAGE
SYSTEMS**

- . 1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.
- . 2 Ensure that traps are fully and permanently primed.
- . 3 Ensure that fixtures are properly anchored, connected to system.
- . 4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.
- . 5 Cleanouts: refer to Section 22 42 00 - Plumbing Fixtures.

1.11 REPORTS

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

1.12 TRAINING

- . 1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel, 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 OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E 202-00, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 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.
- .2 Quality assurance submittals: submit following 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.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 CLEANING SOLUTIONS

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

**3.2 CLEANING
HYDRONIC AND STEAM
SYSTEMS**

- . 1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- . 2 Cleaning Agency:
 - . 1 Retain qualified water treatment specialist to perform system cleaning.
- . 3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- . 4 Cleaning procedures:
 - . 1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - . 1 Cleaning procedures, flow rates, elapsed time.
 - . 2 Chemicals and concentrations used.
 - . 3 Inhibitors and concentrations.
 - . 4 Specific requirements for completion of work.
 - . 5 Special precautions for protecting piping system materials and components.
 - . 6 Complete analysis of water used to ensure water will not damage systems or equipment.
- . 5 Conditions at time of cleaning of systems:
 - . 1 Systems: free from construction debris, dirt and other foreign material.
 - . 2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - . 3 Strainers: clean prior to initial fill.
 - . 4 Install temporary filters on pumps not equipped with permanent filters.
 - . 5 Install pressure gauges on strainers to detect plugging.
- . 6 Report on Completion of Cleaning:
 - . 1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- . 7 Hydronic Systems:
 - . 1 Fill system with water, ensure air is vented from system.
 - . 2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - . 3 Use water metre to record volume of water in system to +/- 0.5%.
 - . 4 Add chemicals under direct supervision of chemical treatment supplier.
 - . 5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - . 6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

- . 7 Add chemical solution to system.
- . 8 Establish circulation, raise temperature slowly to maximum design 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 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 Glycol Systems:
 - . 1 In addition to procedures specified above perform specified procedures.
 - . 2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E 202.
- . 9 Steam Systems: in addition to general requirements as specified above, perform following:
 - . 1 Remove internal components of steam traps until flushing and warm-up have been completed.
 - . 2 Open drip points to atmosphere. If needed for protection of personnel or environment, install flexible hose and direct discharge to safe location.
 - . 3 Starting at drip point closest to source, verify removal of condensate, then re-install steam trap internal parts. Repeat sequence down the line.
 - . 4 Water hammer: determine source and eliminate cause.
- . 10 Steam boilers:
 - . 1 Isolate boilers from piping system.
 - . 2 Fill to normal operating level. Add cleaner. Fire to 50% of design operating steam pressure. Maintain for 24 h, during which blow down boiler every 4 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
HYDRONIC SYSTEMS**

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

**3.4 FIELD QUALITY
CONTROL**

- . 1 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:
 - . 1 Materials and resources.
 - . 2 Storage and collection of recyclables.
 - . 3 Construction waste management.
 - . 4 Resource reuse.
 - . 5 Recycled content.
 - . 6 Local/regional materials.
 - . 7 Certified wood.
 - . 8 Low-emitting materials.

3.5 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22-01, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1-96, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 47/A 47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A 53/A 53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B 75M-99, Standard Specification for Seamless Copper Tube Metric.
 - .4 ASTM B 837-01, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1HB-00, Natural Gas and Propane Installation Code Handbook.
 - .2 CAN/CSA B149.2-00, Propane Storage and Handling Code.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Indicate on manufacturers catalogue literature following: valves.
 - .3 Submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.

. 3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

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

. 5 Instructions: submit manufacturer's installation instructions.

. 6 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 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 DELIVERY, STORAGE AND HANDLING

. 1 Waste Management and Disposal:

. 1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MATERIALS

. 1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

2.2 PIPE

. 1 Steel pipe: to ASTM A 53/A 53M, Schedule 40, seamless as follows:

- . 1 NPS 1/2 to 2, screwed.
- . 2 NPS 2 1/2 and over, plain end.

. 2 Copper tube: to ASTM B 837.

2.3 JOINTING MATERIAL

. 1 Screwed fittings: pulverized lead paste.

. 2 Welded fittings: to CSA W47.1.

. 3 Flange gaskets: nonmetallic flat.

. 4 Brazing: to ASTM B 837.

2.4 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 A 47/A 47M.
- . 5 Bolts and nuts: to ASME B18.2.1.
- . 6 Nipples: schedule 40, to ASTM A 53/A 53M.

. 2 Copper pipe fittings, screwed, flanged or soldered:

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

2.5 VALVES

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- . 1 Install in accordance with Section 23 05 01 - Installation of Pipework, applicable Provincial/Territorial Codes, CAN/CSA B149.1, CAN/CSA B149.2,, supplemented as specified.
- . 2 Install drip points:
 - . 1 At low points in piping system.
 - . 2 At connections to equipment.

3.3 VALVES

- . 1 Install valves with stems upright or horizontal unless otherwise approved by 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 CAN/CSA B149.1 CAN/CSA B149.2 and requirements of authorities having jurisdiction.
- . 2 Manufacturer's Field Services:
 - . 1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - . 2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
 - . 3 Schedule site visits to review work at stages listed:
 - . 1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - . 2 Twice during progress of work at 25% and 60% complete.
 - . 3 Upon completion of work, after cleaning is carried out.
- . 3 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- . 4 Performance Verification:
 - . 1 Refer to Section 23 08 01 - Performance Verification of Mechanical Piping System

3.5 ADJUSTING

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

3.6 CLEANING

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

END OF SECTION

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PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Copper piping valves and fittings for hydronic systems.
- .2 Related Requirements
 - .1 Section.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-04, Specification Filler Metals for Brazing and Bronze Welding.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.4-98, Gray-Iron Threaded Fittings.
 - .2 ANSI/ASME B16.15-1985(2004), Cast Bronze Threaded Fittings.
 - .3 ANSI B16.18-2001, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22-2001, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B 32-04, Standard Specification for Solder Metal.
 - .2 ASTM B 61-02, Standard Specification for Steam or Valve Bronze Castings.
 - .3 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B 88M-03, Standard Specification for Seamless Copper Water Tube Metric.
 - .5 ASTM E 202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturers Standardization Society (MSS)
 - .1 MSS SP 67-2002a, Butterfly Valves.
 - .2 MSS SP 70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS SP 71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS SP 80-2003, Bronze Gate, Globe, Angle and Check Valves.
 - .5 MSS SP 85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

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 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data

Sheets (MSDS) in accordance with Section 01 33 00
- Submittal Procedures.

- . 2 Shop Drawings:
 - . 1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- . 3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- . 4 Closeout Submittals:
 - . 1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- . 1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEEA, TDGA, and applicable Provincial /Territorial regulations.
- . 2 Health and Safety:
 - . 1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 MAINTENANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- . 1 Packing, shipping, handling and unloading:
- . 2 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 FITTINGS

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

2.2 FLANGES

- . 1 Brass or bronze: threaded.

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- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.3 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B 32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: flanged grooved ends.
- .2 Gate Valves Application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 Mechanical Rooms: rising stem, split wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - .2 Elsewhere: Non- rising stem, solid wedge disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
- .3 Butterfly valves: application: isolating each cell or section of multiple component equipment (eg. multi-section coils, multi-cell cooling towers):
 - .1 NPS 2 1/2 and over: lug type grooved ends: as specified Section 23 05 17 - Pipe Welding.
- .4 Globe valves: application: throttling, flow control, emergency bypass:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 NPS 2 1/2 and over:
 - .1 With composition bronze disc, bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
- .5 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified.
 - .2 NPS 2 and under:
 - .1 Mechanical Rooms: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - .2 Elsewhere: globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
- .6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as

specified Section 23 05 23.01 - Valves – Bronze.

. 7 Bypass valves on gate globe valves NPS 8 and larger: NPS 3/4, globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.

. 8 Swing check valves:

. 1 NPS 2 and under:

. 1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.

. 2 NPS 2 1/2 and over:

. 1 Flanged Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron.

. 9 Silent check valves:

. 1 NPS 2 and under:

. 1 As specified Section 23 05 23.01 - Valves - Bronze.

. 2 NPS 2 1/2 and over:

. 1 Flanged Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron.

. 10 Ball valves:

. 1 NPS 2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING INSTALLATION

. 1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

. 2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.

. 3 Slope piping in direction of drainage and for positive venting.

. 4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

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

. 6 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

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

. 2 Install butterfly valves on chilled water and condenser water lines only.

. 3 Install gate ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

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- . 4 Install globe valves for balancing and in by-pass around control valves as indicated.
- . 5 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
- . 6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- . 7 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Boiler Rooms and Mechanical Equipment Rooms.

3.4 CIRCUIT BALANCING VALVES

- . 8 Install ball valves for glycol service.
- . 1 Install flow measuring stations and flow balancing valves as indicated.
- . 2 Remove handwheel after installation and TAB is complete.
- . 3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.5 FLUSHING AND CLEANING

- . 1 Flush and clean in presence of Departmental Representative.
- . 2 Flush after pressure test for a minimum of 4h.
- . 3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.
- . 4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.
- . 5 Refill system with clean water. Circulate for at least 2h. Clean out strainer screens/baskets regularly. Then drain.
- . 6 Drainage to include drain valves, dirt pockets, strainers, low points in system.
- . 7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.6 FILLING OF SYSTEM

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

3.7 FIELD QUALITY CONTROL

- . 1 Testing:
 - . 1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
 - . 2 For glycol systems, retest with ethylene glycol to ASTM E 202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.
- . 2 Balancing:
 - . 1 Balance water systems to within plus or minus 5% of design output.
 - . 2 Refer to Section for applicable procedures.

- . 3 Glycol Charging:
 - . 1 Provide mixing tank and positive displacement pump for glycol charging.
 - . 2 Retest for concentration to ASTM E 202 after cleaning.
 - . 3 Provide report to Departmental Representative.

3.8 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- . 1 Section Includes.
 - . 1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
- . 2 Related Requirements
 - . 1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- . 1 American Society of Mechanical Engineers (ASME).
 - . 1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
 - . 2 ASME B16.3-98, Malleable Iron Threaded Fittings.
 - . 3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - . 4 ASME B16.9-01, Factory-Made Wrought Butt Welding Fittings.
 - . 5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
 - . 6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).
- . 2 American Society for Testing and Materials International, (ASTM).
 - . 1 ASTM A 47/A 47M-99, Standard Specification for Ferritic Malleable Iron Castings.
 - . 2 ASTM A 53/A 53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - . 3 ASTM A 536-84(1999)e1, Standard Specification for Ductile Iron Castings.
 - . 4 ASTM B 61-02, Standard Specification for Steam or Valve Bronze Castings.
 - . 5 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - . 6 ASTM E 202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- . 3 American Water Works Association (AWWA).
 - . 1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- . 4 Canadian Standards Association (CSA International).
 - . 1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
 - . 2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).
- . 5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
 - . 1 MSS-SP-67-025, Butterfly Valves.
 - . 2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - . 3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - . 4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
 - . 5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

**1.3 ACTION AND
INFORMATIONAL
SUBMITTALS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals.
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.

**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 DELIVERY,
STORAGE AND
HANDLING**

- .1 Waste Management and Disposal.
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management And Disposal.

1.6 MAINTENANCE

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

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS6.
 - .2 NPS8 and over, 10.
 - .3 NPS12 and over, 10 mm wall thickness.

2.2 PIPE JOINTS

- .1 NPS2 and under: screwed fittings with PTFE tape or lead-free pipe dope.
- .2 NPS2-1/2 and over: welding fittings and flanges to CAN/CSA W48.
- .3 Roll grooved: standard rigid coupling to CSA B242.
- .4 Flanges: plain or raised face, slip-on weld neck to AWWA C111.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: to AWWA C111.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
- .9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

- . 1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.
- . 2 Pipe flanges and flanged fittings:
 - . 1 Cast iron: to ASME B16.1, Class 125.
 - . 2 Steel: to ASME B16.5.
- . 3 Butt-welding fittings: steel, to ASME B16.9.
- . 4 Unions: malleable iron, to ASTM A 47/A 47M and ASME B16.3.
- . 5 Fittings for roll grooved piping: malleable iron to ASTM A 47/A 47M ductile iron to ASTM A 536.

2.4 VALVES

- . 1 Connections:
 - . 1 NPS2 and smaller: screwed ends.
 - . 2 NPS2.1/2 and larger: Flanged grooved ends.
- . 2 Gate valves: to MSS-SP-70 to MSS-SP-80 Application: Isolating equipment, control valves, pipelines:
 - . 1 NPS2 and under:
 - . 1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 Elsewhere: Class 125, non- rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 NPS2 1/2 and over:
 - . 1 Mechanical Rooms: risingstem, split wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
 - . 1 Operators:.
 - . 2 Elsewhere: Non- rising stem, solid wedge disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
 - . 1 Operators:.
- . 3 Butterfly valves: to MSS-SP-67 Application: Isolating cells or section of multiple component equipment (eg. multi-section coils, multi-cell cooling towers):
 - . 1 NPS2 1/2 and over: Lug type Grooved ends: as specified Section 23 05 17 - Pipe Welding.
- . 4 Globe valves: to MSS-SP- 80 85 Application: Throttling, flow control, emergency bypass:
 - . 1 NPS2 and under:
 - . 1 Mechanical Rooms: withPTFE disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 Elsewhere: Globe, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 NPS2 1/2 and over:
 - . 1 With composition lead free bronze disc, lead free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.
- . 5 Balancing, for TAB:
 - . 1 Sizes: Calibrated balancing valves, as specified this section.

