

- .2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection. Also see "Mandatory Requirements for O&M Manuals" this in Section.
- .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
 - .1 Equipment performance verification test results.
 - .2 Special performance data as specified.
 - .3 For each fan and pump installed, provide performance data in "Curve" or multi rating table.
 - .4 For each plumbing fixture, floor and roof drain installed, provide manufacturer's "cut" of that item and "cuts" of associated brass goods.
- .6 Approvals:
 - .1 Submit 1 copy 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.
 - .2 Copies of extended guarantees and warranties for equipment items such as hot water tanks and heat exchangers shall be included in a separate section of the manual.

- .8 Site records:
 - .1 Departmental Representative will provide 1 set of 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 site mechanical drawings. Update drawings to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
 - .5 The drawings shall indicate the inverts and dimensioned locations of all services at the property line and where they penetrate the building perimeter.
- .9 As-built drawings:
 - .1 Departmental Representative will provide CAD drawings to Contractor who will be responsible for producing the as-built drawings. Contractor shall update CAD drawings using CAD drafting procedures, to show all changes made.
 - .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 one (1) hard copy for check prints to Departmental Representative for approval, and make corrections as directed. Upon acceptance by Departmental Representative, Contractor shall make multiple copies of as-built drawings (electronic and hard copies), and submit completed as-built drawings with Operating and Maintenance Manuals in accordance with Division 1.

1.3 Regulations

- .1 Comply with most stringent requirements of NBC, Provincial and Municipal regulations and by-laws, specified standards, codes and this specification. Practices contained in these standards or standards suggested or recommended by reference organizations, are to be taken as minimum requirements.
- .2 Furnish certificates confirming work installed conforms to requirements of authorities having jurisdiction.
- .3 Drawings and specifications should not conflict with these Regulations but where there are apparent discrepancies, notify the Departmental Representative in writing and obtain clarifications before proceeding with the work.

1.4 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.5 Guarantee Warranty

- .1 Correct promptly at own expense, defects or deficiencies in the work in accordance with the Warranty requirements of the Contract.
- .2 The Departmental Representative shall be the judge as to whether the failure is due to defective workmanship, improper usage or ordinary wear and tear.
- .3 Make good any damage resulting from defective materials or workmanship.
- .4 Rectify any deficiencies or omissions in respect to plans or Specifications which may appear during the guarantee period even though work has been accepted as complete.

1.6 Definitions

- .1 Definitions used in this Division will have the following meaning:
 - .1 "Concealed": pipes, ducts, etc., in trenches, chases, furred spaces, pipe shafts, or hung ceilings.
 - .2 "Exposed": regarding insulation and painting of piping, ducts, etc., will mean that they are not "concealed", as defined herein.
 - .3 "Piping": includes, in addition to pipe, all fittings, valves, hangers, other accessories which comprise a system.
 - .4 "Provide": to supply and install, complete and ready for use.

1.7 Drawings

- .1 Drawings:
 - .1 Are not intended to show structural details or architectural features.
 - .2 Are not to be scaled.
 - .3 Except where dimensioned, indicate general mechanical layouts only.
 - .4 The drawings are mainly schematic and do not attempt to show all offsets. Make such offsets at no additional cost to contract. Offset angles shall be as small as possible.
 - .5 All figured dimensions shall have precedence over scale. Detail drawings shall have precedence over small scale drawings; any difference between same shall be decided upon by the Departmental Representative.
- .2 Provide field (shop) drawings to indicate relative position of various services when required by Departmental Representative and obtain approval before commencing work.
- .3 Shop drawing review by Departmental Representative is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that Departmental Representative approves the detail design inherent in the shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for quantities and dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub-trades.

1.8 Maintenance

- .1 Furnish spare parts in accordance with Section 01 01 50 – General Instructions as indicated in the detailed product specification clauses.
- .2 Provide access doors for concealed expansion joints, traps, strainers, cleanouts, balance dampers, fire dampers, other parts requiring accessibility for operating and maintenance.
- .3 In suspended panel ceilings, use panel in place of access door; provide in such panel a button or other means of identification and easy removal when necessary.

1.9 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 01 50 – General Instructions.

1.10 Discrepancies and Omissions

- .1 Bidders finding discrepancies in, or omissions from, Drawings, Specifications, or other documents, or having any doubt as to the meaning or intent of any part thereof, shall at once notify the Departmental Representative, who will send explanatory written instructions to all bidders. No verbal information will be considered valid.
- .2 Should there be conflict(s) within or between the Specifications and/or Drawings, the most stringent or higher quality requirement shall apply.

1.11 Mandatory Requirements for O&M Manuals

- .1 Employ an independent firm with minimum five (5) years experience in preparing professional quality O&M manuals.
- .2 Hard Copy Requirements:
 - .1 Hard copies shall be placed in D-ring binders with clear overlay on front and spine with labels inserted on front cover and spine. Labels shall include the following information: Front cover label shall include the project name, project location, owner, architect, mechanical consultant, general contractor, mechanical contractor, firm preparing the manuals, and the month and year that the manuals were prepared. It shall also bear the label "Operating & Maintenance Manual for Mechanical Systems".
 - .2 Spine label shall include the project name, project location, and the year that the manuals were prepared. It shall also bear the label "Operating & Maintenance Manual for Mechanical Systems".
 - .3 Indicate Volume X of Y if more than one volume is required.
 - .4 Insert a Title page and Table of Contents in clear plastic covers.
 - .5 Title page shall include the project name, project location, as well as the name, address, phone number of the owner, architect, mechanical consultant, general contractor, mechanical contractor, firm preparing the manuals, and the month and year that the manuals were prepared. It shall also bear the label "Operating & Maintenance Manual For Mechanical Systems".

.6 Index the binder according to the following system:

Tab 1.1 Mechanical Drawing Schedule

Tab 1.2 Description of Systems

- Provide a schematic drawing and component description for each major mechanical system including air handling systems, boiler and hot water heating piping distribution systems and (where applicable) water chillers and chilled water distribution systems. The schematic drawing shall identify each component with a letter designation corresponding to a description briefly explaining the purpose of each component and how it relates to the other components, and be presented in a current version of AutoCAD or similar computer aided drafting program.
- The component description shall be clearly written in a language that may be easily understood by the building operators and maintainers who will be using them.

Tab 1.3 Operating Division

Provide the following:

- Specific operating instructions for each major item of equipment, including air handling systems, pumps, boilers, chillers, etc.
 - Ventilation requirements, Energy considerations, Automatic temperature control settings, Information regarding air filters and pressure drops for clean and dirty conditions.
 - Trouble Shooting Procedure Guide in spreadsheet form with the most likely causes and recommended actions for all foreseeable problems. Trouble Shooting Procedure guides are required for all the major items of equipment including air handling systems, exhaust fans, circulating pumps, mechanical cooling equipment, etc.
 - Mechanical Equipment Starting Procedures.

Tab 1.4 Maintenance and Lubrication Division

Tab 1.5 Equipment Supplier and Contractor Schedule

- Provide a list of Equipment Suppliers and Contractors and include their address, telephone number.
- Provide the Equipment Make/Manufacturer

Tab 2.0 Guarantees, Certificates and Reports

- Including assurance letters, balancing and commissioning reports

Tab 2.1 Valve Tag Schedule

Tab 2.2 Labeling and Identification Schedule

- Piping colour code schedules
- Access panel identification schedules

Tab 2.3 Chemical Cleaning and Treatment

- Chemical cleaning shop drawings, water treatment data

Tab 3.0 Equipment Shop Drawings and Maintenance Data

- Organize this section into numbered tabs.
- Insert final shop drawings that have been reviewed and as-built control schematics.
- For each fan and pump installed, provide performance curves indicating the design point of intersection and the actual operating point.
- For each plumbing fixture, floor and roof drain installed, provide manufacturer's "cut" of that item and "cut" of associated brass goods.
- In addition to the shop drawings provided for the various items of mechanical equipment, this section shall also include the Manufacturers' Literature on:
 - Operating and maintenance instructions
 - Spare parts lists
 - Trouble Shooting information

Tab 4.0 Balance Report

The divider tabs shall be custom laminated mylar plastic and shall be in accordance with the following colour scheme:

- Tabs 1.1 to 1.5 – Orange
- Tabs 2.0 to 2.3 – Green
- Tab 3.0 – Yellow

- .7 Furnish sufficient copies of equipment manufacturer's literature, a set of drawings, approved shop drawings, and Mechanical Specification to the company preparing the O&M manuals to meet the above requirements.

- .2 Digital Manual Requirements
 - .1 The digital version of the manuals and the hard cover version shall be prepared by the same company.
 - .2 In addition to the operating and maintenance manuals provided in hard covered binders, two copies of all information shall be provided in digital format as follows:
 - .3 The information shall be organized into sections in a user-friendly format to make it easy to search for specific information. An indexing system shall be included that remains on an expandable portion of the screen that allows the end user to scroll through the manual information that appears on the main portion of the screen. The digital version content and organization for each manual shall be arranged in a manner identical to the hard copy version. The specific requirements are listed below:
 - .1 Utilize Adobe Acrobat PDF format.
 - .2 If there is more than one volume of manual, indicate "Volume X of Y" for each volume.
 - .3 Include a copy of the latest Adobe Acrobat Reader.
 - .4 The final Digital copies are to be copied to CDR with a custom CDR label. The custom CDR label shall include: Project Name, Location of Project, Date of Assembly, name of Mechanical Consultant, and shall be titled "Operating & Maintenance Manual for Mechanical Systems".
 - .5 The Digital Manual shall be enhanced with the following features: Bookmarks, Thumbnails, Internet Links, Internal Document Links and Optical Character Recognition (OCR). Refer to Scanning Requirements and Organizational Requirements listed below.
 - .4 Scanning Requirements:
 - .1 All pages contained within the hard copy manual are to be scanned and/or digitized to Adobe Acrobat PDF format.
 - .2 Provide a minimum 300 DPI for all scanned pages.
 - .3 All scanned shop drawings may be searched for text with minimum 75% Optical Character Recognition (OCR).
 - .4 All shop drawings are to be scanned to a minimum 8.5"X11" size. If the original page size is 11"X17", the digital copy shall also be 11"X17". Page sizes exceeding 11"X17" may be shrunk down to 11"X17".
 - .5 Rotation of scanned page images/texts shall be displayed within +/- 20 degrees.

- .5 Organizational Requirements:
 - .1 Digital Manual shall be organized in the same manner as the approved Hard Copy Manual. (e.g. Tabs 1.1, 1.2, 1.3, 1.4, 1.5, 2.0, 3.0, 4.0, etc).
 - .2 Bookmark all major tabs and subsections.
 - .3 Bookmark each set of shop drawings (Section 3.0).
 - .4 Link the Table of Contents page to the referenced sections.
 - .5 Insert an introduction/summary page for Sections 1.2, 1.3, 1.4, and 3.0 indicating major subsections. Link these pages to their referenced sections.
 - .6 Link the system descriptions to the referenced schematic drawings contained in section 1.2.
 - .7 Insert Internet Links and Internal Document Links from Section 1.5 to Mechanical Equipment Manufacturers/Suppliers/Contractors official websites.
 - .8 Mechanical Equipment Shop Drawings located in Section 3.0.
- .6 Use the following colour code for links contained in Sections 1.2, 1.3, 1.4, and 1.5.:
 - .1 Internet Links (light blue with underline).
 - .2 Internal Document Link (dark blue) (excludes AutoCAD schematic links).
- .7 Insert a title page for each major piece of equipment located in Section 3.0. The title page shall include the Shop Drawing name, and a link (dark blue in colour) to Section 1.5.
- .8 It is the responsibility of the Mechanical Trade to provide high quality documentation for scanning.
- .9 Digital Manual shall be reviewed by the Departmental Representative for content and layout prior to final submission.

1.12 Security Fasteners

- .1 Fasteners used in areas accessible by inmates shall be TORX with pin, stainless steel screws, which require a special tool to remove the fasteners.
- .2 Use fasteners compatible with material through which they pass.

1.13 Firestopping

- .1 Apply firestop sealant and systems around all penetrations through openings in fire rated wall, floor and ceiling assemblies.
- .2 Seal around conduits penetrating fire separations.

- .3 References:
 - .1 ULC-S115-05 – Standard Method of Fire Tests of Firestop Systems.
- .4 Product Data
 - .1 Submit product data and layout plan in accordance with Section 01 01 50.
 - .2 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation.
 - .3 Submit plan showing location of each penetration and product data to indicate type of firestopping being installed at each location.