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- . 2 NPS2 and under:
 - . 1 Mechanical Rooms: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 Elsewhere: Globe, with plug disc as specified Section 23 05 23.01 - Valves - Bronze.

- . 6 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves - Bronze.

- . 7 Bypass valves on gate globe valves NPS8 and larger: NPS3/4, Globe, with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.

- . 8 Swing check valves: to MSS-SP-71.
 - . 1 NPS2 and under:
 - . 1 Class 125, swing, with composition disc, as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 NPS2 1/2 and over:
 - . 1 Flanged Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

- . 9 Silent check valves:
 - . 1 NPS2 and under:
 - . 1 As specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 NPS2 1/2 and over:
 - . 1 Flanged Grooved ends: as specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

- . 10 Ball valves:
 - . 1 NPS2 and under: as specified Section 23 05 23.01 - Valves - Bronze.

- . 11 Lubricated Plug Valves
 - . 1 NPS2 and under:
 - . 2 NPS2 1/2 and over:
 - . 1 As specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

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

3.2 CIRCUIT BALANCING VALVES

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

3.3 CLEANING, FLUSHING AND START-UP

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

3.4 TESTING

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

.2 For glycol systems, retest with ethylene propylene glycol to ASTM E 202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.5 BALANCING

.1 Balance water systems to within plus or minus 5 % of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.6 GLYCOL CHARGING

.1 Provide mixing tank and positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E 202 after cleaning.

**3.7 PERFORMANCE
VERIFICATION**

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A 53/A 53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .2 ASTM A 135/A 135M-06, Standard Specification for Electric-Resistance-Welded Steel Pipe.
 - .3 ASTM A 312/A 312-08a, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipe.
 - .4 ASTM A 795/A 795M-08, Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
 - .5 ASTM B 61-08, Standard Specification for Steam or Valve Bronze Castings.
 - .6 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .7 ASTM E 202-05, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - .1 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
 - .2 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for valves, couplings and components and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Extra Material/Spare Parts:
 - .1 Provide the following:
 - .1 Valve seats: One for every ten valves each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.

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- . 4 Valve handles: two of each size.
- . 5 Gaskets for flanges: one for every ten flanged joints.

**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 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 PIPING

- . 1 Steel pipe: to ASTM A 53/A 53M ASTM A 795/A 795M ASTM A 135/A 135M, minimum wall thickness 1.45 mm and to supplier installation instructions.

2.2 FITTINGS

- . 1 Cold drawn steel complete with grade "E" EPDM grade "T" Nitrile or grade "O" Fluoroelastomer O-ring.
- . 2 Precision, cold drawn, austenitic stainless steel with grade "E" EPDM grade "T" Nitrile grade "O" Fluoroelastomer O ring

2.3 GATE VALVES

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

2.4 GLOBE VALVES

- . 1 To MSS-SP-80, Class 125, 860 kPa, lead free bronze body, screw-over bonnet, renewable composition disc suitable for service stainless steel disc as specified Section 23 05 23.01 - Valves - Bronze.

**2.5 SWING CHECK
VALVES**

- . 1 To MSS-SP-71 80, Class 125, 860 kPa, lead free bronze body, screw-in cap, bronze swing disc, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.

2.6 BALL VALVES

- . 1 To ASTM B 62 or B16, 4 MPa WOG, lead free bronze brass body, hard chrome plated solid ball, TFE seal, Fluoroelastomer or PTFE adjustable packing, PTFE or TFE seat, lever handle.
 - . 1 Valves with press joint ends are derated to 2 MPa to match adjoining system.

**2.7 SILENT CHECK
VALVES**

- . 1 To ASTM B 62, Class 125, 860 kPa, cast steel, wafer style, lead free brass seat rings, lead free brass inner valve, stainless steel spring heavy duty spring when in vertical down flow applications as specified Section 23 05 23.01 - Valves - Bronze.

**2.8 CIRCUIT
BALANCING VALVES
(CBV)**

- . 1 General:
 - . 1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connected to differential pressure meter.
 - . 2 Accuracy:
 - . 1 Readout to be within plus or minus 2% of actual flow

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at design flow rate.

- . 2 Pressure die-cast dezincification resistant copper alloy Ametal stainless steel construction, 1.7MPa, 121 degrees C, screwed ends, Teflon disc, screw-in bonnet.
 - . 1 Flow control: at least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
- . 3 Insulation: use prefabricated shipping packaging of 5.4R polyurethane as insulation see valves thermal insulation.
- . 4 Drain connection:
 - . 1 NPS 3/4 valved and capped, suitable for hose socket.
 - . 2 Incorporated into valve body or provided as separate item.

PART 3 - EXECUTION

3.1 PIPING

- . 1 Install pipework in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- . 2 Install press joint piping system in accordance with manufacturer's latest recommendations.
- . 3 Visibly mark both ends of pipe with proper insertion depths prior to assembly and installation.

3.2 VALVES

- . 1 Install valves as indicated in Section 23 05 23.01 - Valves - Bronze.
- . 2 Install calibrated balancing valves for balancing purposes as indicated.

3.3 PRESSURE TESTS

- . 1 Test system in accordance with Section 21 05 01 - Common Work Results for Mechanical.
- . 2 Test pressure: test with water to greater of 1 1/2 times maximum system operating pressure or 860 kPa.

3.4 CLEANING AND START UP

- . 1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- . 2 Flush and clean in presence of Departmental Representative DCC Representative Consultant.
- . 3 Flush after pressure test for minimum of 4 hours.
- . 4 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.
- . 5 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.
- . 6 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- . 7 Drainage to include drain valves, dirt pockets, strainers, every low point in system.
- . 8 Re-install strainer screens/baskets after obtaining Departmental

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Representative's DCC Representative's Consultant's approval.

.9 Refill system with clean water adding water treatment as specified propylene glycol.

**3.5 PERFORMANCE
VERIFICATION**

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

**3.6 TESTING AND
BALANCING**

.1 Balance water systems to within plus or minus 5% of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures and to Section 21 05 01 - Common Work Results for Mechanical.

3.7 GLYCOL CHARGING

.1 Provide mixing tank and electric positive displacement pump for glycol charging.

.2 Retest for concentration to ASTM E 202 after cleaning.

.3 Provide report to Departmental Representative.

3.8 CLEANING

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

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Electrical Equipment Manufacturers Advisory Council (EEMAC)
- .3 Canadian Standards Association (CSA International)
 - .1 CSA-B214-07, Installation Code for Hydronic Heating Systems.
- .4 National Electrical Manufacturers' Association (NEMA)
 - .1 NEMA MG 1-2006, Motors and Generators.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit 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 and controllers.

1.4 CLOSEOUT SUBMITTALS

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

1.5 MAINTENANCE

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Size and select components to: CSA-B214.

2.2 IN-LINE CIRCULATORS

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: alloy steel cast bronze cast iron stainless steel.
- .3 Shaft: alloy steel stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.

**2.3 VERTICAL
IN-LINE CIRCULATORS**

- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, TEFC, explosion proof, sleeve bearing, r/min, minimum efficiency %, kW HP.
- .7 Capacity: as indicated in schedule on drawings.
- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: corrosion resistant steel brass or bronze cast iron.
- .3 Shaft: alloy steel stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: flexible rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing, r/min, kW HP.
- .7 Capacity: as indicated in schedule on drawings.

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 hydronic pumps to: CSA-B214.
- .2 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.
 - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.3 START-UP

- .1 General:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .4 Check base for free-floating, no obstructions under base.
 - .5 Run-in pumps for 12 continuous hours minimum.
 - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .7 Eliminate air from scroll casing.
 - .8 Adjust water flow rate through water-cooled bearings.
 - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .10 Adjust alignment of piping and conduit to ensure true flexibility.
 - .11 Eliminate cavitation, flashing and air entrainment.
 - .12 Adjust pump shaft seals, stuffing boxes, glands.
 - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .15 Verify lubricating oil levels.

3.4 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 Verify performance in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Verify that manufacturer's performance curves are accurate.
- .3 Ensure valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH):
 - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
 - .2 Measure using procedures prescribed in Section 01 91 13 - General Commissioning (Cx) Requirements.
 - .3 Where procedures do not exist, discontinue PV, report to Departmental Representative DCC Representative Consultant and await instructions.
- .5 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as

finally set upon completion of TAB.

.7 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements reports supplemented as specified herein. Reports to include:

- .1 Record of point(s) of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
- .2 Use Report Forms specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
- .3 Pump performance curves (family of curves).

**3.5 OPERATION
REQUIREMENTS**

.1 Operational requirements in accordance with Section 01 47 19 - Sustainable Requirements: Operations, include:

- .1 Repair and maintenance materials and instructions.

3.6 CLEANING

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME-04(2007), Boiler and Pressure Vessel Code.
- .2 ASTM International Inc.
 - .1 ASTM A 47/A 47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A 278/A 278M-01(2006), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .3 ASTM A 516/A 516M-06, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
 - .4 ASTM A 536-84(2004), Standard Specification for Ductile Iron Castings.
 - .5 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B51-03(R2003), Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA B51-03(R2005), Boiler, Pressure Vessel, and Pressure Piping Code, Supplement #1.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

PART 2 - PRODUCTS

2.1 DIAPHRAGM TYPE EXPANSION TANK

- .1 Horizontal Vertical galvanized steel steel pressurized diaphragm type expansion tank.
- .2 Capacity: Refer to schedule on drawings.
- .3 Size: As indicated on drawings.
- .4 Diaphragm sealed in elastomer EPDM suitable for 115 degrees C operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification 520 kPa.
- .6 Air precharged as indicated on drawings.

.7 Saddles for horizontal installation or base mount for vertical installation.

.8 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.

.9 Renewable diaphragm.

2.2 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 310 620 690 kPa working pressure.

.2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.

.3 Float: solid material suitable for 115 degrees C working temperature.

2.3 AIR SEPARATOR - BOILER MOUNTED

.1 Complete with dip tube.

.2 Working pressure: 860 kPa.

2.4 AIR SEPARATOR - EXPANSION TANK FITTING

.1 Complete with adjustable vent tube and built-in manual vent valve.

.2 Working pressure: 860 kPa.

2.5 AIR SEPARATOR - IN-LINE

.1 Working pressure: 860 kPa.

.2 Size: NPS 1 1/2 as indicated.

2.6 COMBINATION SEPARATORS/ STRAINERS

.1 Steel, tested and stamped in accordance with ANSI/ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

2.7 COMBINATION LOW PRESSURE RELIEF AND REDUCING VALVE

.1 Adjustable pressure setting: 206 kPa relief, 55 to 172 kPa reducing.

.2 Low inlet pressure check valve.

.3 Removable strainer.

2.8 PIPE LINE STRAINER

.1 NPS 1/2 to 2: bronze body to ASTM B 62, solder end screwed connections, Y pattern.

.2 NPS 2 1/2 to 12: cast steel body to ASTM A 278/A 278M, Class 30, cast iron body to ASTM A 278/A 278M, Class 30 flanged connections.

.3 NPS 2 to 12: T type with ductile iron body to ASTM A 536 malleable iron body to ASTM A 47M, grooved ends.

.4 Blowdown connection: NPS 1.

.5 Screen: stainless steel brass with 1.19 mm perforations.

.6 Working pressure: 860 kPa.

2.9 SUCTION

.1 Body: cast iron with flanged screwed connections.

DIFFUSER

- . 2 Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.
- . 3 Permanent magnet particle trap.
- . 4 Full length straightening vanes.
- . 5 Pressure gauge tappings.
- . 6 Adjustable support leg.

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 GENERAL

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

3.3 STRAINERS

- . 1 Install in horizontal or down flow lines.
- . 2 Ensure clearance for removal of basket.
- . 3 Install ahead of each pump.
- . 4 Install ahead of each automatic control valve larger than NPS 1 and radiation except at radiation and as indicated.

3.4 AIR VENTS

- . 1 Install at high points of systems.
- . 2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink.

3.5 EXPANSION TANKS

- . 1 Adjust expansion tank pressure as indicated to suit design criteria.
- . 2 Install lockshield type valve at inlet to tank.

**3.6 PRESSURE SAFETY
RELIEF VALVES**

- . 1 Run discharge pipe to terminate above nearest drain.

**3.7 SUCTION
DIFFUSERS**

- . 1 Install on inlet to pumps having suction size greater than 50 75.