PART 2 PRODUCTS

2.1 Access Doors

- .1 Access door size shall be as indicated and where not indicated, make 305mm x 406mm [12" x 16"] minimum or 610mm x 457mm [24" x 18"] where persons have to enter. For acoustical ceilings, conform to architectural panel pattern.
- .2 Unless otherwise indicated, access doors shall be hinged, flush type, steel framed panel, 14 gauge minimum, satin finished galvanized steel or type 304 stainless steel, with anchor straps for wet areas, washrooms, and all walls finished in ceramic tile.
- .3 Hinges shall be concealed, spring hinge to allow door to open 175°. Locking devices shall be flush cam type, screwdriver operated, doors and frames shall have prime coated rust inhibiting paint, unless made of stainless steel.
- .4 Where doors are required in fire rated walls, access doors shall be uninsulated and for all fire rated ceilings and walls where maximum temperature rise limitation is applicable, shall be insulated. All fire rated access doors shall have Warnock Hersey or ULC listed 2 hour fire rating and shall be installed in accordance with NFPA 80 and manufacturer's installation instructions.

2.2 Security Access Doors

- .1 Security type access doors shall be fully welded construction. Panels and frames shall be manufactured of 10 gauge steel. In addition to concealed spot welding, individual knuckles on the full length piano hinge shall be welded to the frame and panel. Piano hinge shall have non-removable pin. The return flange on the door panel shall provide rigidity and tamper-resistance edge. Provide deadbolt locks with a Schlage "C" keyway. Electro-statically applied off white finish.

2.3 Firestopping

- .1 Fire stopping and smoke seal systems: in accordance with ULC-S115.
 - .1 Systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115 and not to exceed opening sizes for which they are intended.
 - .2 Fire stop system rating: to match wall/floor/roof assembly of rating indicated.
- .2 Service penetration assemblies: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No. 40 U19.

- .3 Prefabricated flange units, with outer metal flange die-stamped from 0.3 mm thick 316 stainless steel, with inset of premoulded silicone elastomeric ring, factory moulded, U.L.C. or W.H. listed as a through penetration fire stop. Flange hinged for fixing over pipe and then secured tight with self-tapping screw.
- .4 Fire-resistance rating of installed fire stopping assembly not less than the fire- resistance rating of surrounding wall assembly.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: prefabricated silicone elastomeric seal; do not use a cementitious or rigid seal at such locations.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.

PART 3 EXECUTION

3.1 Installation

- .1 Coordinate work with work of other sections to avoid conflict.
- .2 Locate distribution systems, equipment, and materials to provide minimum interferences and maximum usable space.
- .3 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials, regardless of installation sequence.
- .4 Provide tamperproof screws for new and relocated equipment located in inmate accessible areas.

3.2 Cleaning

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

3.3 Cutting and Patching

- .1 Make arrangements with General Contractor for all cutting and patching in this work.
- .2 Minimize cutting and patching. Set sleeves and mark openings in concrete or masonry.
- .3 Conduct ground penetrating radar (GPR) scans prior to coring or cutting existing concrete structure.

3.4 Waterproofing

- .1 Where any work pierces waterproofing including waterproofing concrete, the method of installation shall be as approved by the Departmental Representative before the work is done. Supply and install all necessary sleeves, caulking, roof curbs, and flashing required and make the openings watertight.

3.5 Protection of Work

- .1 Protect equipment and material during construction from the weather, moisture, dust, painting, plastering and physical damage. Clean and return to "as new" condition.

- .2 Mask or grease and cover machined surfaces. Firmly secure covers over equipment openings and open ends of piping, conduit and ductwork as work progresses. Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .3 Any equipment that has operating parts, bearings or machined surfaces that show signs of rusting, pitting or physical damage will be rejected.
- .4 Refinish damaged or marred factory finishes to the satisfaction of the Departmental Representative, using equal quality materials.

3.6 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 01 11 55 – General Instructions and submit report as described in PART 1 - SUBMITTALS.
- .2 Manufacturer's Field Services:
 - .1 Where specified, 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.

3.7 Demonstration and Operating Instructions

- .1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Provide training to Departmental Representative for the controls and operation of mechanical equipment and systems installed and/or modified as part of this project.
- .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 and as-built drawings as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 During substantial performance review of the work the Mechanical Contractor, together with the Departmental Representative, Controls Contractor, and other Subcontractors designated by the Departmental Representative, shall instruct the Owner's operating personnel in the proper operation and maintenance of all systems and equipment installed under the contract.
- .7 It shall be the Mechanical Contractor's responsibility to have the specified equipment manuals prepared, previously approved by the Departmental Representative, and ready for presentation to the Owner at this meeting.
- .8 Convene the meeting with the aforementioned parties at the time called for in the substantial performance review. The arrangements shall include written notices to all the parties concerned. Should the equipment manuals, or system installation not be complete and operable at the proper time, he shall then convene the operating instruction meeting at a later date and pay any additional costs including time and travelling expenses for the personnel involved which are attributable to the delay.

- .9 Keeping a sign-in sheet is mandatory for the demonstration and training session. Submit a copy of the sign-in sheet to Departmental Representative for record.

3.8 Access Doors

- .1 Furnish access doors for concealed expansion joints, traps, strainers, cleanouts, balance dampers, fire dampers, other parts requiring accessibility for operating and maintenance. Access doors shall be provided to General Contractor for installation and shall be coordinated.
- .2 In suspended panel ceilings, use panel in place of access door; provide in such panel a button or other means of identification and easy removal when necessary.
- .3 Security type access doors shall be used at the following locations where inmates may have access to, per Table 1 below:

Table 1

Room	Description / Locations
AD 100	Admission / Discharge
AD 105	B.F. Inmate Washroom

3.9 Firestopping

- .1 Preparation:
 - .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
 - .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .2 Installation:
 - .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
 - .2 Seal holes or voids made by through penetrations, poke-through termination devices, and openings or joints to ensure continuity and integrity of fire separation are maintained.
 - .3 Tighten self-tapping screw on flange unit to ensure adequate tight and permanent seal.
 - .4 Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete. Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.
 - .5 Avoid cutting or penetrating of existing firestop systems already installed by other trades. If unavoidable, especially in renovations, remove existing material and provide new fire stopping system to complete the installation in accordance with this specification.
- .3 Inspection:
 - .1 Notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.
 - .2 Final inspection of through-penetration firestopping shall be performed by the Manufacturer's Authorized Representative in accordance with ASTM E 2174, "Standard

Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard. At project closeout, provide a letter to certification to the Departmental Representative indicating all fire stopping supplied and installed for the project meets Building Code requirements and has been installed in accordance with the Manufacturer’s installation instructions. Include a copy of the letter in the O&M manual.

- .4 Schedule:
 - .1 Fire stop and smoke seal at:
 - .1 Penetrations through fire-resistance rated walls, floors and ceilings.
 - .2 Around mechanical and electrical assemblies penetrating fire separations.
 - .2 Existing floor, wall and ceiling assemblies where there is fire stopping at existing penetration(s) shall be deemed to have fire resistive rating. New penetrations through such assemblies shall be fire stopped. Review existing condition on site and keep records.

3.10 Halocarbons Management

- .1 Comply with all of:
 - .1 Federal Halocarbon Regulations, 2003;
 - .2 Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems (the Environment Canada “Refrigeration Code of Practice”) Cat. No.: En14-207/2015E-PDF, April, 2015.
- .2 Work on Halocarbon Systems includes installation, servicing, leak testing or charging of a refrigeration system or an air-conditioning system or doing any other work on the system that may result in the release of a halocarbon.
- .3 All work on Halocarbon Systems shall be carried out only by a “Certified Person” as defined by the Federal Halocarbon Regulations 2003.
 - .1 Provide copies of all technicians’ certificates to the Departmental Representative.
- .4 Halocarbons listed under Item 1 through 10 of Schedule 1 of Federal Halocarbon Regulations, 2003 (SOR/2003-289) are not acceptable refrigerants.
- .5 Document **all** work on Halocarbon Systems using CSCs halocarbon form “**Information Required for Refrigeration Systems at Federal Correctional Facilities**”. Obtain the latest form from Departmental Representative. Affix the completed form to equipment, and submit a copy of the form to Departmental Representative.
- .6 Comply with the following timelines:
 - .1 Upon delivery of halocarbon-containing equipment to site, submit the following information to Departmental Representative within 24 hours of service;
 - .1 Make
 - .2 Model
 - .3 Serial number
 - .4 Type of halocarbon
 - .5 Halocarbon charging capacity of system (kg or lbs)
 - .6 Factory Halocarbon Charge (kg or lbs)

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- .7 Cooling capacity (kW, Btuh, or Tons)
 - .2 Leak-test factory-charged halocarbon-containing equipment containing over 10kg of refrigerant in accordance with the Refrigeration Code of Practice within one week of equipment delivery to site.
 - .3 Leak-test field-charged halocarbon-containing equipment in accordance with Section 4.4 of the Refrigeration Code of Practice at the time of field charging of system.
 - .4 For all work on Halocarbon Systems, submit forms to Departmental Representative within 48 hours of work.
 - .5 For release of halocarbons >10 kg and <100 kg, submit forms to Departmental Representative within 24 hours of discovery of release.
 - .6 For release or potential release of halocarbons > 100 kg, submit forms to Departmental Representative **immediately**.
 - .7 Conduct annual leak tests of halocarbon-containing equipment with 19kW (5.4 tons) or greater cooling capacity in accordance with the Federal Halocarbon Regulations, 2003 until such time as Interim Certificate of Completion is issued.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 23 05 00 Common Work Results – Mechanical
- .3 Section 23 05 29 Hangers & Support for Piping & Equipment
- .4 Section 23 08 02 Cleaning and Start-up of Mechanical Piping Systems
- .5 This Section applies to all related work under Divisions 22 and 23.

1.2 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-1999, Ready-Mixed Organic Zinc-Rich Coating.

1.3 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 11 55 – General Instructions.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

PART 2 PRODUCTS

2.1 Not Used

- .1 Not Used

PART 3 EXECUTION

3.1 Connections to Equipment

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

3.2 Clearances

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

3.3 Pipework Installation

- .1 Protect openings against entry of foreign material.
- .2 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .5 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .6 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2,400mm above floor in Mechanical Rooms.
- .7 Install dielectric coupling between dissimilar metals.
- .8 Install in accordance with Section 23 05 29 – Hanger & Support for Piping & Equipment.

3.4 Sleeves

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies (where steel sleeves are part of the listed assemblies), and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and un-insulated 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 25mm above finished floor.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: Fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: Provide space for firestopping. Maintain fire rating integrity.
 - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.5 Escutcheons

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 304 stainless steel.
- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe.

3.6 Cleaning of Piping Systems

- .1 Before start-up, clean interior of piping systems in accordance with requirements of Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.7 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.
- .3 Maintain specified test pressure without loss for 24 hours minimum unless specified for longer period of time.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .6 Conceal work only after approval and certification of tests by Departmental Representative.

END OF SECTION

PART 2 PRODUCTS

2.1 General

- .1 Motors to be high efficiency, in accordance with local Hydro company standards and the requirements of 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, 120V, 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°C, 3 phase, 208V, unless otherwise specified or indicated.

2.3 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 specified.
- .3 For motors under 7.5 kW 10HP : 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 10HP 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 to be 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.

2.4 Drive Guards

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2mm thick sheet metal tops and bottoms.
 - .3 38mm 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 fastened in place.
 - .4 Removable for servicing.

PART 3 EXECUTION

3.1 Installation

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

END OF SECTION

PART 1 GENERAL

1.1 Section Includes

- .1 Materials and installation for thermometers and pressure gauges in piping systems.
- .2 This Section applies to all related work under Divisions 22 and 23.

1.2 Related Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results – Mechanical
- .4 Section 23 05 53 Mechanical Identification

1.3 References

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-14.4-[M88], Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
 - .2 CAN/CGSB-14.5-[M88], Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

1.4 Submittal

- .1 Submittals in accordance with Section 01 01 50 – General Instructions.
- .2 Submit shop drawings and product data.

1.5 Health and Safety

- .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.6 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 11 55 – General Instructions.
- .2 Collect, separate and place in designated containers for packaging in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed, labeled and stored safely for disposal away from children.