3.8 CLEANING

- . 1 Clean in accordance with Section 01 74 11 - Cleaning.
 - . 1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- . 1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- . 1 American National Standards Institute (ANSI) / American Society of Mechanical Engineers (ASME)
 - . 1 ASME B16.1-05, Cast Iron Pipe Flanges and Flanged Fittings: Class 25, 125, 250 and 800.
 - . 2 ASME B16.25-07, Buttwelding Ends.
 - . 3 ASME B16.3-06, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - . 4 ANSI/ASME B16.5-03, Pipe Flanges and Flanged Fittings: NPS ½ through 24.
 - . 5 ANSI/ASME B16.9-07, Factory-Made Wrought Steel Buttwelding Fittings.
 - . 6 ANSI B18.2.1-96(R2005), Square and Hex Bolts and Screws (Inch Series).
 - . 7 ANSI/ASME B18.2.2-87(R2005), Square and Hex Nuts (Inch Series).
- . 2 American National Standards Institute (ANSI) / American Water Works Association (AWWA)
 - . 1 ANSI/AWWA C111/A21.11-07, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- . 3 ASTM International Inc.
 - . 1 ASTM A 47/A 47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - . 2 ASTM A 53/A 53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - . 3 ASTM A 126-04, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- . 4 Canadian Standards Association (CSA International)
 - . 1 CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding.
- . 5 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
 - . 1 MSS-SP-70-2006, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - . 2 MSS-SP-71-2005, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
 - . 3 MSS-SP-80-2003, Bronze Gate, Globe, Angle and Check Valves.
 - . 4 MSS-SP-85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - .1 Special servicing requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labeled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.6 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A 53/A 53M, Grade B, as follows:
 - .1 Steam;
 - .1 To NPS 6.
 - .2 NPS 8 and over.
 - .2 Condensate.

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 ANSI/AWWA C111/A21.11.
- .4 Pipe thread: taper.
- .5 Bolts and nuts: carbon steel, to ANSI/ASME B18.2.1 and ANSI/ASME B18.2.2.
- .6 Buttwelding ends: to ANSI/ASME B16.25 as indicated.

2.3 FITTINGS

- .1 Pipe flanges: cast-iron to ASME B16.1, Class 125.
- .2 Screwed fittings: malleable iron to ASME B16.3, Class 150.
- .3 Steel pipe gaskets, flanges and flanged fittings: to ANSI/ASME B16.5.

- . 4 Buttwelding fittings: steel to ANSI/ASME B16.9.
- . 5 Unions: malleable iron, to ASTM A 47/A 47M 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 welded ends.
 - . 2 Elsewhere: Flanged welded ends.
- . 2 Gate valves: Application: Steam service, for isolating equipment, control valves, pipelines.
 - . 1 NPS 2 and under:
 - . 1 Mechanical Rooms: Class 125, rising stem, splitwedge disc, as specified Section 23 05 23.01 - Valves-Bronze.
 - . 2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 23.01 - Valves-Bronze.
 - . 2 NPS 2 1/2 -8:
 - . 1 Mechanical Rooms: Class 150, rising stem, splitwedge disc, cast iron, lead- free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - . 2 Elsewhere: Class 150, Non- rising stem, solid wedge disc, cast iron with lead- free bronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - . 3 NPS 10 and over:
 - . 1 Mechanical Rooms: Class 150, rising stem, splitwedge disc, cast steel with lead- free bronze trim, as specified Section 23 05 23.03 - Valves - Cast Steel.
 - . 2 Elsewhere: Class 150, Non- rising stem, solid wedge disc, cast steel with lead- free bronze 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 Mechanical Rooms: with PTFE disc as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 Elsewhere: with composition disc as specified Section 23 05 23.01 - Valves - Bronze.
 - . 2 NPS 2 1/2 and over:
 - . 1 With composition lead-free bronze disc, cast iron with bronze trim, to Section 23 05 23.02 - Valves - Cast Iron.
- . 4 Gate valves: Application: pumped and gravity condensate return service, steam drip point assemblies.
 - . 1 NPS 2 and under:
 - . 1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 23.01 - Valves-Bronze.
 - . 2 Elsewhere: Class 125, non-rising stem, solid wedge

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- disc, as specified Section 23 05 23.01 - Valves - Bronze.
- . 2 NPS 2 1/2 and over:
 - . 1 Mechanical Rooms: Class 125, rising stem, split wedge disc, cast iron, lead-freebronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.
 - . 1 Operators:
 - . 2 Elsewhere: Class 125, non- rising stem, solid wedge disc, cast iron with lead-freebronze trim, as specified Section 23 05 23.02 - Valves - Cast Iron.

. 5 Drain valves: Gate, Class 125, 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: Class 125, 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 23.02 - Valves - Cast Iron.

2.5 VALVE OPERATORS

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

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 01 - Use of HVAC Systems During Construction, 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 860 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 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society for Mechanical Engineers (ASME International)
- .2 ASTM International Inc.
 - .1 ASTM A 126-04, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - .2 ASTM A 167-99(2004), Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - .3 ASTM A 216/A 216M-07, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service.
 - .4 ASTM A 240/A 240M-07e1, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .5 ASTM A 276-06, Standard Specification for Stainless Steel Bars and Shapes.
 - .6 ASTM A 278/A 278M-01(2006), Standard Specification for Gray Iron Castings for Pressure - Containing Parts for Temperatures up to 650 Degrees F (350 degrees C).
 - .7 ASTM A 351/A 351M-06, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - .8 ASTM A 564/A 564M-04, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - .9 ASTM B 62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature Canadian Registration Number (CRN), and datasheets for steam traps, vacuum breakers, pressure reducing valves, air vents, safety relief valves, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of New

Brunswick.

- . 4 Closeout Submittals:
 - . 1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals and include following:
 - . 1 Special servicing requirements.

**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, labeled with manufacturer's name, address.
- . 3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MATERIALS

- . 1 Cast steel: to ASTM A 216/A 216M.
- . 2 Cast iron: to ASTM A 278, Class 300.
- . 3 Bronze: to ASTM B 62.
- . 4 Stainless steel: to ASTM A 351/A 351M.

**2.2 FLOAT AND
THERMOSTATIC STEAM
TRAPS 0-110 kPa**

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

**2.3 FLOAT AND
THERMOSTATIC STEAM
TRAPS 111-1000 kPa**

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

**2.4 INVERTED BUCKET
STEAM TRAP 0-1000
kPa**

- . 1 Application: for non-modulating steam services on heating coils convertors radiation end of line drips humidifiers as indicated.
- . 2 Materials: body - cast iron cast-steel; valve - chrome steel stainless steel; bucket-stainless steel, with bimetal air vent.
- . 3 Capacity: as indicated.

**2.5 THERMODYNAMIC
DISC STEAM TRAPS**

- . 1 Application: steam tracing process equipment distribution main drip points.

2.7 -1000 kPa

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

**2.6 BALANCED
PRESSURE
THERMOSTATIC STEAM
TRAPS 0-450 kPa**

- . 1 Application: for modulating steam services on radiation hospital equipment special equipment as listed:.
- . 2 Materials: body, union and cap - brass, lead-free; valve, head and renewable seat - stainless steel; bellows-phosphor bronze; inlet with heavy brass union.
- . 3 Capacity: as indicated.

**2.7 VACUUM BREAKERS
2.10-68 kPa**

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

**2.8 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 A 126, Class B.
 - . 2 Diaphragm: stainless steel to ASTM A 167 ASTM A 240/A 240M.
 - . 3 Seat rings: stainless steel to ASTM A 276.
 - . 4 Disc: stainless steel to ASTM A 564/A 564M, ASTM A 276.
 - . 5 Stem: stainless steel to ASTM A 276.
 - . 6 Spring: carbon steel.
 - . 7 Bolting: carbon steel.
- . 5 Pilot valve:
 - . 1 Body: cast iron to ASTM A 126, Class B.
 - . 2 Diaphragm: stainless steel to ASTM A 167 ASTM A 240/A 240M.

**2.9 SAFETY AND
RELIEF VALVES**

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

**2.10 DRIP PAN
ELBOWS**

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

**2.11 PIPE LINE
STRAINERS UP TO NPS
2.15**

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

**2.12 PIPE LINE
STRAINERS NPS 2-1/2
AND OVER**

- . 1 Application: ahead of condensate pumps, steam traps, control valves as indicated.
- . 2 Working pressure: 860 kPa.
- . 3 Body: cast iron.
- . 4 Connections: flanged.
- . 5 Blowdown connection: NPS 1-1/4 complete with gate valve and cap.
- . 6 Screen: stainless steel with 3.2 mm perforations.

2.13 FLASH TANKS

- . 1 Locations: as indicated.
- . 2 Tanks: vertical horizontal type with threaded welded flanged drop tube connections as indicated.
- . 3 Sizes: mm diameter x mm long as indicated.
- . 4 Construction: to ASME code.
- . 5 Maximum working pressure: 860 kPa.
- . 6 Connections: NPS 2 and under, screwed; NPS 2-1/2 and over, flanged; as indicated.
- . 7 Finish: prime coated.
- . 8 Supports: vertical legs for vertical tank; saddles for horizontal tank.

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.
- 3.5 PRESSURE REDUCING VALVES**
 - . 1 Install on 3-valve bypass with strainer on inlet.
 - . 2 Pipe as indicated. Follow manufacturer's installation instructions.
- 3.6 FLASH TANKS**
 - . 1 Pipe arrangement as indicated.
- 3.7 PERFORMANCE VERIFICATION**
 - . 1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
- 3.8 CLEANING**
 - . 1 Clean in accordance with Section 01 74 11 - Cleaning.
 - . 1 Remove surplus materials, excess materials, rubbish, tools and equipment.
 - . 2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for copper tubing and fittings for refrigerant.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.22-01, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-02, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-88, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-01, Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B 280-03, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B52-99, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.

.6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 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 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
.1 Hard copper: to ASTM B 280, type ACR B.
.2 Annealed copper: to ASTM B 280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.
.2 Brazed:
.1 Fittings: wrought copper to ASME B16.22.
.2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
.3 Flanged:
.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
.2 Gaskets: suitable for service.
.3 Bolts, nuts and washers: to ASTM A 307, heavy series.
.4 Flared:
.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 01 - Installation of Pipework.

3.3 BRAZING PROCEDURES

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

3.4 PIPING INSTALLATION

- .1 General:
 - .1 Soft annealed copper tubing: bend without crimping or constriction Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
 - .3 Provide inverted deep trap at top of risers.
 - .4 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

3.5 PRESSURE AND LEAK TESTING

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.
- .3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 h.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 h.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.

- .7 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.

- .8 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements to Departmental Representative.

- .9 Manufacturer's Field Services:
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.

3.7 DEMONSTRATION

- .1 Instructions:
 - .1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

3.8 CLEANING

- .1 Perform cleaning operations as specified in Section and in accordance with manufacturer's recommendations.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, components, equipment and chemicals for installation of complete HVAC water treatment system.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, Section VII-2004.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 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 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Closeout Submittals:
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
 - .2 Include following:
 - .1 Log sheets as recommended by manufacturer Departmental Representative.

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 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .2 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in

accordance with Section 01 74 22 - Construction/Demolition
Waste Management and Disposal.

PART 2 - PRODUCTS

- 2.1 MANUFACTURER** . 1 Equipment, chemicals, service provided by one supplier.
- 2.2 POT FEEDER** . 1 Welded steel. Temperature rating: 90 degrees C.
- 2.3 CHEMICAL FEED PIPING** . 1 Resistant to chemicals employed.
- 2.4 CHEMICAL FEED PUMPS** . 1 Top-mounted electronic metering diaphragm type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with pressure relief valve, check valve, foot valve, injection fitting.
- . 2 Piston type: flow range 0-100%, adjustable, plus or minus 1.0% accuracy (repetitive), on-off operation, with stainless steel piston, pressure relief valve, double ball and check valves.
- 2.5 SHIPPING/ FEEDING CHEMICAL CONTAINERS** . 1 High density moulded polyethylene, with liquid level graduations, cover.
- 2.6 WATER SOFTENER** . 1 General: 1 2 sodium zeolite exchangers with common brine tank with eductor and manifold.
- . 2 Performance: to reduce effluent hardness to less than 1 ppm.
- . 3 Control:
- . 1 Automatic feature to prevent regeneration of both exchangers at same time.
- . 2 Individual metres with solenoid operated diaphragm valves to regenerate unit whenever L have passed through softener.
- . 3 Seven day clock permitting regeneration as required. Provide for adjustment of brine/rinse and backwash cycles.
- . 4 Water metre:
- . 1 Provide totalizing water metre.
- 2.7 WATER TREATMENT FOR HYDRONIC SYSTEMS** . 1 Hot water heating system: pot feeder, 25 L.
- . 2 Glycol system: pot feeder, 25 L.
- . 3 Micron filter for each pot feeder:
- . 1 Capacity 2% of pump recirculating rate at operating pressure.
- . 2 Six (6) sets of filter cartridges for each type, size of micron filter.
- 2.8 WATER TREATMENT FOR STEAM SYSTEMS** . 1 Performance: to control sludge, scale, dissolved solids, provide corrosion protection to following criteria:
- . 2 Chemical feed pump:
- . 1 One pump per feed tank boiler.
- . 3 Chemical container:

- . 1 Containers: as specified.
- . 2 Capacity: 200L.
- . 3 Low water level cut-off and alarm.
- . 4 Agitator:
 - . 1 Sized to suit container.
 - . 2 With stainless steel shaft, stain-less steel impeller.
 - . 3 Motor: W HP.
- . 5 Chemical feed pump control:
 - . 1 Repeat cycle percentage timer. Feed time fully adjustable for 0-100% of repeated time cycle, 30 minute repeat.
 - . 2 Electric interlock with make-up water controls.
 - . 3 Electric interlock with steam boiler feed pump.
 - . 4 Reset timer initiated by signal from contact head metre installed on water make-up line to feed tank.

2.9 CHEMICALS

- . 1 Provide 1 years supply.

2.10 TEST EQUIPMENT

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 CHEMICAL FEED PIPING

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

3.4 CLEANING OF MECHANICAL SYSTEM

- . 1 Provide copy of recommended cleaning procedures and chemicals for approval by 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 one year after system start-up. Service to include:
- .1 Initial water analysis and treatment recommendations.
 - .2 System start-up assistance.
 - .3 Operating staff training.
 - .4 Visit plant every days during period of operation and as required until system stabilizes, and advise on treatment system performance.
 - .5 Provide necessary recording charts and log sheets for one year operation.
 - .6 Provide necessary laboratory and technical assistance.
 - .7 Provide clear, concise, written instructions and advice to operating staff.

3.6 WATER SOFTENER

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

3.7 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
 - .1 Commissioning Agency: to be installing water treatment sub-contractor water treatment supplier holder of service contract.
 - .2 Timing:
 - .1 After start-up deficiencies rectified.
 - .2 After start-up and before TAB of connected systems.
 - .3 Pre-commissioning Inspections: verify:
 - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
 - .2 Suitability of log book.
 - .3 Currency and accuracy of raw initial water analysis.
 - .4 Required quality of treated water.
 - .4 Commissioning procedures - applicable to Water Treatment Systems:
 - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
 - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
 - .3 Establish test intervals, regeneration intervals.
 - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
 - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.

- . 6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
- . 7 Advise Departmental Representative in writing on matters regarding installed water treatment systems.
- . 5 Commissioning procedures - Water Softeners:
 - . 1 Demonstrate compliance with specifications by chemical analyses of raw water and treated water.
 - . 2 Determine, demonstrate actual softening capacity between regenerations.
 - . 3 Establish regeneration intervals and procedures.
 - . 4 Train O&M personnel in regeneration procedures.
- . 6 Commissioning procedures - Closed Circuit Hydronic Systems:
 - . 1 Analyze water in system.
 - . 2 Based upon an assumed rate of loss approved by Departmental Representative, establish rate of chemical feed.
 - . 3 Record types, quantities of chemicals applied.
- . 7 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.
- . 8 Certificates:
 - . 1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- . 9 Commissioning Reports:
 - . 1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- . 10 Commissioning activities during Warranty Period:
 - . 1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

3.8 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A 480/A 480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A 635/A 635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A 653/A 653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .5 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.
- .6 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.5 DELIVERY,
STORAGE AND
HANDLING**

- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 47 19 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

**2.1 SEAL
CLASSIFICATION**

- .1 Classification as follows:

<u>Maximum Pressure Pa</u>	<u>SMACNA Seal Class</u>
500	C
250	C
125	C
125	Unsealed

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

- 2.2 SEALANT** .1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.
- 2.3 TAPE** .1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.
- 2.4 DUCT LEAKAGE** .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.
- 2.5 FITTINGS** .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
- .1 Rectangular: standard radius short radius with single thickness turning vanes Centre line radius: 1.5 times width of duct.
- .2 Round: smooth radius. Centre line radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
- .1 To 400 mm: with single double thickness turning vanes.
- .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
- .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
- .2 Round main and branch: enter main duct at 45 degrees with conical connection.
- .3 Provide volume control damper in branch duct near connection to main duct.
- .4 Main duct branches: with splitter damper.
- .5 Transitions:
- .1 Diverging: 20 degrees maximum included angle.
- .2 Converging: 30degrees maximum included angle.
- .6 Offsets:
- .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
- .1 Maximum included angles: as for transitions.
- 2.6 FIRE STOPPING** .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.
- 2.7 GALVANIZED STEEL** .1 Lock forming quality: to ASTM A 653/A 653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA.
- .3 Joints: to ASHRAE SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.
- 2.8 STAINLESS STEEL** .1 To ASTM A 480/A 480M, Type 304.
- .2 Finish: No. 4.
- .3 Thickness, fabrication and reinforcement: to ASHRAE SMACNA as

indicated.

. 4 Joints: to ASHRAE and SMACNA be continuous inert gas welded.

2.9 DISHWASHER EXHAUST SYSTEMS

. 1 To ASHRAE and SMACNA. Aluminum type: 3003-H-14.

. 2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA as indicated.

. 3 Joints: to ASHRAE SMACNA be continuous weld.

. 4 Drainage: at low point.

. 5 Slope: slope duct to drain and hood.

2.10 KITCHEN EXHAUST SYSTEMS

. 1 Construct in accordance with NFPA 96.

. 2 Material: Type 304 stainless steel where exposed, stainless steel where concealed or black sheet where concealed.

. 3 Thickness: to NFPA 96.

. 4 Fabrication: joints, continuous inert gas welded for stainless steel, ARC welded for black steel.

. 5 Reinforcement: to SMACNA.

. 6 Drainage: at low point.

2.11 HANGERS AND SUPPORTS

. 1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

. 1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

. 1 Maximum size duct supported by strap hanger: 500.

. 2 Hanger configuration: to ASHRAE and SMACNA.

. 3 Hangers: black galvanized steel angle with black galvanized steel rods to ASHRAE and SMACNA following table:

<u>Duct Size</u> (mm)	<u>Angle Size</u> (mm)	<u>Rod Size</u> (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

. 4 Upper hanger attachments:

. 1 For concrete: manufactured concrete inserts.

. 2 For steel joist: manufactured joist clampsteel plate washer.

. 3 For steel beams: manufactured beam clamps:

PART 3 - EXECUTION

3.1 GENERL

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

3.2 HANGERS

- . 1 Strap hangers: install in accordance with SMACNA.
- . 2 Angle hangers: complete with locking nuts and washers.
- . 3 Hanger spacing: in accordance with ASHRAE SMACNA as follows:

<u>Duct Size</u> (mm)	<u>Spacing</u> (mm)
to 1500	3000
1501 and over	2500

3.3 WATERTIGHT DUCT

- . 1 Provide watertight duct for:
 - . 1 Dishwasher exhaust.
 - . 2 Fresh air intake.
 - . 3 Minimum 3000 mm from duct mounted humidifier in all directions.
 - . 4 As indicated.
- . 2 Form bottom of horizontal duct without longitudinal seams.
 - . 1 Solder weld joints of bottom and side sheets.
 - . 2 Seal other joints with duct sealer.
- . 3 Slope horizontal branch ductwork down towards fume hoods served.
 - . 1 Slope header ducts down toward risers.
- . 4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve trap primer and discharging to open funnel drain as indicated.

**3.4 KITCHEN EXHAUST
SYSTEMS**

- . 1 Install to NFPA 96 and as indicated.

**3.5 SEALING AND
TAPING**

- . 1 Apply sealant to outside of joint to manufacturer's recommendations.
- . 2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.6 LEAKAGE TESTS

- . 1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- . 2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- . 3 Do leakage tests in sections.
- . 4 Make trial leakage tests as instructed to demonstrate workmanship.
- . 5 Do not install additional ductwork until trial test has been passed.
- . 6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- . 7 Complete test before performance insulation or concealment Work.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

- .2 Related Requirements

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

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

- .1 Material Safety Data Sheets (MSDS).

- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

- .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.

- .3 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

- .1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

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

- .6 Instructions: submit manufacturer's installation instructions.

- .7 Manufacturer's Field Reports: manufacturer's field reports specified.

- .8 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:

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

**1.5 DELIVERY,
STORAGE AND
HANDLING**

- . 1 Waste Management and Disposal:
 - . 1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

- . 1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

**2.2 FLEXIBLE
CONNECTIONS**

- . 1 Frame: galvanized sheet metal frame mm thick with fabric clenched by means of double locked seams.
- . 2 Material:
 - . 1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

**2.3 ACCESS DOORS IN
DUCTS**

- . 1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- . 2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- . 3 Gaskets: neoprene foam rubber.
- . 4 Hardware:
 - . 1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - . 2 301 to 450 mm: four sash locks complete with safety chain.
 - . 3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - . 4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - . 5 Hold open devices.
 - . 6 300 x 300 mm glass viewing panels.

2.4 TURNING VANES

- . 1 Factory or shop fabricated single thickness double thickness with without trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

- . 1 1.6 mm thick steel zinc plated after manufacture.
- . 2 Cam lock handles with neoprene expansion plug and handle chain.
- . 3 28 mm minimum inside diameter. Length to suit insulation thickness.
- . 4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

- . 1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- . 2 Sheet metal thickness to co-responding round duct standards.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- . 1 Flexible Connections:
 - . 1 Install in following locations:
 - . 1 Inlets and outlets to supply air units and fans.
 - . 2 Inlets and outlets of exhaust and return air fans.
 - . 3 As indicated.
 - . 2 Length of connection: 100mm.
 - . 3 Minimum distance between metal parts when system in operation: 75 mm.
 - . 4 Install in accordance with recommendations of SMACNA.
 - . 5 When fan is running:
 - . 1 Ducting on sides of flexible connection to be in alignment.
 - . 2 Ensure slack material in flexible connection.
- . 2 Access Doors and Viewing Panels:
 - . 1 Size:
 - . 1 600 x 600 mm for person size entry.
 - . 2 450 x 450 mm for servicing entry.
 - . 3 300 x 300 mm for viewing.
 - . 4 As indicated.
 - . 2 Locations:
 - . 1 Fire and smoke dampers.
 - . 2 Control dampers.
 - . 3 Devices requiring maintenance.
 - . 4 Required by code.
 - . 5 Reheat coils.
 - . 6 Elsewhere as indicated.
- . 3 Instrument Test Ports:
 - . 1 General:
 - . 1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - . 2 Locate to permit easy manipulation of instruments.
 - . 3 Install insulation port extensions as required.
 - . 4 Locations:
 - . 1 For traverse readings:
 - . 1 Ducted inlets to roof and wall exhausters.
 - . 2 Inlets and outlets of other fan systems.
 - . 3 Main and sub-main ducts.
 - . 4 And as indicated.
 - . 2 For temperature readings:
 - . 1 At outside air intakes.
 - . 2 In mixed air applications in locations as approved by Departmental Representative.
 - . 3 At inlet and outlet of coils.
 - . 4 Downstream of junctions of two converging air streams of different temperatures.

. 5 And as indicated.

. 4 Turning vanes:

. 1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 FIELD QUALITY CONTROL

. 1 Manufacturer's Field Services:

. 1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

. 2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

. 3 Schedule site visits, to review Work, at stages listed:

. 1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

. 2 Twice during progress of Work at 25% and 60% complete.

. 3 Upon completion of the Work, after cleaning is carried out.

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

3.4 CLEANING

. 1 Perform cleaning operations as specified in Section and in accordance with manufacturer's recommendations.

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

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.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm as indicated.
- .3 Locking quadrant with shaft extension to accommodate insulation

thickness.

- . 4 Inside and outside nylon bronze end bearings.
- . 5 Channel frame of same material as adjacent duct, complete with angle stop.

2.3 MULTI-BLADED DAMPERS

- . 1 Factory manufactured of material compatible with duct.
- . 2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- . 3 Maximum blade height: 100 mm as indicated.
- . 4 Bearings: pin in bronze bushings self-lubricating nylon.
- . 5 Linkage: shaft extension with locking quadrant.
- . 6 Channel frame of same material as adjacent duct, complete with angle stop.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- . 1 Install where indicated.
- . 2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- . 3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- . 4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- . 5 Dampers: vibration free.
- . 6 Ensure damper operators are observable and accessible.
- . 7 Corrections and adjustments conducted by Engineer.

3.3 FIELD QUALITY CONTROL

- . 1 Tests:
 - . 1 Tests to cover period of not less than days and demonstrate that system is functioning as specified.

3.4 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 653/A 653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 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 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

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

- . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 MULTI-LEAF DAMPERS

- . 1 Opposed and or parallel blade type as indicated.
- . 2 Structurally formed extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and extruded aluminum frame.
- . 3 Pressure fit self-lubricated bronze bearings.
- . 4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- . 5 Performance:
 - . 1 Leakage: in closed position less than 2% of rated air flow at Pa differential across damper.
 - . 2 Pressure drop: at full open position less than Pa differential across damper at m/s.
- . 6 Insulated aluminum dampers:
 - . 1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
 - . 2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.2 DISC TYPE DAMPERS

- . 1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A 653/A 653M.
- . 2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A 653/A 653M.
- . 3 Gasket: extruded neoprene, field replaceable, with 10 year warranty.
- . 4 Bearings: roller self lubricated and sealed.
- . 5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.
- . 6 Performance:
 - . 1 Leakage: in closed position less than 0.001 % of rated air flow at kPa pressure differential across damper.
 - . 2 Pressure drop: at full open position less than kPa differential across damper at m/s.