PART 2 PRODUCTS

2.1 General

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

2.2 Thermometers

- .1 Industrial, adjustable angle, liquid-in-glass:
 - .1 Case: aluminum.
 - .2 Stem: Aluminum, 89mm [3-1/2"] length, adjustable angle.
 - .3 Window: acrylic or glass.
 - .4 Accuracy: 1%
 - .5 Scale length: 180mm [7"] minimum.
 - .6 Reading: dual Celsius and Fahrenheit.
 - .7 Socket: comply with industrial standard dimension.

2.3 Thermometer Wells

- .1 Copper pipe: copper or bronze, 3/4 NPT.
- .2 Steel pipe: brass or stainless steel, 3/4 NPT.

2.4 Pressure Gauges

- .1 100 mm [4.0"] dial type: to ASME B40.100, Grade 1A, phosphor bronze bourdon tube having 1.0% accuracy full scale unless otherwise specified.
 - .1 Casing: Stainless Steel.
 - .2 Reading: S.I./Imperial.
 - .3 Range: indicate mid-scale under normal operating conditions.
- .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.

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 all piping. Provide heat conductive material inside well.
- .2 Install on inlet and outlet of:
 - .1 Hot water boilers.
 - .2 Heat exchangers.
 - .3 Chillers.
 - .4 DHW tanks, heaters.
- .3 Install wells as indicated for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.3 Pressure Gauges

- .1 Install in the following locations:
 - .1 Suction and discharge of pumps, and across pump strainers. Provide a single pressure gauge with point needle valves to isolate each point.
 - .2 Upstream and downstream of PRV's.
- .2 Use extensions where pressure gauges are installed through insulation.

END OF SECTION

PART 1 GENERAL

1.1 Related Section

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results – Mechanical
- .4 Section 23 05 48 Vibration & Seismic Control for Ductwork, Piping and Equipment
- .5 All work installed under Divisions 22 and 23 shall conform to this Section.

1.2 References

- .1 American National Standards Institute / Sheet Metal and Air Conditioning Contractors National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 001-2008, Seismic Restraint Manual, Guidelines for Mechanical Systems, 3rd Edition.
- .2 American Society of Mechanical Engineers (ASME):
 - .1 ASME B31.1-12, Power Piping.
- .3 American Society for Testing and Materials (ASTM):
 - .1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS):
 - .1 MSS SP58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 National Plumbing Code 2010.

1.3 System Description

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

- .4 Design hangers and supports to support systems under all 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 to be in accordance with MSS SP58.
- .2 Performance Requirements:
 - .1 Design supports and hangers to withstand seismic events as specified Section 23 05 48 – Vibration & Seismic Control for Ductwork, Piping and Equipment.

1.4 Submittals

- .1 Submittals: in accordance with Section 01 11 55 – General Instructions.
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .3 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
 - .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.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 11 55 – General Instructions.

1.5 Quality Assurance

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .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 11 55 – General Instructions.

PART 2 PRODUCTS

2.1 Design Requirements:

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.

2.2 General

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

2.3 Upper Attachment

- .1 Concrete:
 - .1 Inserts for cast-in-place concrete: galvanized steel wedge. ULC listed for pipe NPS 3/4 through NPS 8 - Grinnell/Anvil Fig. 281.
 - .2 Carbon steel plate with clevis for surface mount: malleable iron socket with expansion case and bolt. Minimum two expansion cases and bolts for each hanger – Grinnell/Anvil, plate fig. 49, socket fig. 290, expansion case fig. 117.
- .2 Steel Beam (bottom flange):
 - .1 Cold piping NPS 2 and under: malleable iron C clamp - Grinnell/Anvil fig. 61.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping: malleable iron beam clamp - Grinnell/Anvil fig. 292.
- .3 Steel Beam (top):
 - .1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp - Grinnell/Anvil Fig. 61.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.
- .4 Steel Joist:
 - .1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket - Grinnell/Anvil: washer plate, fig. 60; clevis, fig. 66; socket, fig. 290.
- .5 Steel Channel or Angle (bottom):

- .1 Cold piping NPS 2 and under; malleable iron C clamp - Grinnell/Anvil fig. 86.
- .2 Cold piping NPS 2-1/2 and larger and all hot piping; universal channel clamp - Grinnell/Anvil fig. 226.
- .6 Steel Channel or Angle (top):
 - .1 Cold piping NPS 2 and under; malleable iron "top of beam" C clamp - Grinnell/Anvil fig. 61.
 - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.
- .7 Wood beam or ceiling:
 - .1 Ceiling plate and flanges: malleable iron – Grinnell/Anvil Fig. 128R.
 - .2 Eye socket: galvanized steel – Grinnell/Anvil fig. 189 or 190.

2.4 Middle Attachments (Rod)

- .1 Carbon steel black (electro-galvanized/cadmium plated for mechanical rooms) continuous threaded rod - Grinnell/Anvil fig. 146.
- .2 Ensure that hanger rods are subject to tensile loading only.

2.5 Pipe Attachments

- .1 Piping with less than 25 mm [1"] horizontal movement, NPS 2 and under: adjustable swivel ring hanger - Grinnell/Anvil fig. 69.
- .2 Piping with less than 25 mm [1"] horizontal movement, NPS 2-1/2 and over: adjustable clevis hanger - Grinnell/Anvil fig. 260.
- .3 Suspended hot piping with horizontal movement more than 25 mm [1"], all steam piping: pipe roller - Grinnell/Anvil fig. 174 or Grinnell/Anvil fig. 181 up to NPS 6 and Grinnell/Anvil fig. 171 NPS 8 and larger.
- .4 Bottom-supported hot piping and steam piping: pipe roller stand - Grinnell/Anvil fig. 271.
- .5 Spring hangers; where required to offset expansion on horizontal runs which follow long vertical risers - Grinnell/Anvil fig. 171 single pipe roll hanger with Grinnell/Anvil fig. 178.
- .6 Use oversize pipe hangers for:
 - .1 Cold piping, all sizes.
 - .2 Hot piping, NPS 2-1/2 and over.
 - .3 Steam piping (supply, condensate return), all sizes.
- .7 Perforated band iron, wire or chain hangers will not be approved.
- .8 All hangers for copper pipe shall be copper, copper clad, felt lined or use plastic tape wrapped pipe at hanger.

2.6 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel - Grinnell/Anvil fig. 261.
- .2 Copper pipe: carbon steel copper finished - Grinnell/Anvil fig. CT-121.

2.7 Protection Shields

- .1 Cold piping, all sizes: protection shield with calcium silicate pipe insulation under shield with uninterrupted vapour barrier.
- .2 Hot piping with less than 25 mm [1"] horizontal movement, NPS 2 and under: insulation over pipe hanger.
- .3 Hot piping with less than 25 mm [1"] horizontal movement, NPS 2-1/2 and over: protective shield with calcium silicate insulation under shield.
- .4 Hot piping with horizontal movement more than 25 mm [1"], all sizes: protective shield with calcium silicate insulation under shield.
- .5 Steam piping (supply and condensate), all sizes: protective shield with calcium silicate insulation under shield.

2.8 Wall Supports

- .1 Horizontal pipe adjacent to wall:
 - .1 Angle iron wall brackets with specified hangers.
- .2 Vertical pipe adjacent to wall.
 - .1 Exposed pipe wall support for lateral movement restraint - Grinnell/Anvil fig. 262 or 263.
 - .2 Channel type support.

2.9 Floor Support

- .1 Horizontal pipe.
 - .1 Do not support piping from the floor unless specifically indicated.
- .2 Vertical pipe.
 - .1 Mid-point of risers between floor slabs - adjustable fabricated steel supports.

PART 3 EXECUTION

3.1 Installation

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems per Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.
- .3 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .4 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations. Supporting piping from underside of light weight roof deck (without concrete) is not permitted.

- .5 Use expansion anchor on existing concrete structure.

3.2 Hanger Spacing

- .1 HVAC piping: in accordance with table below.
- .2 Plumbing piping: in accordance with the most stringent requirements of the table below as well as the following:
 - .1 National. Plumbing Code.
 - .2 Authority Having Jurisdiction.
- .3 Pipe hanger rods shall be sized in accordance to SMACNA Seismic Restraint Manual based on Seismic Hazard Level (SHL). For SHL, see Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.

MAXIMUM HANGER SPACING						
PIPE DIA. NPS	STEEL SCH.40	COPPER L,K Hard Drawn	CAST.I STD.	GLASS	ABS/PVC	PEX
1/2	1.8 m [6'-0"]	1.8 m [6'-0"]			1.2 m [4'-0"]	0.8 m [2'-6"]
3/4 & 1	2.4 m [8'-0"]	2.4 m [8'-0"]			1.2 m [4'-0"]	0.8 m [2'-6"]
1-1/4	2.4 m [8'-0"]	3.0 m [10'-0"]			1.2 m [4'-0"]	0.8 m [2'-6"]
1-1/2 & 2	2.4 m [8'-0"]	3.0 m [10'-0"]	3.0 m [10'-0"]		1.2 m [4'-0"]	0.8 m [2'-6"]
2-1/2, 3, 4 & 5	2.4 m [8'-0"]	3.0 m [10'-0"]	3.0 m [10'-0"]	2.4 m [8'-0"]	1.2 m [4'-0"]	0.8 m [2'-6"]
6 & 8	3.0 m [10'-0"]	3.0 m [10'-0"]	3.0 m [10'-0"]	2.4 m [8'-0"]	1.2 m [4'-0"]	0.8 m [2'-6"]

3.3 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.

3.4 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 13mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.5 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.

3.6 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 23 05 00 Common Work Results – Mechanical
- .3 This Section applies to all related work under Divisions 22 and 23.

1.2 References

- .1 National Building Code of Canada (NBC)
- .2 American National Standards Institute / Sheet Metal and Air Conditioning Contractors National Association (ANSI/SMACNA):
 - .1 ANSI/SMACNA 001-2008, Seismic Restraint Manual, Guidelines for Mechanical Systems, 3rd Edition.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01 11 55 – General Instructions.
- .2 Provide vibration isolation systems shop drawings complete with performance and product data. Shop drawings shall demonstrate compliance with the National Building Code and shall bear the seal of a Professional Engineer.
- .3 Provide detailed drawings of all seismic restraint systems for piping and equipment.

1.4 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 11 55 – General Instructions.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 PRODUCTS

2.1 Vibration Isolation System – General

- .1 Performance of vibration isolation systems shall be designed by manufacturer specializing in vibration isolation materials and devices.
- .2 Size and shape of bases type shall be coordinated with submitted equipment.
- .3 Products shall of the same manufacturer unless otherwise noted.

2.2 Elastomeric Pads

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm [3/8"] minimum thick; 50 durometer; maximum loading 350 kPa [50 psi].

- .2 Type EP2 - rubber waffle or ribbed; 9 mm [3/8"] minimum thick; 30 durometer natural rubber; maximum loading 415 kPa [60 psi].
- .3 Type EP3 - neoprene-steel-neoprene; 9 mm [3/8"] minimum thick neoprene bonded to 1.71 mm [16 gauge] steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa [50 psi].
- .4 Type EP4 - rubber-steel-rubber; 9 mm [3/8"] minimum thick rubber bonded to 1.71 mm [16 gauge] steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa [60 psi].

2.3 Hangers

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

2.4 Acoustic Barriers for Anchors and Guides

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

2.5 Flexible Pipe Connectors

- .1 Inner corrugated hose: stainless steel.
- .2 Outer braid: Braided wire mesh stainless steel outer jacket.
- .3 Type of end connection: threaded for 50mm [2"] or smaller; flange for 65mm [2-1/2"] or larger.
- .4 Operating conditions:
 - .1 Working pressure: 1379 kPa [200 psi].
 - .2 Working temperature: 4540 °C [850 °F].

2.6 Seismic Control Measures

- .1 General:
 - .1 Design anchorage and attachment methods for all systems and/or equipment as specified herein.
 - .2 Seismic control systems to work in all directions.
 - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .4 Drilled or power driven anchors and fasteners not permitted.
 - .5 No equipment, equipment supports or mounts to fail before failure of structure.