2.3 BACK DRAFT DAMPERS

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

2.4 RELIEF DAMPERS

- . 1 Automatic multi-leaf steel aluminum dampers with ball bearing centre pivoted and counter-weights set to open at Pa static pressure, as indicated.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers are observable and accessible.

3.3 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fire and smoke dampers, and fire stop flaps.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
 - .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

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.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Operators.
 - .4 Fusible links.
 - .5 Design details of break-away joints.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide following:

- . 1 6 fusible links of each type.

**1.6 DELIVERY,
STORAGE, AND
HANDLING**

- . 1 Packing, shipping, handling and unloading:
 - . 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - . 2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 FIRE DAMPERS

- . 1 Fire dampers: arrangement Type A BC, listed and bear label of ULC UL Warnock Hersey, meet requirements of provincial fire authority Fire Commissioner of Canada (FCC) CFFM and ANSI/NFPA 90A authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.
- . 2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - . 1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
 - . 2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- . 3 Top hinged: offset single damper, round or square; multi-blade hinged or interlocking type; roll door type; guillotine type; sized to maintain full duct cross section as indicated.
- . 4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- . 5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- . 6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- . 7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- . 8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- . 9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Co-ordinate with installer of firestopping.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

3.3 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation of flexible ductwork, joints and accessories.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .3 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .4 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 (Addendum No.1, November 1997).
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.
- .5 Underwriters' Laboratories Inc. (UL).
 - .1 UL 181-96, Standard for Factory-Made Air Ducts and Air Connectors.
- .6 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in

accordance with Section 01 74 22 - Construction/Demolition
Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

- . 1 Factory fabricated to CAN/ULC-S110.
- . 2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- . 3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

- . 1 Type 1: spiral wound flexible aluminum stainless steel, as indicated.
- . 2 Performance:
 - . 1 Factory tested to 2.5 kPa without leakage.
 - . 2 Maximum relative pressure drop coefficient:

2.3 METALLIC - INSULATED

- . 1 Type 2: spiral wound flexible aluminum with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- . 2 Performance:
 - . 1 Factory tested to 1000 Pa without leakage.
 - . 2 Maximum relative pressure drop coefficient: 3.
 - . 3 Thermal loss/gain: 1.3 W/m².°C. mean.

2.4 NON-METALLIC - UNINSULATED

- . 1 Type 3: non-collapsible, coated mineral base fabric aluminum foil mylar type, mechanically bonded to, and helically supported by, external steel wire, as indicated.
- . 2 Performance:
 - . 1 Factory tested to 2.5 kPa without leakage.
 - . 2 Maximum relative pressure drop coefficient: 3.

2.5 NON-METALLIC - INSULATED

- . 1 Type 4: non-collapsible, coated mineral base fabric or aluminum foil mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, 25 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl or reinforced mylar/neoprene laminate jacket.
- . 2 Performance:
 - . 1 Factory tested to 1000 Pa without leakage.
 - . 2 Maximum relative pressure drop coefficient: 3.
 - . 3 Thermal loss/gain: 1.3 W/m².EC mean.

2.6 METALLIC ACOUSTIC INSULATED - MEDIUM PRESSURE

- . 1 Type 5: Spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate Type M vapour barrier, as indicated.
- . 2 Performance:
 - . 1 Factory tested to 2.5 kPa without leakage.
 - . 2 Maximum relative pressure drop coefficient: 3.
 - . 3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Duct Diam:	Frequency (Hz)				
	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

**2.7 METALLIC -
 ACOUSTIC INSULATED
 - HIGH PRESSURE**

.1 Type 6: Spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible mineral fibre thermal insulation and encased in spiral wound flexible aluminum jacket, as indicated.

.2 Performance:

- .1 Factory tested to 2.5 kPa without leakage.
- .2 Maximum relative pressure drop coefficient: 3.
- .3 Acoustical performance: minimum attenuation (dB/m) to following table:

Duct Diam:	Frequency (Hz)				
	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

**2.8 NON-METALLIC -
 ACOUSTIC INSULATED**

.1 Type 7: non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible mineral fibre acoustic insulation and encased in aluminum foil/mylar laminate Type M vapour barrier, as indicated.

.2 Performance:

- .1 Factory tested to 2.5 kPa without leakage.
- .2 Maximum relative pressure drop coefficient: 3.
- .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Duct Diam:	Frequency (Hz)				
	125	250	500	1000	2000
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

PART 3- EXECUTION

**3.1 DUCT
INSTALLATION**

- . 1 Install in accordance with: CAN/ULC-S110 UL-181 NFPA 90A NFPA 90B SMACNA.
- . 2 Do leakage test in accordance with Section 23 05 94 - Pressure Testing of Ducted Air System.
- . 3 Do trial test to demonstrate workmanship.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- . 1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- . 1 American Society for Testing and Materials International, (ASTM).
 - . 1 ASTM C 423-02a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - . 2 ASTM C 916-85(2001)e1, Standard Specification for Adhesives for Duct Thermal Insulation.
 - . 3 ASTM C 1071-00, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - . 4 ASTM C 1338-00, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - . 5 ASTM G 21-96(2002), Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- . 2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - . 1 Material Safety Data Sheets (MSDS).
- . 3 National Fire Protection Association (NFPA).
 - . 1 NFPA 90A-02, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - . 2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- . 4 North American Insulation Manufacturers Association (NAIMA).
 - . 1 NAIMA AH116-5th Edition, Fibrous Glass Duct Construction Standards.
- . 5 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - . 1 SMACNA, HVAC DCS, HVAC, Duct Construction Standards, Metal and Flexible-95 (Addendum No.1, Nov. 97).
 - . 2 SMACNA IAQ Guideline for Occupied Buildings 95.
- . 6 Underwriter's Laboratories of Canada (ULC).
 - . 1 CAN/ULC-S102-03-EN, Methods of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- . 1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- . 2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials.

1.4 HEALTH AND SAFETY

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

1.5 DELIVERY,

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

**STORAGE AND
HANDLING**

damage.

**1.6 WASTE
MANAGEMENT AND
DISPOSAL**

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 DUCT LINER

.1 General:

- .1 Mineral Fibre duct liner: air surface coated mat facing.
- .2 Flame spread rating shall not exceed 25.
- .3 Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102 and NFPA 90A NFPA 90B.
- .4 Recycled Content: EcoLogo certified with minimum 35% by weight recycled content.
- .5 Fungi resistance: to ASTM C 1338 ASTM G 21.

.2 Rigid:

- .1 Use on flat surfaces where indicated
- .2 25 mm thick, to ASTM C 1071, Type 2, fibrous glass rigid board duct liner.
- .3 Density: 48 kg/m³ minimum.
- .4 Thermal resistance to be minimum 0.76 (m².degrees C)/W for 25 mm thickness 1.15 (m².degrees C)/W for 38 mm thickness 1.53 (m².degrees C)/W for 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
- .5 Maximum velocity on faced air side: 20.3 m/sec.
- .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C 423.
- .7 Recycled Content: EcoLogo certified containing minimum 45% by weight recycled content.

.3 Flexible:

- .1 Use on round or oval surfaces surfaces indicated.
- .2 25 mm thick, to ASTM C 1071 Type 1, fibrous glass blanket duct liner.
- .3 Density: 24 kg/m³ minimum.
- .4 Thermal resistance to be minimum 0.37 (m².degrees C)/W for 12 mm thickness 0.74 (m².degrees C)/W for 25 mm thickness 1.11 (m².degrees C)/W for 38 mm thickness 1.41 (m².degrees C)/W to 50 mm thickness when tested in accordance with ASTM C 177, at 24 degrees C mean temperature.
- .5 Maximum velocity on coated air side: 25.4 30.5 m/sec.
- .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C 423.

2.2 ADHESIVE

.1 Adhesive: to NFPA 90A and NFPA 90B ASTM C 916.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degreesC to plus 93 degreesC.

.3 Water-based fire retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation.
Polymer Nylon Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

PART 3 - EXECUTION

3.1 GENERAL

- .1 Do work in accordance with SMACNA and as indicated except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 90 100% coverage of adhesive to ASTM C 916
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMACNA HVAC DCS NAIMA AH116.
- .2 In systems, where air velocities exceed 20.3 m/sec, install galvanized sheet metal nosing to leading edges of duct liner.

3.3 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply two coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Departmental Representative.
- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.
 - .2 Air curtains.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Air Conditioning and Mechanical Contractors (AMCA)
 - .1 AMCA Publication 99-2003, Standards Handbook.
 - .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
 - .2 Capacity: flow rate, total static pressure, bhp W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

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

- Submittal Procedures.

- . 2 Shop Drawings:
 - . 1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- . 3 Provide :
 - . 1 Fan performance curves showing point of operation, BHP kW and efficiency.
 - . 2 Sound rating data at point of operation.
- . 4 Indicate:
 - . 1 Motors, sheaves, bearings, shaft details
 - . 2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate.
- . 5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - . 1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- . 6 Closeout Submittals:
 - . 1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

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

1.6 MAINTENANCE

- . 1 Extra Materials:
 - . 1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - . 1 Spare parts to include:
 - . 1 Matched sets of belts.
 - . 2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - . 1 Bearings and seals.
 - . 2 Addresses of suppliers.
 - . 3 List of specialized tools necessary for adjusting, repairing or replacing.

1.7 DELIVERY, STORAGE, AND HANDLING

- . 1 Packing, shipping, handling and unloading:
 - . 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - . 2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 FANS GENERAL

- . 1 Motors:
 - . 1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
 - . 2 For use with variable speed controllers.
 - . 3 Sizes as indicated specified.
- . 2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and or outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment. inlet outlet dampers and vanes and as indicated.
- . 3 Factory primed before assembly in colour standard to manufacturer.
- . 4 Scroll casing drains: as indicated.
- . 5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- . 6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- . 7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 CENTRIFUGAL FANS

- . 1 Fan wheels:
 - . 1 Welded steel aluminum construction.
 - . 2 Maximum operating speed of centrifugal fans not more than 40 50 % of first critical speed.
 - . 3 Air foil forward curved backward inclined blades, as indicated.
- . 2 Bearings: heavy duty split pillow-block flange mounted grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 80,000 100,000 200,000 hours.
- . 3 Shaft seals on laboratory fume hood and biological safety cabinet exhaust fans:
 - . 1 Single disc multi-disc labyrinth water-cooled stuffing box carbon ring with nitrogen air purging seals.
- . 4 Housings:
 - . 1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, steel, aluminum, for smaller wheels, braced, and with welded supports.
 - . 2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.
 - . 3 Provide bolted latched airtight access doors with handles.
- . 5 Variable volume control devices:
 - . 1 Mounted by fan manufacturer.
 - . 2 Adjustable inlet vanes: operated from a centre mechanism linked to each damper vane. Support each vane at ends in

bronze bearings. On DWDI fans interconnect vanes to operate in unison. Provide locking devices for manual operation.

. 3 Variable Speed Drives: refer to Sections.

2.3 CABINET FANS - GENERAL PURPOSE

. 1 Fan characteristics and construction: as centrifugal fans.

. 2 Casing floor mounted Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, variable speed V-belt drive and guard inside or outside casing.

. 3 Fabricate casing of zinc coated or phosphate treated steel of mm thickness as indicated reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint to CAN/CGSB 1.181. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 50 mm thick rigid acoustic insulation, pinned and cemented, kg/m³ density, complete with perforated metal liner complete with metal nosings on exposed edges.

2.4 IN-LINE CENTRIFUGAL FANS

. 1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct belt drive.

. 2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

2.5 AIR CURTAIN

. 1 Construction: Provide factory-assembled units of sufficient structural strength to be supported from ends without intermediate support. Ship units completely assembled.

. 2 Cabinet:

. 1 Material: Minimum 16-gage aluminized steel with white colored powder coat finish with mill aluminum inlet screen, all welded construction.

. 2 Mounting: Provide for horizontal mounting.

. 3 Removable top and bottom panel for access.

. 3 Motors: as indicated in schedule.

. 4 Fans: Balanced forward curved centrifugal type, double inlet, double width design, mounted in matched fan housings with aerodynamically formed air inlet venturis. Manufacture wheels and housings from galvanized steel.

. 5 Discharge Nozzles:

. 1 Provide uniform velocity across width of air door.

. 2 Aperture: 3-1/2 inches slot by width of air door.

. 6 Vanes: 1-1/2 inches minimum height; constructed of airfoil-shaped aluminum extrusions; adjustable plus or minus 20 degrees to deflect airflow.

. 7 Inlet:

. 1 Location: Front.

. 2 Screen: Perforated pattern mill aluminum with border.