- .6 Supports of cast iron or threaded pipe not permitted.
- .7 Seismic control measures not to interfere with integrity of firestopping.
- .8 For equipment mounted on housekeeping pad, specify the minimum distance between anchor bolt and edge of housekeeping pad.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Seismic restraints:
 - .1 Cushioning action to be gentle and steady.
 - .2 Shall never reach metal-like stiffness.
- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
 - .2 Provide seismic restraints in addition to vibration isolation system to resist complete isolator unloading.
- .4 Piping systems:
 - .1 Provide seismic restraints for all piping in accordance to the latest edition of SMACNA Seismic Restraint Manual.
 - .2 Seismic restraints may be omitted for the following conditions:
 - .1 Fuel, medical gas, compressed air, vacuum piping less than 25mm [1"] diameter.
 - .2 All other piping less than 32mm [1-1/4"] diameter located inside boiler rooms, mechanical rooms and refrigeration rooms.
 - .3 All other piping less than 65mm [2-1/2"] diameter located outside boiler rooms, mechanical rooms and refrigeration rooms.
 - .4 All piping suspended by individual hangers 305mm [12"] or less in length, as measured from the top of the pipe to the bottom of the structural support for the hanger.
 - .3 To be compatible with requirements for anchoring and guiding of piping systems.
 - .4 Wet weight of piping shall be to be used for designing seismic restraint systems.
 - .5 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
 - .6 Where cable is used for restraining vibration isolated piping systems, install cable with sufficient slack to avoid short-circuiting of vibration isolators.
- .5 Ductwork systems:
 - .1 Provide seismic restraints for all ductwork in accordance to the latest edition of SMACNA Seismic Restraint Manual as described below:
 - .1 All rectangular ducts with cross sectional areas 0.56m² [6 ft²] and larger.
 - .2 All round ducts with diameters 711 mm [28"] and larger.

- .2 Seismic restraints may be omitted for the following conditions:
 - .1 All ductwork suspended by hangers 305mm [12"] or less in length, as measured from the top of the duct to the bottom of the structural support for the hanger.
- .6 Bracing methods:
 - .1 Approved by Departmental Representative.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

PART 3 EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 Field Quality Control

- .1 Provide the services of the Professional Engineer(s) who designed the restraint systems for "Field Review" of the installed components, and submit the following to the Departmental Representative:
 - .1 Schedule B, signed and sealed; provided at the commencement of the project.
 - .2 Signed and sealed shop drawings of seismic restraints for equipment, piping and ductwork; provided prior to installation.
 - .3 Typewritten inspection reports; provided during the construction period.
 - .4 Schedule C-B, signed and sealed; provided after performing "Field Review".

3.4 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results – Mechanical
- .4 This Section applies to all related work under Divisions 21, 22 and 23.

1.2 References

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

1.3 Quality Assurance

- .1 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.4 Delivery, Storage, and Handling

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 11 55 – General Instructions.
 - .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 11 55 – General Instructions.
 - .2 Dispose of unused paint and coating material at official hazardous material collections site approved by Departmental Representative.
 - .3 Do not dispose of unused paint and coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

PART 2 - PRODUCTS

2.1 Manufacturer's Equipment Nameplates

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

- .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

	<u>Sizes (mm)</u>	<u>No. of Lines</u>	<u>Height of Letters (mm)</u>
1	10 x 50	1	3
2	13 x 75	1	5
3	11 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

- .2 Use maximum of 25 letters/numbers per line.
- .4 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: Size #9.
 - .2 Source and Destination identifiers: Size #6.
 - .3 Terminal cabinets, control panels: Size #5.
 - .3 Equipment elsewhere: Sizes as appropriate.

2.3 Piping Systems Governed by Codes

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

- .2 Sprinklers: to NFPA 13.

2.4 Identification of Piping Systems

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

Background colour: Legend, arrows:

Yellow	BLACK
Green	WHITE
Red	WHITE

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

Contents	Background Colour Marking	Legend
Hot water heating supply	Yellow	HEATINGSUPPLY
Hot water heating return	Yellow	HEATINGRETURN
Domestic hot water supply	Green	DOM.HWSUPPLY
Domestic HW recirculation	Green	DOM.HWCIRC
Domestic cold water supply	Green	DOM.CWS

Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN.VENT
Natural gas and propane	to Codes	
Fire protection water	Red	FIREPROT.WTR
Sprinklers	Red	SPRINKLERS

2.5 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.

2.6 Valves, Controllers

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

2.7 Controls Components Identification

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

2.8 Language

- .1 Identification in English.

PART 3 - EXECUTION

3.1 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 has been completed.

3.3 Installation

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide 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 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 General

- .1 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 Company

- .1 Testing and balancing shall be performed by an agency that specializes in this type of work. Provide proof that the agency has successfully completed five projects of similar size and scope
- .2 All work shall be performed by persons with proven ability and thoroughly versed in the type of testing and balancing. Submit names, complete with experience, record and references for review by the Consultant prior to work being carried out.
- .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 installed equipment and systems so as to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and installed 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 be to satisfaction of authority having jurisdiction.
- .2 TAB of existing equipment already in operation and affected by the renovation.

1.5 Coordination

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

1.6 Pre-TAB Review

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

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:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weather-stripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Division 23.
 - .4 All provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 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 5%, minus 5%.
 - .2 Hydronic systems: plus or minus 10%.

1.11 Accuracy Tolerances

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

1.12 Instruments

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

1.13 Submittals

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

1.14 Preliminary TAB Report

- .1 Prior to calling Substantial Completion, 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 to be in accordance with Associated Air Balance Council Manual.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Include final TAB report in O&M manual. Provide one (1) copy of final TAB Report to Departmental Representative.

1.16 Verification

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results to be at discretion of 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. Markings not to be eradicated or covered in any way.

1.18 Completion of TAB

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

1.19 Air Systems

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC, NEBB, SMACNA and ASHRAE.
- .2 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop, temperatures (dry bulb, wet bulb, dew point, duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .3 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .4 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 Water Systems (HVAC):

- .1 Water circulating systems shall be balanced by means of balancing fittings and tabulated results shall include the following:
 - .1 Differential head across all circulating pumps.
 - .2 Flow and return water temperature to supply and return header for all zones.
 - .3 Water temperature supplied to and returning from each coil and heating element.
- .2 Contractor shall arrange with balancing technician to have water flow through radiation elements checked prior to installation of radiation enclosure.

1.21 Domestic Hot Water Systems

- .1 Meet requirements as specified for liquid systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of heaters, tank, pump, circulator, at controllers, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.
- .4 Domestic hot water recirculation system shall be balanced by proportioning the water flow at balancing fittings and ensuring adequate flow through each circuit.

1.22 Other TAB Requirements

- .1 Testing of Fire Dampers & Fire Stop Flaps:
 - .1 Conduct a "trip" test on all fire dampers and fire stop flaps to ensure that fire mechanisms function correctly and that dampers attain a fully closed position when tripped.
 - .2 Send a copy of test results tabulating the fire damper location, size, and date of trip test, to the Departmental Representative for record purposes. Copies shall also be inserted in Equipment Maintenance Manuals.
 - .3 Dampers and Flaps which fail to function correctly shall be re-tested after corrective action has been completed. Any fusible links damaged when conducting tests shall be replaced by the Contractor. A signed and dated test label shall be attached to each fire damper upon completion of test and resetting of fire damper.

PART 2 - PRODUCTS

2.1 Not Used

- .1 Not used.

PART 3 - EXECUTION

3.1 General

- .1 Test and balance new/existing equipment and systems serving the new / renovated areas and buildings.

END OF SECTION

PART 1 GENERAL

1.1 Summary

- .1 Related Sections:
 - .1 Section 01 11 55 General Instructions
 - .2 Section 01 35 33 Health and Safety Requirements
 - .3 Section 01 91 00 Commissioning
 - .4 Section 23 05 00 Common Work Results – Mechanical
 - .5 Section 23 05 93 Testing, Adjusting and Balancing
 - .6 Section 23 31 14 Metal Ducts

1.2 References

- .1 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.

1.3 Submittals

- .1 Make submittals in accordance with Section 01 11 55 – General Instructions.
- .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 48 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 33 - 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 Tolerance

- .1 Equipment and system components such as VAV boxes, duct heating leakage: 2%.

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 to be 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 Reference Standard.

- .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. Prorate 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 and mixing boxes 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.

3.5 Field Quality Control

- .1 Performance Verification:
 - .1 Departmental Representative 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 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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results - Mechanical
- .4 Section 23 05 29 Hangers and Supports for HVAC Piping and Equipment

1.2 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-2013; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-10, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335/C335M-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-11, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .5 Thermal Insulation Association of Canada (TIAC):
 - .1 Mechanical Insulation Best Practice Guide, 2013.

- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Standard for Thermal Insulation Polyotrene, Boards and Pipe Covering.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

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 defined herein.
- .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.

1.4 Submittals

- .1 Submittals: in accordance with Section 01 11 55 – General Instructions.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 11 55 – General Instructions. 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 01 50 – General Instructions.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 11 55 – General Instructions.
- .4 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
 - .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.

1.5 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 of TIAC.

- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled 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 11 55 – General Instructions.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

PART 2 PRODUCTS

2.1 Fire and Smoke Rating

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

2.2 Insulation

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612. Provide factory applied vapour retarder jacket to CGSB 51-GP-52Ma as scheduled in PART 3 of this Section.

- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553. Provide factory applied vapour retarder jacket to CGSB 51-GP-52Ma as scheduled in PART 3 of this section.
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.
- .5 Evidence shall be provided to the Departmental Representative on the site of ULC listings of all products being used. Duct insulation adhesives and coatings shall be non-toxic as defined by WCB Regulations.

2.3 Jackets

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: Compatible with insulation.
 - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .2 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: 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.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .5 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .6 Contact adhesive: quick-setting
 - .1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.
- .7 Canvas adhesive: washable.
 - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 19 mm wide, 0.5 mm thick stainless steel.

- .10 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation.
- .11 Fasteners: 2 mm diameter pins with 35 mm square clips, length to suit thickness of insulation.

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 ductwork systems 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 manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .3 Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Seal vapor barrier penetrations with vapor barrier adhesive.
- .6 Supports, Hangers in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .7 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.
- .8 All ductwork exposed to weather shall have waterproof seams for weathertight construction. Ductwork exposed to weather which are not insulated or finish painted, shall be coated with two applications of bitumastic waterproofing compound to prevent corrosion. Exposed ducts, which are insulated, shall have aluminum jacket.

3.4 Duct Insulation Schedules

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular, cold, dual temperature supply air ducts	C-1	Yes	50
Round, cold, dual temperature supply air ducts	C-2	Yes	50

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular, warm air ducts	C-1	No	25
Round, warm air ducts	C-2	No	25
Supply, return and exhaust ducts exposed in space being served			None
Outside air ducts to mixing plenum	C-1	Yes	25
Exhaust ducts between dampers and louvers	C-1	No	25
Rectangular ducts outside	C-1	Special	50
Round ducts outside	C-2	Special	50
Acoustically lined ducts			None
Outdoor supply duct, exposed to weather	C-2	Yes	50
Outdoor exhaust duct, exposed to weather	C-2	No	50

.2 Finish: Conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	None	None
Indoor, exposed within Service Rooms, including but not limited to mechanical equipment rooms, electrical equipment rooms, telecom/LAN rooms, janitor rooms	CRF/1	CRD/1
Indoor, exposed elsewhere	CRF/2	CRD/2
Outdoor, exposed to weather	CRF/3	CRD/3

3.5 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results - Mechanical
- .4 Section 23 05 05 Installation of Pipe Work.
- .5 Section 23 05 29 Hangers and Supports for Piping and Equipment

1.2 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-2013; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-10, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335/C335M-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C411-11, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .8 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .9 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC):
 - .1 Mechanical Insulation Best Practice Guide, 2013.

- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-11, Standard for Thermal Insulation Polyotrene, Boards and Pipe Covering.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

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 defined herein.
- .2 TIAC Codes:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.4 Submittals

- .1 Submittals: in accordance with Section 01 11 55 – General Instructions.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 11 55 – General Instructions. 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 11 55 – General Instructions.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 11 55 – General Instructions.
- .4 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
 - .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.

1.5 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 of TIAC.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled 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 11 55 – General Instructions.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 Fire and Smoke Rating

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

2.2 Insulation

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.

- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: Rigid molded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.9 / ASTM C547.
 - .2 Maximum "k" factor: to CAN/CGSB-51.9.
- .4 TIAC Code A-2: Rigid molded calcium silicate without factory applied vapour retarder jacket.
 - .1 Calcium silicate: to CAN/CGSB-51.2 / ASTM C533.
 - .2 Maximum "k" factor: to CAN/CGSB-51.2.
- .5 TIAC Code A-3: Rigid molded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.9 / ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.9 / ASTM C547.
- .6 TIAC Code C-2: Mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/ULC-S702 / ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702 / ASTM C553.
- .6 TIAC Code A-6: Flexible unicellular tubular elastomer.
 - .1 Insulation: flexible closed-cell elastomer to ASTM C534.
 - .2 Jacket: to CGSB 51-GP-52Ma. Required for outdoor application.
 - .3 Maximum "k" factor: 0.27.
 - .4 Vapour transmission: 0.08 perm-inch.
 - .5 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants.
- .7 To be formaldehyde free, low VOC; resists mold and mildew.
- .8 Evidence shall be provided to the Engineer on the site of ULC listings of all products being used. Duct insulation adhesives and coatings shall be non-toxic as defined by WCB Regulations.

2.3 Insulation Securement

- .1 Tape: Self-adhesive, aluminum, reinforced, 50mm wide minimum.
- .2 Contact adhesive: Quick setting.
 - .1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.
- .3 Canvas adhesive: Washable.
 - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .4 Tie wire: 1.5mm diameter stainless steel.
- .5 Bands: Stainless steel, 19mm wide, 0.5mm thick.

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 To CAN/CGSB-51.12.
 - .2 Hydraulic setting or Air drying on mineral wool, to ASTM C 449.

2.5 Vapour Retarder Lap Adhesive

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

2.6 Indoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 Outdoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m.

2.8 Jackets

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CGSB 51-GP-53M with pre-formed shapes as required.
 - .2 Colours: White.
 - .3 Minimum service temperatures: 20°C [68°F].
 - .4 Maximum service temperature: 65°C [150°F].
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 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/m cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C 921.
 - .2 Lagging adhesive: Compatible with insulation.
 - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .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: Stucco embossed.
 - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

PART 3 - EXECUTION

3.1 Pre-Installation Requirement

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

3.2 Installation

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized pipe supports, saddles and shoes. See Section 23 05 29 – Hangers and Supports for Piping and Equipment.
- .6 Seal vapor barrier penetrations with vapor barrier adhesive.

3.3 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: high temperature fabric for indoor applications and aluminum for outdoor applications.

3.4 Installation of Elastomeric Insulation

- .1 Insulation to remain dry at all times. Overlaps to manufacturer's instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.5 Piping Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS Bands at 300mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.

- .3 TIAC Code: A-2.
 - .1 Securements: SS Bands at 300mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
 - .4 Direct contact with pipe and hanger is not acceptable. Install hanger outside of sheet metal protection shield covering an insert section of high density calcium silicate insulation.
- .4 TIAC Code: A-3.
 - .1 Securements: SS Bands at 300mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .5 TIAC Code: A-6.
 - .1 Seals: lap seal adhesive, lagging adhesive.
 - .2 Installation: TIAC Code: 1501-CA; per manufacturer's recommendation.
- .6 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Insulation securements: SS Bands at 300mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .7 Thickness of insulation to be as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000mm long.
 - .2 Do not insulate exposed run-outs to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp °C	TIAC Code	Run out	To NPS1	1 ¼-2	2 ½-4	5-6	8 & over
Hot Water Heating	60-94	A-1	25	38	38	38	38	38
Hot Water Heating	< 59	A-1	25	25	25	25	38	38
Domestic HW		A-1	25	25	25	38	38	38
Domestic CW		A-3	25	25	25	25	25	25

- .7 Finishes:
 - .1 Exposed indoors: Canvas or PVC jacket.
 - .2 Exposed indoor in Service Rooms: Canvas or PVC jacket.
 - .1 Service Rooms include but are not limited to mechanical equipment rooms, electrical equipment rooms, telecom/LAN rooms, janitor rooms.
 - .3 Concealed, indoors: ASJ, no further finish.
 - .4 Exposed outdoors: Aluminum jacket.

3.6 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions.
- .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 Sections

- .1 Section 01 91 13 Commissioning
- .2 Section 23 05 93 Testing, Adjusting and Balancing

1.2 Quality Assurance

- .1 The commissioning of mechanical systems shall be executed in accordance with the intent of:
 - .1 ASHRAE Guideline 1.1-2007, HVAC&R Technical Requirements for the Commissioning Process.
 - .2 ANSI/ASHRAE/IES Standard 202-2013, Commissioning Process for Buildings and Systems.

1.3 General

- .1 Commissioning of the mechanical systems, including the HVAC, and Plumbing and Drainage Systems, shall be carried out by an independent Commissioning Agent acceptable to the Departmental Representative with technicians specifically trained in commissioning procedures.
- .2 The Mechanical Subcontractor shall retain a Commissioning Agent, who shall be active in the commissioning process and actively encourage his own forces and sub-trades to work together to achieve optimum system performance for the mechanical systems in a timely manner. Refer to Section 01 91 13 – Commissioning for additional requirements.
- .3 It is not intended that this work shall, in any way, replace normal factory startup service for equipment or relieve the Contractor or his sub-trades of their responsibility for providing first-class installation in satisfactory working order.
- .4 As part of the final commissioning report, submit a Certificate stating that the commissioning procedures have been completed, that complete factual reports have been distributed and that directions have been given to the Contractor to correct faults and omissions and finally, that follow-up testing, after the correction of faults and omissions has been completed and recorded.
- .5 Be responsible for the performance and commissioning of all equipment supplied under the Sections of Division 21, 22, 23. Commissioning is the process of advancing the installation from the stage of static completion to full working order in accordance with the contract documents and design intent. It is the activation of the completed installation.
- .6 In consultation with the General Contractor, ensure that sufficient time is allowed and fully identified on the construction schedule for the proper commissioning of all mechanical systems.

1.4 Commissioning and Demonstration

- .1 Submit a schedule for the commissioning phase of the work. This schedule shall show:
 - .1 Equipment start-up schedule.
 - .2 Submission dates for the various documents required prior to substantial completion.
 - .3 Timing of the commissioning, testing, balancing, and demonstration process.

- .2 Commissioning is concluded when the air and water system is balanced and the installation is in full working order and acceptable for use. The work shall include the following:
 - .1 Balancing of the air systems as specified in this section.
 - .2 Set up air diffusers, registers and grilles for optimum distribution/comfort.
 - .3 Plug all air pressure and flow measuring holes.
 - .4 Adjust vibration isolators and earthquake restraints for optimum performance.
 - .5 Verification and certification of the sealing of all HVAC penetrations through fire separations (rated & non-rated) and sound separations. Forms in Section 23 08 02 shall be used for this purpose.
 - .6 Verification of water tightness of all roof and exterior wall penetrations.
 - .7 Verification that coil drain pan operates.
 - .8 Set up all automatic control valves/dampers and automatic temperature control devices.
 - .9 Set up and test all alarm and protective devices.
 - .10 EMCS:
 - .1 Commissioning of EMCS is primarily responsible by Controls Contractor. Refer to Section 25 05 01 EMCS General Requirements.
 - .2 The Commissioning Agent shall assign one person experienced and qualified in commissioning control systems through practical experience and a comprehensive knowledge of the interactive nature of HVAC systems and DDC controls **to verify** the performance of the control systems by conducting random tests of the control sequences until the Commissioning Agent is satisfied that the controls are performing according to the intended control sequences.
 - .3 The Controls Contractor shall loan a current copy of all control software/devices needed for full access to the control system, at no charge to the Commissioning Agent. The software/devices shall be returned to the Controls Contractor in good working order at the completion of the commissioning process, or the Commissioning Agent must reimburse the Controls Contractor for the purchase price of the material.
- .3 In addition to the piping, equipment and systems listed above provide commissioning of all plumbing piping, equipment and systems including the following:
 - .1 Domestic cold water including PRV set-point.
 - .2 Domestic hot water and recirculation including temperature set points.
 - .3 Domestic tempered water including set-points.
 - .4 Sanitary waste and venting.
 - .5 Plumbing fixtures including adjustments of all flush valves, and setting temperature limit stops on shower valves.

- .4 At the conclusion of commissioning, demonstrate the operation of the systems to the Departmental Representative. For demonstration and instruction to Operating staff requirements, refer to this section of the specification and also to section 25 05 01 EMCS: General Requirements.
- .5 The verification process shall include the demonstration of the following:
 - .1 The ease of access that has been provided throughout for servicing coils, motors, drives, control dampers and damper operators.
 - .2 Location of and opening and closing of all access panels.
 - .3 Operation of all automatic control dampers and automatic temperature control devices.
 - .4 Operation of all alarm and protective devices.
 - .5 Operation of all equipment and systems under each mode of operation, and failure.
- .6 At the completion of commissioning, testing, balancing and demonstration submit the following to the Departmental Representative:
 - .1 A letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.
 - .2 Completed copies of all commissioning check lists plus copies of start-up reports from specialty contractors and vendors.
 - .3 "As-Built" record drawings, as specified.
 - .4 A list of all alarm and protective devices tested, with the final operating settings.
- .7 Training
 - .1 During "Substantial Performance" review, the Mechanical Contractor, Control Subcontractor, and other Subcontractors designated by the Departmental Representative shall provide training to the operating personnel in the proper operation and maintenance of all systems and equipment installed under the contract.
 - .2 It shall be the Mechanical Contractor's responsibility to have the specified equipment manuals prepared, previously approved by the Departmental Representative, and ready for presentation to the Departmental Representative at this meeting.
 - .3 Convene the meeting with the aforementioned parties at the time called for in the substantial performance review. The arrangements shall include written notices to all the parties concerned. Should the equipment manuals, or system installation not be complete and operable at the proper time, he shall then convene the operating instruction meeting at a later date and pay any additional costs including time and travelling expenses for the personnel involved which are attributable to the delay.

PART 2 - PRODUCTS

2.1 Not Used

PART 3 - EXECUTION

3.1 Not Used

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

- .1 Section 01 91 13 Commissioning
- .2 Section 22 42 01 Plumbing Specialties and Accessories
- .3 Section 23 05 93 Testing, Adjusting and Balancing
- .4 Section 23 08 00 Commissioning of Mechanical Systems
- .5 Section 23 08 02 Cleaning and Start-up of Mechanical Piping Systems
- .6 This Section applies to all related work under Divisions 22 and 23.

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-12, 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 Potable Water Systems

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 22.
 - .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 as a result of flushing and/or cleaning.

1.5 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 21.
- .2 Verification of controls, detection devices, alarm devices is specified Division 28.

1.6 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 01 - Plumbing Specialties and Accessories.
- .6 Roof drains:
 - .1 Refer to Section 22 42 01 - Plumbing Specialties and Accessories.
 - .2 Remove caps as required.

1.7 Reports

- .1 In accordance with Section 01 91 13 – Commissioning and Section 23 08 00 –Commissioning of Mechanical Systems

PART 2 - PRODUCTS

2.1 Not Used

- .1 Not Used.

PART 3 - EXECUTION

3.1 Not Used

- .1 Not Used.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Works Results - Mechanical

1.2 References

- .1 American National Standards Institute (ANSI)
 - .1 IEEE C57.13-2013, Standard Requirements for Instrument Transformers.
 - .2 National Electrical Manufacturer's Association (NEMA)

1.3 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 11 55 – General Instructions. Include product characteristics, performance criteria, and limitations.
 - .2 Include:
 - .1 Information as specified for each device.
 - .2 Manufacturer's detailed installation instructions.
- .2 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
 - .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.

1.4 Quality Assurance

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6 Waste Management Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 11 55 – General Instructions.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan

- .3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 Thermostats

- .1 Low voltage wall thermostat as supplied with equipment.
- .2 Provide tamperproof screws or security pop-rivet fasteners for devices located inmate accessible areas.

2.2 Thermostat Guards

- .1 Thermostat guards: lockable, clear plastic. Slots for air circulation to thermostat.

2.3 Time Switch (Clock Type)

- .1 All time switches shall be seven day, 24 hour program type with carry over feature capable of accepting settings to nearest 15 minutes with minimum "on" cycle of 45 minutes.
- .2 Where specified manual override timers shall be clockwork type without "hold" position, calibrated for 1 to 4 hours timing duration.