. 8 Air Inlet Filter: Flat-faced cleanable polyester with aluminum frame

- . 9 Control Panel:
 - . 1 UL listed, industrial type, pre-wired, with components consisting of motor starter, terminal strip, motor overloads, and control transformer with 24 volt fused secondary
 - . 2 Single power supply.
 - . 3 Enclosure: Oil-tight and dust-tight NEMA Type 4 enclosure with neoprene door gasket.
 - . 4 Mounting: Unit mounted. End to be field determined.
 - . 5 Time Delay Relay: Adjustable in field from 0.1 second to 10 hour delay. Set delay for one (1) minute(s) unless otherwise indicated.
 - . 6 Disconnect Switch: Provide units with non-fused toggle disconnects based on number of power supplies required.
 - . 7 HAND-OFF-AUTOMATIC Switch: Switch allows manual on-off operation or operation controlled by automatic door switch that activates unit when door opens and deactivates unit when door closes.
 - . 8 24 Volt Control: NEMA 4 plunger door switch.
- . 10 MOUNTING ACCESSORIES
 - . 1 Provide brackets and other mounting accessories as required to permit installation and proper functioning of air door to meet project conditions of use.
 - . 2 Fabricate mounting accessories from aluminized steel:
 - . 1 Wall Brackets.

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 FAN INSTALLATION

- . 1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- . 2 Provide sheaves and belts required for final air balance.
- . 3 Bearings and extension tubes to be easily accessible.
- . 4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

- . 1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified.

3.4 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Roof exhausters.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 Air Movement and Control Association (AAMC)
 - .1 AMCA Publication 99-2003, Standards Handbook (Revised 2003).
 - .2 AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
 - .3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American National Standards Institute (ANSI)
 - .1 ANSI/AMCA 210-99, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force. Provide confirmation of testing.
 - .2 Capacity: flow rate, total static pressure Pa, r/min, bhp W, model and size and sound ratings as indicated on schedule.
- .2 Statically and dynamically balanced. Constructed to AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, unit to bear AMCA certified rating seal.
- .5 Bearings: sealed lifetime oilite ball bearings heavy duty grease lubricated ball or roller bearings of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 80,000 100,000 hours.

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

- . 2 Shop Drawings:
 - . 1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - . 1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of New Brunswick.
 - . 2 Include :
 - . 1 Fan performance curves showing specified point of operation.
 - . 2 Sound rating data.
- . 3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - . 1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- . 4 Closeout Submittals
 - . 1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- . 1 Packing, shipping, handling and unloading:
 - . 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - . 2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.7 MAINTENANCE

- . 1 Extra Materials:
 - . 1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- . 2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - . 1 Bearings and seals.
 - . 2 Addresses of suppliers.
 - . 3 List of specialized tools necessary for adjusting, repairing or replacing.

PART 2 - PRODUCTS

2.1 ROOF EXHAUSTERS

- . 1 Centrifugal or Axial V belt direct driven.
 - . 1 Housings: spun aluminum galvanized black steel prefinished in enamel FRP PVC stainless steel complete with resilient mounted motor and fan.

- .2 Impeller: aluminum non-overloading.
- .3 Adjustable motor sheave.
- .4 12 mm mesh 2.0 mm diameter aluminum birdscreen.
- .5 Automatic Motorized gasketed aluminum backdraft dampers.
- .6 Disconnect switch within fan housing.
- .7 Continuous curb gaskets, cadmium plated stainless steel securing bolts and screws, and special mated sound insulating 300 mm high curbs where indicated. Hinge curb plate for access to internals for maintenance.

.2 Sound curbs: of same manufacturer as fan and built to suit model specified.

- .1 Double baffle and self-flashing type. Required decibel sound attenuation spectrum:

Frequency Octave Band	1	2	3	4	5	6	7	8
dB Attenuation	3	5	11	16	22	20	17	13

- .2 Pressure loss through curbs: 37 Pa max at rated L/s.

.3 Two speed fan motors: two windings or split windings with speeds of approximately RPM high and r/s low as indicated.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.

3.3 ANCHOR BOLTS AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified in section.

3.4 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

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 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

- . 1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.
- . 2 Frames:
 - . 1 Full perimeter gaskets.
 - . 2 Plaster frames where set into plaster or gypsum board and as specified.
 - . 3 Concealed fasteners.
- . 3 Concealed manual volume control damper operators.
- . 4 Colour: standard as directed by Departmental Representative.
- . 5 Types and capacities: as indicated on the drawings.

2.2 MANUFACTURED UNITS

- . 1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

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 manufacturers instructions.
- . 2 Install with flat head oval head stainless steel cadmium plated screws in countersunk holes where fastenings are visible.
- . 3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- . 4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere as indicated.

3.3 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Filters and filter gauges for various types of mechanical air handling equipment.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
 - .1 ANSI/NFPA 96-04, Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.1-1992, Gravimetric And Dust Spot for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI Approved).
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .2 CAN/CGSB-115.11-M85, Filters, Air, High Efficiency, Disposable, Bag Type.
 - .3 CAN/CGSB-115.12-M85, Filters, Air, Medium Efficiency, Disposable, Bag Type.
 - .4 CAN/CGSB-115.13-85, Filter Media, Automatic Roll.
 - .5 CAN/CGSB-115.14-M91, High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
 - .6 CAN/CGSB-115.15-M91, High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
 - .7 CAN/CGSB-115.16-M82, Activated Carbon for Odor Removal from Ventilating Systems.
 - .8 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type, Medium Efficiency.
 - .9 CAN/CGSB-115.20-95, Polarized Media Air Filter.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Underwriters' Laboratories of Canada
 - .1 ULC -S111-95, Standard Method of Fire Tests for Air Filter Units.
 - .2 ULC-S649-1993, Exhaust Hoods and Related Controls for Commercial and Institutional Kitchens.

1.3 ACTION AND

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature,

**INFORMATIONAL
SUBMITTALS**

specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

- . 2 Shop Drawings:
 - . 1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- . 3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - . 1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- . 4 Closeout Submittals
 - . 1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

**1.4 QUALITY
ASSURANCE**

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

**1.5 DELIVERY,
STORAGE, AND
HANDLING**

- . 1 Packing, shipping, handling and unloading:
 - . 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - . 2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE

- . 1 Extra Materials:
 - . 1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - . 2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.
 - . 3 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank in accordance with section 01 78 00 - Closeout Submittals.

PART 2 - PRODUCTS

2.1 GENERAL

- . 1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 50 degrees C.
- . 2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- . 3 Pressure drop when clean and dirty, sizes and thickness: as indicated

on schedule.

2.2 ACCESSORIES

- .1 Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum same material as casing/hood, 1.6 mm thick, except where specified.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side and/or from upstream downstream face of filter bank.

2.3 FIBROUS GLASS PANEL FILTERS

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diameter hinged wire mesh screen.
- .3 Performance: minimum average synthetic dust weight arrestance 70% to ASHRAE 52.1.
- .4 Fire rated: to ULC -S111.
- .5 Nominal thickness: mm.

2.4 COTTON PANEL FILTERS

- .1 Disposable pleated reinforced cotton dry media: to CAN/CGSB 115.18.
- .2 Holding frame: galvanized steel, or slide in channel for side access.
- .3 Performance:
 - .1 Average atmospheric dust spot efficiency 30 % to ASHRAE 52.1.
 - .2 Average synthetic dust weight arrestance 90 % to ASHRAE 52.1.
- .4 Fire Rated: to ULC -S111.
- .5 Nominal thickness: mm.

2.5 GREASE FILTERS

- .1 Media: washable, 50 mm thick: to ULC- S649 and ANSI/NFPA 96.
- .2 Holding frame: 1 mm thick galvanized stainless steel V or inclined as indicated.
- .3 Stainless steel blank-off plates.
- .4 Individual, removable drip trays with handles.

2.6 CARTRIDGE TYPE FILTERS, MERV 13 EFFICIENCY

- .1 Media: deep pleated, disposable, high efficiency, to CAN/CGSB-115.14.
- .2 Holding frame : galvanized steel with bracing.
- .3 Media support : welded wire grid.

.4 Performance: average atmospheric dust spot efficiency 80-85 % to ASHRAE 52.1.

.5 Fire rated: to ULC -S111.

**2.7 FILTER GAUGES
- DIAL TYPE**

.1 Diaphragm actuated, direct reading.

.2 Range: 0 to 2 times initial pressure 0 to 250 Pa.

**2.8 FILTER GAUGES
- MANOMETER TYPE**

.1 Inclined acrylic tube.

.2 Complete with levelling screws.

.3 Range: 0 to 2 times initial pressure 0 to 250 Pa.

PART 3 - EXECUTION

**3.1 MANUFACTURER'S
INSTRUCTIONS**

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

**3.2 INSTALLATION
GENERAL**

.1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

**3.3 REPLACEMENT
MEDIA**

.1 Replace media with new upon acceptance.

.2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

3.4 FILTER GAUGES

.1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.

.2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

3.5 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, accessories and installation for breechings, chimneys and stacks.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

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

1.3 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 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of New Brunswick.
 - .2 Indicate following:
 - .1 Methods of sealing sections.
 - .2 Methods of expansion.
 - .3 Details of thimbles.
 - .4 Bases/Foundations.
 - .5 Supports.
 - .6 Guy details.
 - .7 Rain caps.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Closeout Submittals
 - .1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

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1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEEA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer signifying adherence to codes and standards.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 BREECHINGS

- .1 Shop fabricated stainless steel, with sweep bends from boiler outlet to thimble or chimney as indicated.

2.2 FUELS: PRESSURE CHIMNEY AND BREECHING

- .1 ULC labelled, 760 degrees C rated.
- .2 Sectional, prefabricated, double wall with air space and mineral wool insulation with mated fittings and couplings.
 - .1 Liner: 0.9 mm thick, type 316 stainless steel up to 900 mm diameter, 1.2 mm up to 1200 mm.
 - .2 Shell: 0.6 mm thick, type 304 stainless steel up to 600 mm diameter, 0.9 mm up to 1200 mm.
 - .3 Outer seals between sections: to suit application.
 - .4 Inner seals between sections: to suit application.
 - .5 Insulation thickness: 50 mm minimum
 - .6 Storm collar and flashing for non-combustible roofs.
 - .7 Ventilated roof thimble and roof support assembly for combustible roofs.
 - .8 Self-supporting above roof line.
 - .9 Stack cap.
 - .10 Lateral tee 45°, drain tee cap.

2.3 ACCESSORIES

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single double acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations of Sheet Metal and Air Conditioning Contractors National Association Inc. (SMACNA)

as indicated.

. 4 Rain cap.

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION - GENERAL

. 1 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.

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

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

. 4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.

. 5 Install flashings on chimneys penetrating roofs, as indicated and required.

. 6 Install rain caps and cleanouts, as indicated and required.

. 7 Chimney is to be self-supporting above roof line.

3.3 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- . 1 Section Includes:
 - . 1 Heating boiler units:
 - . 1 Steam boilers.
 - . 2 Installation.
 - . 3 Commissioning.

1.2 REFERENCES

- . 1 New Brunswick Regulation 84-175, Boiler And Pressure Vessel Act.
- . 2 American Boiler Manufacturer's Association (ABMA)
- . 3 American National Standards Institute (ANSI)
 - . 1 ANSI Z21.13-2004/CSA 4.9-2004, Gas-Fired Low-Pressure Steam and Hot Water Boilers.
- . 4 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
 - . 1 ANSI/ASME Boiler and Pressure Vessel Code, Section IV, 2004.
- . 5 Canadian Gas Association (CGA)
 - . 1 CAN1-3.1-77(R2001), Industrial and Commercial Gas-Fired Package Boilers.
 - . 2 CAN/CSA-B149.1-05, Natural Gas and Propane Installation Code.
- . 6 Canadian Standards Association (CSA International)
 - . 1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.
 - . 2 CSA B139-04, Installation Code for Oil Burning Equipment.
 - . 3 CSA B140.7-05, Oil Burning Equipment: Steam and Hot-Water Boilers.
- . 7 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
- . 8 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - . 1 Material Safety Data Sheets (MSDS).

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

Submittal Procedures.