2.4 Dampers and Actuators

- .1 All control dampers not furnished with packaged equipment shall be supplied by the controls subcontractor and installed by the sheet metal subcontractor. Provide damper actuators for all dampers shown or specified.
- .2 All dampers in a mixing application shall be parallel blade with direction of closing producing opposed air streams for optimal mixing. Return air dampers shall be a tight closing, low leakage type with replaceable blade and edge seals.
- .3 All dampers for outdoor air application shall be parallel blade, insulated, tight closing, low leakage type with replaceable blade and edge seals.
- .4 Actuators shall be electronic, direct coupled. Control voltage shall be 0-10 VDC, or 4-20 mA with an internal spring return on power failure. Actuators shall permit manual positioning of damper when actuator is not powered.

2.5 Electrical Components, and Conduit

- .1 Provide all control system components, except those supplied as part of packaged equipment controls, but including all auto sequencing devices, electric relays, safety devices and electrical interlocks required to accomplish specified sequences. Refer to the electrical motor schedule in the electrical drawings and/or specification, which delineate the limits of electrical work in Division 26 (Electrical) serving mechanical systems.
- .2 Provide all control circuit transformers required for control systems and not supplied by Division 26 including line voltage power connection from indicated outlets shall be included by Division 23.
- .3 All line voltage wiring shall be copper with RW90 X-Link P.E. insulation #12 minimum size. AWG wire shall be sized to meet code.
- .4 All wiring installed under this contract shall be plenum rated FT-6 or FT-4, if approved by all authorities having jurisdiction. Locate wiring away from top or bottom of ceiling joists or trusses to

minimize possibility of accidental damage. Number 18 gauge wire may be used in Class 2 circuits unless voltage drops are excessive. THHN wire will not be acceptable. Twisted shielded wiring, minimum of 22 gauge wire shall be used for all co-axial communication wiring. Line voltage alternating current wiring shall not be run in the same conduit, or cabling as low voltage wiring.

- .5 Use 1m of flexible conduit for all connections to vibrating equipment. Use liquid tight flex cable and connections where required.
- .6 The Control Contractor shall locate magnetic starters from the electrical drawings. All electrical work provided by this Contractor shall comply with all requirements of the Division 16 electrical specification, the Canadian Electrical Code and Local Codes and Ordinances.
- .7 Wire all line voltage thermostats for single phase equipment.
- .8 Division 26 has been requested to provide specific devices, including magnetic starters supplied with 120 volt holding coils, HOA switching and space for the addition of auxiliary contacts. The Control Contractor shall provide all necessary normally open and normally closed contacts, wired to a terminal strip within the starter enclosure, required to achieve the specified control interlocking and sequencing. Manual starters for 120 volt equipment are to contain On-Off selector, external H.O.A., integral overload protection and pilot lights. The Controls Contractor shall provide control wiring interlocks from the control contacts provided on the automatic branch lines of the assembly, which will be contained within the associated Motor Control or Starter Assembly.
- .9 Refer to Division 26 Specifications and Motor Schedule for the scope of work to be provided by the Electrical Contractor. Division 23 shall supply and install all components, in addition to those outlined within the Division 26 documents, as may be deemed necessary to provide all interlocks or sequences as called for elsewhere within the specifications.
- .10 All power supplies for controls are this Contractor's responsibility unless otherwise specified in the Electrical Specifications. All control transformers to be located in fan rooms or mechanical rooms only and are to be mounted in serviceable locations.
- .11 Line voltage will not be run with signal or trunk wiring or be present in the same junction box.
- .12 Run all wiring parallel to building lines. All wiring to be installed in a neat, workmanlike manner.
- .13 Support wiring independent of piping, ductwork, and equipment. Keep wiring clear of hot piping, ductwork/equipment.
- .14 Identify all junction boxes with control company label.
- .15 There shall be no splices in any of the control wiring except at devices or control panels.

2.5 Temperature Control Panels

- .1 Provide temperature control panels constructed of heavy gauge furniture steel with baked enamel finish, hinged door with locking latches, flush mounted gauges and thermometers. Each mounted device shall have an identity label, which shall be in English text for switches or instruments mounted on panel faces. All panel wiring shall terminate at numbered and identified terminal strips. All wires and pneumatic tube within the panel shall be identified and neatly arranged.

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 Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats and temperature sensors 1.5m above floor.
- .2 Install damper motors on outside of ducts. Do not locate inside air stream.
- .3 The installation shall conform to each manufacturer's recommended procedures and to all applicable codes, statutes and ordinances.
- .4 Equipment shall be installed so as to allow for easy maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding space.
- .5 All transmitters, interfaces, terminations and control relays, etc. shall be mounted in field cabinets that may be locked.
- .6 Equipment shall be installed in locations providing adequate ambient conditions for its specified functioning, allowing for adequate ventilation.
- .7 Permanently identify each wire, cable, conduit and tube at each terminal.
- .8 All wall mounted devices in new finished space shall be mounted on a wall box.
- .9 Provide tamperproof screws to new and relocated equipment, controls enclosures and devices which are located in inmate accessible areas.

3.3 Enclosure and Conduit

- .1 Relays, transformers, and controls devices shall be installed in controls enclosures.
- .2 All wires penetrating the enclosure that are not required to be in conduit must be neatly bundled and strapped in place.
- .3 The wiring diagram shall be affixed on the inside of the door/cover of the enclosure.
- .4 The inside bottom of the enclosure shall be clean of dirt, metal shavings, and debris.
- .5 Wiring is to be in EMT conduit with set screw metal fittings in all wall spaces and exposed locations as well as in pipe chases, service spaces, attics, and crawl spaces which are entered for service access. Wiring in suspended ceiling spaces does not require conduit but shall be neatly installed parallel to building lines using bridle rings. All conduits shall be piped smoothly and neatly following building lines. Wiring above existing ceilings and wall cavities may be run free-air.
- .6 Prior to start of construction, submit proposed locations of control panels to Departmental Representative for review and approval.

3.3 Ventilation and Heating Controls [Parks Canada]

- .1 Provide wiring, relays and other field devices to complete the following controls sequence.

- .2 Provide time clock to schedule start/stop of the supply and exhaust fan. When the ventilation is enabled, motorized damper MD-1 shall first open. Once the damper is open, the end switch shall enable the supply fan. The exhaust fan shall be interlocked with the supply fan.
- .3 Install airflow switch, duct mounted thermostat and remote adjuster for the electric duct heater. Locate remote adjuster as shown on floor plan. Upon proven airflow, the duct heater shall start and maintain supply air temperature of 10°C (50°F).

3.4 Ventilation and Heating Controls [Parks Canada]

- .1 Provide wiring, relays, transformers and other field devices to complete the following controls.
- .2 Kitchen exhaust fan KEF-1 serving the Kitchen is to be controlled by line voltage wall mounted switch c/w timer [by Div. 26].
- .3 Supply Fan SF-1 and associated electric duct heater EDH-1 serve the Kitchen are to be interlocked with KEF-1. Provide a duct mounted thermistor to control EDH-1 leaving air temperature. Provide control wiring from the thermistor to the duct heater [by Div. 26]. Set the thermistor to 20°C (adjustable).
- .4 When fire suppression system for kitchen hood is activated, shut-down KEF-1, SF-1 and Duct Heater DH-1.

3.5 Water Bottle Filling Station WBFS-1

- .1 Provide wiring and other field devices to complete operation.

3.6 Drain Water Tempering Valve DTV-1

- .1 Provide valve, control valve, wiring and other field devices to complete operation.

3.7 Trap Primer TP-1

- .1 Provide transformer, solenoid valve (12V) valve, wiring and other field devices to complete operation.

3.8 Lavatory Faucet Control L-1 and L-2

- .1 Provide control wiring between faucet and control valve. Provide other field devices to complete operation. Set adjustable faucet operation.

3.9 Domestic Hot Water Re-circulating Pump Controls [Parks Canada]

- .1 Provide aquastat with brass immersion well in domestic hot water recirculation pipe to cycle domestic hot water re-circulating pump. Line voltage wiring by Division 26.

3.10 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 91 00 Commissioning
- .3 Section 23 05 05 Installation of Pipe Work
- .4 Section 23 05 29 Hangers & Supports for Piping & Equipment
- .5 Section 23 05 48 Vibration & Seismic Controls for Ductwork, Piping & Equipment
- .6 Section 23 08 00 Commissioning of Mechanical Systems

1.2 References

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-13, Pipe Flanges and Flanged Fittings.
 - .2 ASME B18.2.1-96, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A47/A47M-09, Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .3 Canadian Standards Association (CSA)
 - .1 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.
 - .2 CAN/CSA-B137 Series, 2013, Thermoplastic Pressure Piping Compendium.
 - .3 CSA Z662-11, Oil and Gas Piping Systems
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CGA B149.1-10, Natural Gas and Propane Installation Code.
 - .2 CAN/CGA B149.2-10, Propane Storage and Handling Code.

1.3 Submittals

- .1 Submit product data in accordance with Section 01 11 55 – General Instructions.
- .2 Indicate on manufacturers catalogue literature following: valves.

1.4 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual specified in Section 01 11 55 – General Instructions.

1.5 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 11 55 – General Instructions.

- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 Pipe

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS 2 1/2 and over, plain end.
- .2 Underground gas piping: High Density polyethylene pipe meeting the requirements of CSA B137.4.
- .3 Epoxy coated steel pipe risers designed for connection to plastic service piping for NPS 2 (50mm) size and smaller.

2.2 Jointing

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Underground Piping shall be joined by heat fusion, electrofusion, or mechanical methods in accordance with CSA Z662 and the manufacturer's instructions.

2.3 Fittings

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

2.4 Valves

- .1 Provincial Code and CSA B137.1 approved, lubricated type.
- .2 All valves used shall match existing and labeled to match existing nomenclature.
- .3 Provide seismic actuated shut off valve at building wall.

PART 3 EXECUTION

3.1 Installation

- .1 Install in accordance with Section 23 05 05 - Installation of Pipework, Section 23 05 29 – Hangers & Supports for Piping & Equipment, and Section 23 05 48 – Vibration & Seismic Controls for Ductwork Piping & Equipment.
- .2 Install in accordance with CAN/CGA B149.1 and local authority having jurisdiction.
- .3 Install underground gas piping strictly in accordance with manufacturer's instructions. Provide warning tape (plain tape only) buried directly above gas pipe, 300mm below finished grade. The installation of plastic pipe underground shall include installation of a tracer wire and tracer wire shall terminate above ground at riser locations. At the service meter and at indicated building locations, provide epoxy coated steel pipe risers designed for connection to plastic service piping. Provide dielectric fittings and a lubricated plug valve where the underground pipe is connected to the pipe entering the building.
- .4 Project new gas piping to new and relocated equipment to meet codes.

3.2 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 Provide shutoff valve and insulated union for di-electric isolation of building gas piping.

3.2 Field Quality Control

- .1 Test system in accordance with CAN/CGA B149.1, CAN/CGA B149.2 and requirements of authorities having jurisdiction.

3.3 Purging

- .1 Purge after pressure test in accordance with CAN/CGA B149.1, CAN/CGA B149.2.

3.4 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.

3.5 Reports

- .1 In accordance with Section 01 91 00 – Commissioning and Section 23 08 00 – Commissioning of Mechanical Systems.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

- | | | |
|----|------------------|---------------------------------|
| .1 | Section 01 11 55 | General Instructions |
| .2 | Section 23 05 00 | Common Work Results-Mechanical |
| .3 | Section 23 05 93 | Testing Adjusting and Balancing |

1.2 Waste Management and Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 11 55 – General Instructions.
- .2 Dispose of unused cleaning solutions at official hazardous material collections site approved by the Departmental Representative.
- .3 Do not dispose of unused cleaning solutions into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.
- .4 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .5 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

1.3 Scope

- .1 All air systems installed by this contract shall be cleaned by a Cleaning Contractor.
- .2 The Cleaning Contractor shall visit the site in the case of existing systems or shall review the drawings and specifications of new systems, in order to be fully acquainted with the scope of work and requirements before tendering. No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit the site or inspect the contract documents.
- .3 The following air systems shall be cleaned, as applicable:
 - .1 Relief
 - .2 Supply
 - .3 Return
 - .4 Exhaust
 - .5 Air Conditioning
- .4 All components within each system shall be thoroughly cleaned to the Departmental Representative's satisfaction and shall include but not be limited to the following:
 - .1 Intake exhaust and relief louvres
 - .2 Bird screens
 - .3 Auto dampers
 - .4 Filter frames
 - .5 Coils
 - .6 Fans & motors - complete assembly
 - .7 All plenum surfaces

- .8 Terminal heating/cooling coils
- .9 Supply air grilles, registers and diffusers
- .10 Ductwork
- .11 Mixing boxes, air terminal units
- .12 Return, exhaust and relief air grilles and diffusers.

1.4 Qualifications

- .1 Cleaning shall be performed by a cleaning service company with high capacity cleaning equipment designed specifically for the work involved, executed by personnel specifically trained for the application.

PART 2 PRODUCTS

2.1 Cleaning Equipment

- .1 Cleaning shall generally by high capacity power vacuum.
- .2 High pressure compressed air, wire brushing and/or non-toxic solvent cleaning shall be used where dirt or scale cannot be removed otherwise.

PART 3 EXECUTION

3.1 Cleaning HVAC Systems

- .1 The Cleaning Contractor shall provide access as required for the work and shall reseal and make good any duct or insulation damaged in the process of this work.
- .2 Remove cheesecloth from grilles, etc., let over from the temporary use of the air systems.
- .3 Air systems must not be shut down without prior approval from the owner
- .4 The Cleaning Contractor shall be responsible for removing and replacing filter media. In new buildings this Contractor will remove the temporary filters and replace with new after cleaning the systems. In existing buildings this Contractor may re-use existing filter media (cleaned if possible) or new media will be provided by the Owner as established by the Departmental Representative.
- .5 The Cleaning Contractor shall mark balancing damper positions before cleaning and return them to their original position when cleaning is completed unless the system is to be balanced.
- .6 Re-install any grilles, registers and diffusers which may have been removed for cleaning purposes.

3.2 Report

- .1 After completion of the work, the Contractor shall provide four copies of a certificate stating that all systems have been cleaned as specified and that all access panels for all cleaning openings are in place. This certificate shall be placed in the Operating and Maintenance Manuals.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

- | | | |
|----|------------------|---|
| .1 | Section 01 11 55 | General Instructions |
| .2 | Section 01 35 33 | Health and Safety Requirements |
| .3 | Section 23 05 00 | Common Work Results - Mechanical |
| .4 | Section 23 05 48 | Vibration and Seismic Controls for Ductwork, Piping and Equipment |
| .5 | Section 23 05 94 | Pressure Testing of Ducted Air Systems |
| .6 | Section 23 07 13 | Thermal Insulation for Ducting |
| .7 | Section 23 31 10 | Cleaning of Mechanical Duct Systems |

1.2 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A312/A312M-2014, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - .2 ASTM A480/A480M-2013, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .3 ASTM A635/A635M-2013, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
 - .4 ASTM A653/A653M-2013, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Agency (NFPA)
 - .1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 91-2010, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Non-combustible Particle Solids.

- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 ANSI/SMACNA 006-2006, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2nd Edition, 2012.
 - .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.
- .7 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .8 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-07, Surface Burning Characteristics of Building Materials and Assemblies.
- .9 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 Submittals

- .1 Submit shop drawings and product data in accordance with Section 01 01 50 – General Instructions.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets for the following:
 - .1 Sealants.
 - .2 Adhesive
 - .3 Duct tape.
 - .4 Duct liners.

1.4 Quality Assurance

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

- .3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

PART 2 PRODUCTS

2.1 Seal Classification

- .1 Classification as follows:

Pressure Class	Maximum Pressure (Pa)	SMACNA Seal Class
Medium Pressure	750	[B]
Low Pressure	500	[B]

- .2 Seal classification:
 - .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant.

2.2 Ductwork - General

- .1 Duct dimension noted on drawings are clear inside dimensions. Insulation thickness shall be as noted on the drawings.
- .2 All seams, joints and raw edges shall be sealed and covered with glassfab.
- .3 Insulation shall be applied with mechanical fasteners and suitable adhesives. Duct insulation adhesive and coatings shall be non-toxic as defined by WCB Regulations.
- .4 Round duct: with spiral seams. Sections shall be joined with a RT1 slip joint, screw fastened and sealed with no visible duct sealant to interfere with finish painting.
- .5 Exposed round duct shall be installed in a neat workmanlike manner parallel to building walls and roof with no sags or misalignment, and shall be true and round.
- .6 Ductwork downstream of low-pressure single duct air terminal units shall be constructed to 500 Pa low pressure duct.
- .7 Ductwork upstream of single duct air terminal units shall be constructed to 1,000 Pa medium pressure duct.

2.3 Fittings

- .1 Fabrication: to SMACNA. Fittings shall be 2 gauges heavier than connecting ductwork.
- .2 Radius elbows:
 - .1 Rectangular: Centre-line radius equal to 1.5 times width of duct, with single thickness turning vanes.
 - .2 Round: Centre-line radius equal to 1.5 times diameter. 5-gore for 300mm [12"] and larger; die-stamped for 254mm [10"] and smaller.
- 3 Mitered elbows, rectangular:
 - .1 To 400mm [16"]: with single thickness turning vanes.
 - .2 Over 400mm [16"]: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: 45° entry on branch.
 - 2 Round main and branch: enter main duct at 45° or with conical connection. The use of spin-in collars is not acceptable.
- .5 Transitions:
 - .1 Diverging: 20° maximum angle.
 - .2 Converging: 30° maximum angle.
- .6 Offsets: full radius elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.

2.4 Galvanized Steel

- .1 Lock forming quality: to ASTM A653, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.
- .4 Applications:
 - .1 All supply and exhaust ductwork unless otherwise noted.

2.6 Stainless Steel

- .1 Material: 316 stainless steel to ASTM A312.
- .2 Thickness: minimum 1.2mm [18 gauge], built for structural strength.
- .3 Joints: continuously welded.
- .4 Duct system shall be fitted with copper-grounding straps, connected to the duct and to an effective grounding system.
- .5 Applications:
 - .1 Canopy exhaust duct.
 - .2 **Kitchen exhaust duct.**
 - .3 As noted on drawings.

- .4 May be used as an alternative to aluminum duct at Contractor's option.

2.7 Hangers and Supports

- .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct. Maximum size duct supported by strap hanger: 500mm [20"].
- .2 Hangers, hanger configuration and attachment to structure: to SMACNA.

2.8 Duct Liner

- .1 Fibrous glass duct liner: air stream side faced with FSK facing.
- .2 Rigid:
 - .1 Use on flat surfaces.
 - .2 25mm [1"] or 50mm [2"] thick fibrous glass rigid board duct liner.
 - .3 Density: 36 kg/m³ [2.2 lb/ft³].
 - .4 Thermal resistance: RSI-0.76 [R-4.3] for 25mm [1"], RSI-1.53 [R-8.7] 50mm [2"].
- .3 Flexible:
 - .1 Use on round or oval surfaces.
 - .2 25mm [1"] or 50mm [2"] thick fibrous glass blanket duct liner as indicated.
 - .3 Density: 24 kg/m³ [1.5 lb/ft³].
 - .4 Thermal resistance: RSI-0.74 [R-4.2] for 25mm [1"], RSI-1.47 [R-8.3] 50mm [2"].
- .4 Fasteners shall be weld pins with metal retaining clips and square head.
- .5 Flame and smoke ratings:
 - .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.9 Sealant

- .1 For indoor and outdoor applications:
 - .1 Water based, fiber reinforced, non-toxic, elastomeric duct sealant. Suitable for indoor and outdoor use, non-sagging, non-cracking, UV resistant, freeze/thaw stable, paintable. Temperature range of -32°C to 99°C [-26°F to 210°F]. ULC listed and comply with NFPA 90A and NFPA 90B.
 - .2 Flame and smoke ratings:
 - .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.
- .2 For outdoor applications only:

- .1 Solvent based, fiber reinforced, elastomeric duct sealant. Suitable for outdoor unit, non-sagging, non-cracking, UV-proof, freeze/thaw stable, paintable. Temperature range of -45°C to 120°C [-50°F to 250°F].
- .3 Maximum VOC limit 420 g/L to SCAQMD Rule 1168 and SMACNA Technical Resource Bulletin (TRB) #9-09.

2.10 Adhesive

- .1 Water-based vinyl copolymer adhesive. Temperature range of -23°C to 71°C [-10°F to 160°F]. ULC listed and comply with NFPA 90A and NFPA 90B. Adhesive shall be non-toxic as defined by WorksafeBC Regulations.
- .2 Flame and smoke ratings:
 - .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.
- .3 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.

2.11 Duct Tape System

- .1 Two part system combined of treated woven fibreglass tape and liquid sealant/adhesive. ULC listed and comply with NFPA 90A and NFPA 90B.
- .2 Flame and smoke ratings:
 - .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

PART 3 EXECUTION

3.1 General

- .1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE, SMACNA, and as indicated.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.
- .7 All openings in ductwork shall be sealed with temporary duct cover during construction. Failure to maintain duct cleanliness will require the inside of all air ducts, plenums and equipment in the air stream to be cleaned with an industrial vacuum cleaner before system balancing is started.
- .8 Apply protective galvanize coating to galvanized ductwork and accessories which have been welded.

- .9 Apply duct sealer to all joints of metal ducts, connections to diffusers, plenums and flexible duct.
- .10 Provide medium pressure duct for the following:
 - .1 Ductwork serving systems with air terminal units, extending from the air handling unit discharge to the inlet of air terminal units.
 - .2 As indicated.
- .11 The use of plastic duct tape is not permitted.
- .12 Thermal insulation to Section 23 07 13 – Thermal Insulation for Ducting.

3.2 Hangers

- .1 Strap hangers: Install in accordance with SMACNA.
- .2 Rectangular duct: Extend strap hanger down on both sides of duct, turn under bottom 25mm [1"] minimum. On each strap provide two sheet metal screws on the side and one in the bottom.
- .3 Angle hangers: complete with locking nuts and washers.
- .4 Hanger spacing: to SMACNA.
- .5 Seismic restraint to Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.

3.3 Ductwork Exposed to Weather

- .1 All ductwork exposed to weather shall have watertight seams.
- .2 Exposed ducts which are not insulated or finished with paint shall be coated with two applications of bitumastic waterproofing compound to prevent corrosion.
- .3 Supports for ductwork exposed to weather and miscellaneous metals exposed to weather shall be electro-galvanized or hot dip galvanized steel, or coated with two applications of bitumastic waterproofing compound.

3.4 Duct Liner

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425mm on centres.
 - .3 Acoustically lined round ducts shall have perforated inner metal liner.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.
- .4 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.

- .5 Replace damaged areas of liner.
- .6 Protect leading and trailing edges of duct sections with sheet metal nosing having 15mm [1/2"] overlap and fastened to duct.
- .7 Provide 50mm [2"] liner for ductwork exposed to weather which is not insulated.

3.5 Watertight Duct

- .1 Provide watertight duct for:
 - .1 Dishwasher exhaust.
 - .2 Fresh air intake.
 - .3 Minimum 3,000 mm from duct mounted humidifier in all directions.
- .2 Form bottom of horizontal duct without longitudinal seams.
 - .1 Solder or weld joints of bottom and side sheets.
 - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served.
 - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and trap primer and discharging to open funnel drain.

3.6 Kitchen Exhaust Systems

- .1 Install to NFPA 96.

3.7 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.

3.8 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 Perform leakage tests in sections.
- .4 Perform trial leakage tests, as instructed to demonstrate workmanship.
- .5 Install no additional ductwork until trial tests have been achieved.
- .6 Test section minimum of 30m [100 ft] long with not less than three branch takeoffs and two 90^a elbows.
- .7 Complete tests before insulation or concealment.

3.9 Cleaning

- .1 Perform cleaning operations as specified in Section 01 11 55 – General Instructions, Section 23 31 10 – Cleaning of Mechanical Duct Systems and in accordance with manufacturer's recommendations.

3.10 Standards

- .1 As per National Building Code of Canada (NBC 2015), systems for ventilation of commercial cooking equipment shall be designed, constructed and installed to conform to NFPA 96. The British Columbia Building Code 2012 refers to the same NFPA 96 document (requested by the Building Inspector from the Township of Langley).
- .2 Clearance from the duct or the exhaust fan to the interior surface of enclosures of combustible construction should be no less than 457 mm (18 in.) [NFPA 2014, 7.7.2.2.1].
- .3 Clearance from the duct or the exhaust fan to the interior surface of enclosures of non-combustible or limited-combustible construction should be no less than 152 mm (6 in.) [NFPA 2014, 7.7.2.2.2].
- .4 A portion of the duct is located outdoors (supply and exhaust) in a non-heated attic space. Duct insulation will be required to prevent condensation. Supply and exhaust duct exposed in the space being served will not require thermal insulation unless otherwise noticed on drawings.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

- .1 Section 01 01 50 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 01 74 11 Cleaning
- .4 Section 23 05 00 Common Work Results - Mechanical
- .5 Section 23 31 10 Cleaning of Mechanical Duct Systems

1.2 References

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 ANSI/SMACNA 006-2006, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-07, Standard Method of Tests for Air Ducts.
 - .2 UL 181-2013, Standard for Factory-Made Air Ducts and Air Connectors.