- . 1 Submit drawings stamped and signed by professional engineer registered or licensed in Province s Territory ies of, Canada.
- . 2 Indicate the following:
 - . 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.
 - . 4 Piping hook-ups.
 - . 5 Equipment electrical drawings.
 - . 6 Burners and controls.
 - . 7 All miscellaneous equipment.
 - . 8 Flame safety control system.
 - . 9 Breeching and stack configuration.
 - . 10 Stack emission continuous monitoring system to measure CO, O, NOx, SO, stack temperature and smoke density of flue gases.
- . 3 Engineering data to include:
 - . 1 Boiler efficiency at 25%, 50%, 75%, 100%, and 110% of design capacity.
 - . 2 Radiant heat loss at 100% design capacity.
- . 3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - . 1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - . 2 Instructions: submit manufacturer's installation instructions.
 - . 1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- . 4 Closeout Submittals:
 - . 1 Submit operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- . 1 Regulatory Requirements: work to be performed in compliance with CEPA, CEEA, TDGA, and New Brunswick Boiler and Pressure Vessel Act, Regulation 84-175.
- . 2 Health and Safety:
 - . 1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

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

- . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.
- . 2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.6 MAINTENANCE

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

PART 2 - PRODUCTS

2.1 STEAM BOILER (SB-01 and SB-02)

- . 1 Packaged skid-mounted boiler:
 - . 1 Provide a complete skid-mounted, natural gas-fired, steam boiler package complete with two boilers, economizer, water softener, water treatment, hotwell, steam separator, relief valves, drip pan elbow, drains, drain cooler, and boiler feedwater system and all associated controls to operate all aspects of the boiler package.
 - . 2 Package shall be factory assembled, wired, tested and shipped in skids as indicated on the drawings.
 - . 3 Contractor shall assemble skids and make all necessary connections as required and as indicated by the manufacturer.
 - . 4 Contractor is to install any items which are shipped loose.
 - . 5 Package shall be complete with gas burner and necessary accessories and controls.
 - . 6 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7 CAN1-3.1.
 - . 7 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
 - . 8 Designed and constructed to ANSI/ASME Boiler and Pressure vessel Code.
 - . 9 CRN (Canadian Registration Number), to CSA B51.
 - . 10 Boiler/burner package to bear ULC CGA label.
- . 2 Boiler Skid (SB-01 and SB-02)
 - . 1 The boiler skids shall consist of two separate, but coordinated packaged steam boilers skids complete with economizer.
 - . 2 The economizer shall be smooth tube design and integral to the shell of the boiler. It shall require no additional piping or supports but be supported and integrated into the boiler proper with all interconnecting pipe and connections included.
 - . 3 Boiler shall operate on natural gas.
 - . 4 Provide a steam separator complete with relief valves, drip pan elbow and drains as shown and required.
 - . 5 The Burner shall be a modulating forced draft design capable of burning natural gas. The Burner and the associated control system shall be capable of modulating from 20% to

- 100% of the rated load. The unit will cycle into standby mode when the steam demand falls below 20%.
- . 6 The steam separator shall be designed, built, tested and stamped per ASME Section I. The unit shall be sized to properly separate steam from water and solids and to provide a minimum of 99.5 % dry steam at the outlet nozzle. The separator shell shall be made from SA53 black pipe. The heads shall be SAE 285 carbon steel. Excess water and solids shall exit the separator through an inverted bucket steam trap for return to the feedwater vessel. The separator shall have openings provided for steam outlet, safety relief valves, coil connection, drain, pressure/ temperature indicators, and an inspectors test cock. The steam separator shall not maintain a water level so as to prevent carry over and be designed for high TDS levels.
 - . 7 Vent to atmosphere.
 - . 8 Provide a cooling water system to temper the relief prior to draining.
 - . 9 The steam generator shall be capable of accepting feedwater with a total dissolved solids (TDS) concentration of up to 8550 ppm. (Normal Operating range of 3000-6000 ppm). The unit shall operate without surface and bottom blowdown.
 - . 10 The steam generator shall be capable of accepting feedwater with a total dissolved solids (TDS) concentration of up to 8550 ppm. (Normal Operating range of 3000-6000 ppm). The unit shall operate without surface and bottom blowdown.
- . 3 **Feedwater System Skid**
 - . 1 Provide a complete packaged feedwater skid matched the boiler system.
 - . 2 Package shall include open hotwell, relief piping, sample cooler, feedwater chemical treatment, TDS control system.
 - . 3 Provide all required pumps, valves, control valves, gauges and electrical connections and controls.
 - . 4 Provide connections to SB-01 and SB-02, condensate return, water softener and connections to other skids as required.
 - . 4 **Water Softener Skid**
 - . 1 Provide a complete water softener skid mounted package to match the steam boiler system.
 - . 2 Provide sample port for testing water quality.
 - . 3 Run softener discharge to drain.
 - . 5 **Blowdown Skid**
 - . 1 Provide a complete blowdown skid mounted package to match the steam boiler system.
 - . 2 Provide cooling water to tank.
 - . 3 Vent to atmosphere.
 - . 6 **Boiler Flue**
 - . 1 Boiler flue shall be sized to match the boilers and proposed routing of flues as shown on the drawing and as recommended by the boiler manufacturer.
 - . 7 **Performance:**
 - . 1 In accordance with American Boiler Manufacturers

- Association (ABMA), or ANSI Z21.13/CSA 4.9 (gas burning) testing procedures.
- . 2 As indicated on the drawings.
- . 3 Boiler efficiency: 80 % minimum at 30% to 100% firing rates.
- . 4 Flue gas temperature leaving boiler:
 - . 1 Not to exceed 260 degrees C.
 - . 2 Above dewpoint conditions at minimum firing rate.

- . 8 Electrical:
 - . 1 Power: 575V, 3ph, 60Hz
 - . 2 Controls: 120 V, 1 phase, 60 Hz.
 - . 3 Electrical components: CSA approved.

- . 9 Controls:
 - . 1 Factory wired. Enclosed in Electrical and Electronic Manufacturers' Association of Canada (EEMAC) 1 steel cabinet.
 - . 2 Control Panel: Each steam generator shall have its own control panel mounted and wired on its frame. The steam generator shall utilize a Clayton Allen Bradley Micrologix 1200 or 504 PLC system of the level indicated below. The primary operating voltage shall be 575v. A 110V control voltage transformer will be supplied as an integral component of the control panel.
 - . 3 The following PLC Level shall be supplied:
 - . 1 Level I utilizing an Allen-Bradley fixed PLC. The following readouts shall be available through the Operator Interface Unit (OIU) and, in ASCII format, at an RS-232 serial port:
 - . 1 Firing Rate
 - . 2 Flame Strength
 - . 3 Steam Pressure
 - . 4 Steam Pressure Set Point
 - . 5 Steam Pressure Limit Set Point
 - . 6 Machine Run Hours
 - . 7 Trap Timing
 - . 4 The controls shall integrate with the building management system and guarded plant panel as required.

- . 10 Safety Controls
 - . 1 Provide the following safety controls as a minimum:
 - . 1 Temperature control devices.
 - . 2 Steam limit pressure switch.
 - . 3 Combustion air pressure switch.
 - . 4 Overcurrent protection.
 - . 5 Flame safe guard.
 - . 2 Guarded Plant Requirements: The boilers shall be equipped with devices as required by the New Brunswick Boiler and Pressure Vessel Act and as follows to output to the Guarded Plant Panel and shut the boilers down:
 - . 1 High pressure steam limit pressure switch.
 - . 2 Low water cutout switch.
 - . 3 High water level limiting switch.
 - . 4 Pre-purge and flame failure device to prevent the supply of fuel to the boiler.

- .11 Thermal insulation:
 - .1 50 mm thick mineral fibre. Seal insulation at handholes, manholes, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
- .12 Jackets: heavy gauge metal, finished with heat resisting paint.
- .13 Mounting:
 - .1 Structural steel base, lifting lugs.
- .14 Anchor bolts and templates:
 - .1 Supply for installation by other Divisions. Anchor bolts to be sized to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .15 Factory start-up, instruction, on-site performance tests: 3 days.
- .16 Trial usage:
 - .1 Departmental Representative D may use boilers for test purposes prior to acceptance and commencement of warranty period.
 - .2 Supply labour, materials and instruments required for tests.
- .17 Temporary use by contractor:
 - .1 Contractor may use boilers only after written approval from Departmental Representative.
 - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
 - .3 Refurbish to as-new condition before final inspection and acceptance.
- .18 Physical constraints: Boiler package shall fit in areas shown on drawings including height including boiler flue.

2.2 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ANSI/ASME requirements.
- .2 Auxiliary Pressure Control System
 - .1 Provide for automatic startup of an idle, or standby, steam generator to supplement steam production of the on-line, or primary steam generator, during periods when steam demand exceeds that of the primary unit's rated output capacity.
- .3 Steam boilers:
 - .1 Safety valves: ANSI/ASME rated, to release entire boiler capacity, complete with drip pan elbow and vent pipe.
 - .2 Pressure gauge: 130 mm diameter range 0 to 200 kPa, complete with syphon and cock.
 - .3 Water column assembly: with tri-cocks, gauge glass, protective rods, blowdown valves operated from firing floor.
 - .4 High water level: audible alarm.
 - .5 Low water level: fuel cut-off with visual and audible alarms and feedwater pump control switch.
 - .6 Feedwater regulator on 3-valve bypass with drain valve, stop valve and check valve.
 - .7 Continuous blow-down stop valve.

- . 8 Soot blower element, supply valve and drain valve.
- . 9 Auxiliary low water cut-off with separate cold water connection to boiler.
- . 10 Steam stop stop-check valve.
- . 11 Quick-opening blowdown valve and shut-off valve.
- . 12 Stack thermometer: range 65 to 400 degrees C.
- . 13 Drain valve: NPS 2.
- . 14 One 1 set cleaning tools.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- . 1 Install in accordance with ANSI/ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- . 2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- . 3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- . 4 Pipe all drains full size to nearest drain.
- . 5 Pipe steam relief valve through roof with drip pan elbow piped to nearest drain.
- . 6 Pipe blowdown/drain to blowdown tank/floor drain.
- . 7 Provide 100mm minimum housekeeping pads for each skid extending 150mm beyond the equipment baseplates.
- . 8 Level, anchor and ground skids to housekeeping pads.
- . 9 Natural gas fired installations - in accordance with CAN/CSA-B149.1.
- . 10 Provide combustion air as required and shown on the drawings.

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 GUARDED PLANT

- . 1 Guarded plant panel is to be provided by the Controls contractor and connected to the boiler package as required by the New Brunswick Boiler and Pressure Vessel Act.
- . 2 Boilers are to have required safeties to meet the requirements of New Brunswick Boiler and Pressure Vessel Act.

3.5 FIELD QUALITY CONTROL

- . 1 Startup:
 - . 1 By Manufacturer.

- . 2 Commissioning:
 - . 1 Factory Manufacturer to:
 - . 1 Certify installation.
 - . 2 Start up and commission installation.
 - . 3 Carry out on-site performance verification tests.
 - . 4 Demonstrate operation and maintenance.
 - . 2 Provide Departmental at least 48 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.6 CLEANING

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

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, 2010.
- .2 CSA International
 - .1 CSA B51-09, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of New Brunswick.
 - .2 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
 - .1 Indicate manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

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

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 EQUIPMENT

- . 1 Plate Heat Exchanger:
 - . 1 Designed, constructed and tested in with accordance ASME Boiler and Pressure Vessel Code CSA B51 and provincial pressure vessel regulations.
 - . 2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
 - . 3 Plates: type 316 stainless steel titanium alloy 825 corrosion-resistant alloys.
 - . 4 Gaskets: as recommended by manufacturer to suit fluid temperature nitrile rubber EPDM fluoroelastomer neoprene chlorosulfonated polyethylene resin cured butyl rubber.
 - . 5 Nozzles: ASA rubber rated flange type.
 - . 6 Supports: as indicated.
 - . 7 Piping connections: as indicated.
 - . 8 Capacity: as indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- . 1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- . 2 General: install level and firmly anchored to supports as indicated in accordance with manufacturer's recommendations.
- . 3 Plate exchangers: install in accordance with manufacturer's recommendations.

3.3 APPURTENANCES

- . 1 Install with safety relief valve piped to drain.
- . 2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.

3.4 FIELD QUALITY CONTROL

- . 1 Site Tests and Inspections:
 - . 1 Perform tests as directed by Departmental Representative to ensure heat exchangers are functional.
 - . 2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- . 2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
- . 3 Manufacturer's Field Services:

- . 1 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- . 2 Ensure manufacturer's representative is present before and during critical periods of installation construction of field joints and testing.
- . 3 Schedule site visits:
 - . 1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - . 2 Twice during progress of Work at 25% and 60% complete.

3.5 SYSTEM START-UP

- . 1 General: perform start-up operations in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- . 2 Flush piping system with valves closed to heat exchanger and opening the by-pass valve located at each heat exchanger.
- . 3 Check heater for cleanliness on primary and secondary sides.
- . 4 Check water treatment system is complete, operational and correct treatment is being applied.
- . 5 Check installation, settings, operation of relief valves and safety valves.
- . 6 Check installation, location, settings and operation of operating, limit and safety controls.
- . 7 Check supports, seismic restraint systems.
- . 8 General: perform performance verification in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.
- . 9 Timing: only after TAB of hydronic systems have been successfully completed.
- . 10 Primary side:
 - . 1 Measure flow rate, pressure drop and 2 water temperatures at heater inlet and outlet.
 - . 2 Control valve: verify proper operation without binding, slack in components. Measure temperature at control valve inlet, pressure drop across inlet to common, bypass to common, inlet to bypass.
 - . 3 Secondary side:
 - . 1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - . 2 Verify installation and operation of air elimination devices.
 - . 4 Calculate heat transfer from primary and secondary sides.

- . 5 Simulate heating water temperature schedule and repeat above procedures.
- . 6 Verify settings, operation, safe discharge from safety valves and relief valves.
- . 7 Verify settings, operation of operating, limit and safety controls and alarms.
- . 8 Reports:
 - . 1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, supplemented as specified herein.

3.6 CLEANING

- . 1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- . 2 Leave Work area clean at end of each day.
- . 3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- . 4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.
- . 5 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 DEMONSTRATION

- . 1 Training: provide training in accordance with Section 01 91 01 - General Commissioning (Cx) Requirements: Training of O&M Personnel.

3.8 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials, components and installation for heat reclaim devices.
- .2 Related Requirements
 - .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 84-1991, Method of Testing Air-to-Air Heat Exchangers (ANSI approved).
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

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 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .5 Certificates:
 - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.

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.
- .2 Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.

1.5 DELIVERY, STORAGE, AND

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

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written instructions and Section 01 61 00 - Common Product Requirements.

- . 2 Waste Management and Disposal:
 - . 1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 GENERAL

- . 1 Comply with ASHRAE 84.

2.2 MANUFACTURED UNIT

- . 1 Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, energy wheel, frost control, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point connection.

2.3 CABINET

- . 1 Capacity: as indicated.
 - . 1 Materials: Formed double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - . 1 Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
 - . 2 Internal assemblies: 18 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
 - . 2 Access doors shall be hinged
 - . 3 Shall have factory-installed duct flanges on all duct openings.
 - . 4 Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - . 1 Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - . 1 Thickness: 25 mm
 - . 2 Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - . 3 Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
- . 2 Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty.
- . 3 The wheel media shall be a polymer film matrix in a stainless steel

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framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.

. 4 Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.

. 5 Control panel / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections

. 6 Frost control: modulating wheel.

. 7 Modulating frost control. Control system shall include an outdoor air thermostat and pressure sensor on the wheel assembly to initiate frost control sequence.

. 8 Motorized dampers / Exhaust Air, Intake Air: by others.

. 9 Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed.

. 10

2.4 MOTOR

. 1 General: Blower motors greater than $\frac{3}{4}$ horsepower shall be "NEMA Premium" unless otherwise indicated. Minimum compliance with EPA's minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley. Comply with requirements in Division 23 05 13, matched with fan load.

2.5 BLOWER

. 1 Blower section construction, Supply Air and Exhaust Air: Belt drive motor and blower shall be assembled onto a 14 gauge galvanized steel platform and must have neoprene vibration isolation devices.

. 2 Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

. 3 Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.

. 4 Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.

. 5 Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.6 UNIT CONTROLS

. 1 Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status, operating settings and alarm conditions. DDC controller shall have a built-in keypad to permit operator to access read-out screens and change settings without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable. Owner-specified ventilating conditions can be input by means of pushbuttons.

. 2 Operating protocol: The DDC shall be factory-programmed for BACnet IP for monitoring of the unit's status and control of the unit's function.

. 3 Variable Frequency Drive (VFD): unit shall have factory installed variable frequency drives for modulation of the blower motors. The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.

. 4 Sensors
. 1 Dirty Filter Sensor
. 2 Rotation Sensor

2.7 FILTERS

. 1 Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.

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 manufacturers recommendations.
. 2 Support independently of adjacent ductwork with flexible connections.
. 3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers,

3.3 START-UP SERVICE

. 1 Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Measure and record electrical values for voltage and amperage.

3.4 FIELD QUALITY CONTROL

. 1 Tests:
. 1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical

3.5 CLEANING

. 1 Proceed in accordance with Section 01 74 11 - Cleaning.
. 2 Upon completion and verification of performance of installation,

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remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 REFERENCES

- .1 American National Standards Institute/Air-Conditioning and Refrigeration Institute (ANSI/ARI)
 - .1 ANSI/ARI 430-99(R2002), Central-Station Air-Handling Units.
- .2 American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .4 Master Painters Institute (MPI)
 - .1 MPI-INT 5.3-2007, Galvanized Metal.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation, filters, adhesives, and paints, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province s Territory ies of, Canada.
 - .2 Indicate following: fan fan curves showing point of operation motor drive bearings filters mixing box dampers VAV coil; include performance data.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include following: fan bearings motor damper VAV control air volume total cooling sensible cooling EDB EWB OAT.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide one spare sets of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for

equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

. 4 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative DCC Representative Consultant, supply 1 complete set of filters for each filter unit or filter bank.

. 1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.

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

. 3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates padding and packaging materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.6 DELIVERY, STORAGE AND HANDLING

PART 2 – PRODUCTS

2.1 GENERAL

. 1 Factory assembled components to form units supplying air at designed conditions, as indicated.

. 2 Certify ratings: to ANSI/ARI 430 with ARI seal.

. 3 Horizontal and Vertical type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, dampers bypass section heating coil, cooling coil humidifier spray section mixing box blender air mixing device filter mixing box.

2.2 CASINGS

. 1 Galvanized steel mm thickness thickness as indicated reinforced and braced for rigidity.

. 2 Hinged access panels.

2.3 ACOUSTIC LINER

. 1 Ensure that expanded polystyrene and polyurethane insulation materials were not produced with ozone depleting substances.

. 2 Insulate internal surface of panels with 50mm neoprene coated rigid duct liner of 72kg/m³ density.

. 1 Apply with 100% coverage of adhesive with clip pins.

. 2 Adhesives: maximum VOC limit 80 200 250 g/L to SCAQMD Rule 1168 to GSES GS-36.

. 3 Cover with 0.8 mm thick perforated galvanized sheet metal.

. 4 Cover leading and trailing edges with sheet metal nosing and at edges around access doors and panels complete with 15 mm overlap.

2.4 DRAIN PANS

. 1 Construction: stainless steel.

. 2 Rounded corners.

. 3 Insulation: external foam type, minimum 13 mm thick.

. 4 Drain connection: at low point.

.5 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.

.6 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

2.5 FANS

.1 Cabinet hung free standing AMCA-rated for sound and performance centrifugal fans with backward inclined forward curved airfoil wheels, selected to operate in stable part of performance curve at times and heavy duty 100,000 200,000 hours service self-aligning split pillow block bearings.

.2 Provide internally and or externally mounted motor as indicated complete with adjustable V-belt drive and guard.

.3 Motor: inverter duty to ASHRAE 90.1.

.4 Maximum sound power levels, as indicated.

.5 Internally mounted motor and fan.

2.6 VIBRATION ISOLATION

.1 Flexible connections at inlet and outlet of fan section: to Section 23 33 00 - Air Duct Accessories.

.2 Vibration isolators on fan section as indicated complete with seismic restraints: in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

2.7 FILTER BOX

.1 Material to match casing.

.2 For flat type filter arrangement: as indicated.

.3 Provide access to filter through hinged door with suitable hardware.

.4 Provide blank-off plates and gaskets to prevent air bypass.

.5 Filters: in accordance with Section 23 44 00 - HVAC Air Filtration.

.1 Minimum Efficiency Reporting Value (MERV) value 8 filtration media to ASHRAE 52.2, to be used on return air section of air handling unit.

.2 Immediately prior to occupancy, replace filtration media with new filtration media with Minimum Efficiency Reporting Value (MERV) of 13 in accordance with ASHRAE 52.2.

2.8 MIXING BOX

.1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5°C of design across face of outlet.

.2 Dampers:

.1 Dampers for mixing boxes: in accordance with Section 23 33 15 - Dampers - Operating.

2.9 COILS

.1 Capacity: as indicated on drawings.

.2 Ratings: ARI certified.

- . 3 Construction:
 - . 1 Casings: 1.5 mm thick galvanized sheet steel.
 - . 1 Supports of galvanized steel channel double angle frames.
 - . 2 Blank-off plates. Insulated sandwich construction.
 - . 2 Hot water coils: cleanable fins.
 - . 1 Tubes: copper brass steel.
 - . 2 Fins: copper aluminum plate spiral wound.
 - . 3 Headers: cast iron steel cast brass.
 - . 4 Pressure tests: 1.7 MPa.
 - . 3 Direct expansion refrigerant coils:
 - . 1 Serpentine type, Straight tube type arranged to prevent trapping of oil.
 - . 1 Liquid distributors to ensure even distribution of liquid refrigerant to all circuits.
 - . 2 Silver solder or braze joints in refrigerant tubing.
 - . 3 Evacuate and charge coil with nitrogen and seal before sending to site.
 - . 2 Tubes: copper.
 - . 3 Fins: copper aluminum plate spiral wound.
 - . 4 Headers: copper.
 - . 5 Pressure tests: to Canadian Refrigeration Code. Dehydrated. Sealed with nitrogen charge.

2.10 DUCTLESS SPLIT COOLING UNIT

- . 1 Type
 - . 1 Indoor Unit: Provide packaged, air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, evaporator fans and motors, refrigerant coils, discharge grilles, permanent removable filters, controls and refrigerant.
 - . 2 Outdoor Unit: Provide packaged, self contained, factory assembled pre-wired and pre-piped unit consisting of cabinet, compressor, outdoor refrigerant coil and fan, service valves, check valves, reversing valves, filter strainer, gauge ports, relays, contactors, circuit breakers, and starters.
 - . 3 Indoor unit and outdoor unit shall be of same manufacturer and shall be matched for performance.
- . 2 Refrigeration Compressors
 - . 1 Compressor shall be high performance rotary type.
 - . 2 Units must be equipped with high pressure cut-off with manual reset.
 - . 3 Mounted enclosed panel shall include:
 - . 1 Suction and discharge refrigerant pressure gauge tappings.
 - . 2 High and low pressure cut out.
 - . 3 Low ambient kit for operation to -40°C.
 - . 4 Time delays to prevent repeated cycling of compressor on low loads, crank case heater.
- . 3 Outdoor Condensing Units
 - . 1 Provide weatherproof outdoor unit with compressors for horizontal air flow, factory pre-wired and pre-piped, baked

- . 2 enamel finish, complete with access doors.
- . 2 Provide single circuited coils with mechanical expanded copper tubing into aluminium fin. Clean, dehydrate and test coils. Seal and ship with holding charge of refrigerant.
- . 3 Provide fan section with direct drive propeller fan. Supply drip-proof motors, resiliently mounted, pre-lubricated with built-in overload protection. Provide fan and coil guards.
- . 4 Indoor Evaporator Units
 - . 1 Provide indoor, wall mounted unit complete with evaporator coils, condensate drain, factory pre-wired and pre-piped.
 - . 2 Coils shall be ARI certified, single circuited, constructed of seamless copper tubing force fitted to aluminium continuous flat plate.
 - . 3 Clean and dehydrate coils, charge with inert gas and seal for shipment.
- . 5 Refrigerant Piping and Accessories
 - . 1 Provide refrigerant grade angle, globe and ball shut-off valves.
 - . 2 Provide pressure gauge taps at compressor inlet and outlet and at all other locations required.
 - . 3 Provide staged oil traps where evaporator is below compressor.
 - . 4 Reversing valves and control circuitry.
- . 6 Controls
 - . 1 Provide programmable, solid state electronic, microprocessor controls as specified and required, including relays and control devices or current to DDC control systems.
 - . 2 Provide control devices to maintain proper compressor head pressures. Interlock condenser operation to refrigeration cycle and to switch reversing valves, etc.
 - . 3 Provide 7-day programmable time schedules with night setback scheduling and automatic/on fan control. Provide auto restart backup for program protection on power failure.

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 Provide appropriate protection apparatus.
- . 2 Install units in accordance with manufacturer's instructions and as indicated.
- . 3 Ensure adequate clearance for servicing and maintenance.

3.3 FANS

- . 1 Install fan sheaves required for final air balance.
- . 2 Install flexible connections at fan inlet and fan outlets.
- . 3 Install vibration isolators.

3.4 DRIP PANS

- .1 Install deep seal P-traps and trap seal primer on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 Common Results for HVAC.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials. WHMIS acceptable to Labour Canada, and Health Canada for.
- .3 Submit product data sheets for unit heaters. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Mounting methods.
 - .4 Physical size.
 - .5 kW rating, voltage, phase.
 - .6 Cabinet material thicknesses.
 - .7 Limitations.
 - .8 Colour and finish.
- .4 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence, cleaning procedures and

1.3 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Equipment, capacity and piping connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

1.4 CLOSEOUT SUBMITTALS

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 22 - Construction/Demolition Waste Management And Disposal, and with Waste Reduction Workplan.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

- .1 Cabinet: type semi-recessed or fully recessed as indicated, 1.6 mm thick steel with rounded exposed corners and edges, removable panels, glass fibre insulation and integral air outlet and inlet.
- .2 Finish with factory applied primer coat and paint.
- .3 Special cabinets front panels: as indicated.
- .4 Coils: aluminum fins mechanically bonded to copper tubes. Hydrostatically tested to 1 MPa.
- .5 Fans: centrifugal double width wheels, statically and dynamically

balanced, direct driven, sleeve bearings, resilient mounted.

. 6 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

. 7 Filters: removable 25 mm thick fibrous glass throwaway permanent washable type.

. 8 Capacity: as indicated.

2.2 HORIZONTAL UNIT HEATERS

. 1 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.

. 2 Coils: seamless copper tubing, silver brazed to steel headers with evenly spaced aluminum fins mechanically bonded to tubing. Hydrostatically test to 1 MPa.

. 3 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.

. 4 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor supports.

. 5 Air outlet: two-way four-way adjustable louvres.

. 6 Capacity: as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

. 1 Install in accordance with manufacturer's instructions.

. 2 Check final location with Departmental Representative if different from that indicated prior to installation.

. 3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative directive.

. 4 Hot water units: for each unit, install ball valve on inlet and lockshield calibrated balancing valve on outlet of each unit. Install drain valve at low point.

. 5 Install manual air vent at high point.

. 6 Clean finned tubes and comb straight.

. 7 Provide supplementary suspension steel as required.

. 8 Install thermostats in locations indicated.

. 9 Before acceptance, set discharge patterns and fan speeds to suit requirements.

END OF SECTION