1.3 Submittals

- .1 Submittals in accordance with Section 01 01 50 – General Instructions.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
 - .1 Flexible ducts.
 - .2 Flexible duct connectors.
 - .3 Duct access doors.
 - .4 Turning vanes.
 - .5 Instrument test ports.
- .3 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.

- .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: manufacturer's field reports specified.
- .7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 01 50 – General Instructions.

1.4 Quality Assurance

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 01 50 – General Instructions.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan (WMP).
 - .4 Separate for reuse and recycling and place in designated containers in accordance with Waste Management Plan (WMP).
 - .5 Divert unused materials from landfill to recycling facility as approved by Departmental Representative.

PART 2 PRODUCTS

2.1 General

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

2.2 Flexible Duct

- .1 General:
 - .1 UL-181 listed and labeled as Class I air duct, and complies with NFPA 90A and 90B.
- .2 Non-metallic, Insulated:
 - .1 Constructed of CPE liner duct permanently bonded to a spring steel wire helix and with factory applied fibreglass insulation, lower permeability vapour barrier and laminate jacket for low and medium pressure systems.
 - .2 Maximum rated pressure: 1,000Pa [4" w.g.] positive, 250Pa [1" w.g.] negative.
 - .3 Operating temperature: -29 to 121 °C [-20 to 250 °F].
 - .4 Thermal resistance: RSI-0.74 [R-4.2].

- .5 Application: cold air supply duct.
- .3 Non-metallic, un-insulated:
 - .1 Constructed of supporting helix of coated spring steel wire permanently bonded to a coated woven fiberglass.
 - .2 Maximum rated pressure: 2,500Pa [10" w.g.] positive, 250Pa [1" w.g.] negative.
 - .3 Operating temperature: -18 to 121 °C [-0 to 250 °F].
 - .4 Application: warm air supply duct.

2.3 Flexible Duct Connectors

- .1 Frame: galvanized sheet metal frame 0.66mm [24 gauge] thick with fabric clenched by means of double locked seams.
- .2 Fabric:
 - .1 Indoor: Fire resistant, self extinguishing, neoprene coated fibreglass fabric, temperature rated at -40°C to 90°C [-40°F to 200°F], thickness of 0.63mm [0.025"].
 - .2 Outdoor: Fire resistant, self extinguishing, DuPont Hypalon coated fibreglass fabric, temperature rated at -40°C to 120°C [-40°F to 250°F], thickness of 0.61mm [0.024"].

2.4 Access Doors in Ducts

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm [24 gauge] thick complete with sheet metal angle frame.
- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6mm [24 gauge] thick complete with sheet metal angle frame and 25mm [1"] thick rigid fibreglass insulation.
- .3 Gaskets: neoprene.
- .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.

2.5 Turning Vanes

- .1 Factory-made, single or double thickness as specified elsewhere, with trailing edge. Vanes shall be constructed of same material as duct, 0.55mm [26 gauge].
- .2 Rails shall be fabricated of same material as duct, 0.66m [24 gauge]. Vanes shall be attached to rails using fasteners.

2.6 Instrument Test Ports

- .1 Alloy casting with screw-in cap, neoprene gasket, 18 mm [3/4"] inside diameter opening for pitot tube or velometer.

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 Duct

- .1 Provide flexible duct connecting air outlets as indicated. Flexible duct with integral volume damper is not acceptable.
- .2 Install flexible duct fully extended, without tight bends and kinks. The radius at the centre-line shall not be less than one duct diameter. Do not install in compressed state.
- .3 Length of flexible duct shall within 1,500mm to 2,100mm (5'-0" to 7'-0").
- .4 Provide support for flexible duct at 1,200mm (4'-0") on centre. Maximum permissible sag is 42 mm/m (1/2 inch per foot) of spacing between support. A connection to a rigid duct or equipment shall be considered a support joint.
- .5 Sheet metal strap for flexible duct support shall be minimum 38mm (1-1/2") wide.
- .6 Sheet metal collars to which the flexible ducts are attached shall be minimum 50mm (2") in length.
- .7 Repair torn or damaged vapour barrier jackets approved duct tape. If the internal core is penetrated, replace the flexible duct.
- .8 Do not use flexible duct for connecting mixing box and air terminal unit inlets.
- .9 Do not use flexible duct on return and exhaust ductwork.

.2 Flexible Duct Connectors

- .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 [4"].
- .3 Minimum distance between metal parts when system in operation: 75mm [3"].
- .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.
- .6 Flexible duct connector exposed to weather shall have a sheet metal shield for additional UV protection.

- .3 Access Doors in Ducts
 - .1 Size:
 - .1 610mm x 1520 mm [24"x60"] for person size entry.
 - .2 460mm x 460 mm [18"x18"] for service.
 - .3 300mm x 200mm [12"x8"] for cleaning.
 - .4 As indicated.
 - .2 Locations:
 - .1 Fire dampers and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 On both sides of turning vanes.
 - .7 At the base of all duct risers.
 - .8 At 12,000mm [40'-0"] intervals in all duct systems, and 6,000mm [20'-0"] intervals in horizontal exhaust ducts for cleaning purposes.
- .4 Instrument Test Ports
 - .1 Install in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 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.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.
- .5 Turning Vanes
 - .1 Install in accordance with manufacturer's recommendations.

3.3 Cleaning

- .1 Proceed in accordance with Section 01 01 50 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results – Mechanical
- .4 Section 23 31 10 Cleaning of Mechanical Duct Systems
- .5 Section 23 33 00 Air Duct Accessories

1.2 References

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 ANSI/SMACNA 006-2006, HVAC Duct Construction Standards, Metal and Flexible, 3rd Edition.
 - .2 SMACNA – Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 2002.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112-10, Standard Method of Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC-S112.2-07, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505-1974, Standard for Fusible Links for Fire Protection Service.
- .3 National Fire Protection Agency (NFPA)
 - .1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.

1.3 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.
 - .1 Indicate the following:
 - .1 Volume dampers.
 - .2 Remote control damper regulators.
 - .3 Fire dampers.
 - .4 Fire stop flaps.
 - .5 Smoke dampers.
 - .6 Backdraft dampers.
 - .7 Relief dampers.

- .2 Quality assurance submittals: submit following in accordance with Section 01 01 50 – General Instructions.
 - .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.

1.4 Quality Assurance

- .1 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General 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 11 55 – General Instructions.

1.6 Extra Materials

- .1 Provide maintenance materials in accordance with Section 01 11 55 – General Instructions.
- .2 Provide following:
 - .1 Six (6) fusible links for each type of fire damper.

PART 2 PRODUCTS

2.1 General

- .1 Manufacture to SMACNA standards.

2.2 Single Blade Volume Dampers

- .1 Blade: Of same material as duct. Two gauges heavier than duct but not less than 0.6mm [24 gauge], stiffened.
- .2 Maximum dimension: 305mm [12"] height for rectangular ducts.
- .3 Axles: 9.5mm [3/8"] continuous square rod up to 457mm [18"] wide duct, and 13mm [1/2"] continuous square rod up to 1,219mm [48"] wide duct.
- .4 Linkage: shaft extension with locking quadrant and position indicator.
- .5 Bearings: bronze oilite.
- .6 Frame: of the same material as duct. Complete with angle stop for rectangular duct.

2.3 Multi-Bladed Volume Dampers

- .1 Opposed blades: 1.2mm [18 gauge] of same material as adjacent duct, stiffened.
- .2 Maximum blade width: 150mm [6"].
- .3 Axles: 9.5mm [3/8"] or 13mm [1/2"] continuous square rod.
- .4 Bearings: bronze oilite.
- .5 Linkage: shaft extension with locking quadrant and position indicator.
- .6 Frame: 51mm [2"] or 40 x 13 x 3 mm [1-1/2"x1/2"x1/8"] structural or roll-formed channel, complete with angle stop.

2.4 Remote Control Damper Regulators

- .1 Cable controlled damper regulator for concealed ceiling applications.
- .2 Cable: 1.4mm [0.054] stainless steel Bowden cable encapsulated in 1.6mm [1/16"] flexible galvanized spiral wire sheath.
- .3 Control kit: die-cast aluminum housing with 76mm [3"] diameter chrome-plated cover, with steel rack and pinion gear drive converting rotary motion to push-pull motion.
- .4 Provide hardware kit for damper by others.

2.5 Fire Dampers

- .1 Dynamic type, Arrangement B, ULC listed and labelled, meeting requirements of provincial fire authority and NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN/ULC-S112. Factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .2 Frame and integral sleeve shall be of same material as duct with mounting angles furnished by the damper manufacturer. Sleeve thickness to SMACNA and NFPA-90A.
- .3 Top hinged: offset, round or square, interlocking blade type and sized to maintain full duct cross section.
- .4 Fusible link: 74°C [165°F], replaceable.
- .5 40 x 40 x 3 mm [1-1/2" x 1-1/2" x 1/8"] retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

2.6 Fire Stop Flaps

- .1 To be ULC listed and labelled and fire tested in accordance with CAN4-S112.2.
- .2 Construct of same material as duct, minimum 1.5 mm thick with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.
- .3 Flaps to be held open with fusible link conforming to ULC-S505 and close at 74°C.

2.7 Smoke Dampers

- .1 Class I leakage rate, with airfoil blades, pressure sensitive blade edge and jamb seals for low leakage, concealed linkage. Both damper and actuator shall be ULC listed and labelled.
- .2 Constructed frame and blades of same material as duct.
- .3 Operation: Normally open position. Damper shall close upon detection of smoke or from remote alarm signalling device.

2.8 Backdraft Dampers

- .1 Multi-blade, gravity-operated, centre pivoted, constructed of same material as duct with nylon bearings.

2.9 Relief Dampers

- .1 Multi-blade, insulated, counter-weight, centre pivoted, constructed of same material as duct with brass bearings, set to open at 12.4 Pa [0.05 in. w.g.] static pressure unless otherwise noted.

PART 3 EXECUTION

3.1 General

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.

3.2 Volume Damper

- .1 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- .2 Run-outs to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .3 All dampers to be vibration free.
- .4 Attach fluorescent tape to regulator handle for concealed volume dampers.
- .5 Provide remote control damper regulator for volume dampers above inaccessible ceiling where ceiling access panel is not provided, and as indicated.

3.3 Fire Dampers

- .1 Install in accordance to Part 3, Sub-section 3.1.8 of the National Building Code.
- .2 Provide fire damper where duct penetrates through fire-rated floor, wall, or fire separation.
- .3 Provide fire stop flap at fire-rated ceiling assembly.
- .4 Provide access door per Section 23 33 00 – Air Duct Accessories.

3.4 Smoke Dampers

- .1 Provide smoke dampers in the supply and return air streams if the air handling system:
 - .1 serves more than one storey.
 - .2 serves more than one suite in a storey.
- .2 Coordinate with Division 26 for power and Division 28 for interlock/interfaces.
- .3 Provide access door per Section 23 33 00 – Air Duct Accessories.

3.4 Field Quality Control

- .1 Tests:
 - .1 Tests to cover period of not less than 2 days and demonstrate that system is functioning as specified.

3.5 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.
- .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 Sections

.1	Section 01 11 55	General Instructions
.2	Section 01 35 33	Health and Safety Requirements
.3	Section 01 91 13	Commissioning
.4	Section 23 05 13	Common Motor Requirements for HVAC Equipment
.5	Section 23 05 48	Vibration & Seismic Controls for HVAC Piping & Equipment
.6	Section 23 08 00	Commissioning of Mechanical Systems
.7	Section 23 33 00	Air Duct Accessories
.8	Section 23 31 10	Cleaning of Mechanical Duct Systems

1.2 References

- .1 Air Movement and Control Association (AMCA)
 - .1 ANSI/AMCA 99-10, Standards Handbook.
 - .2 ANSI/AMCA 204-12: Balance Quality and Vibration Levels for Fans.
 - .3 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .4 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
 - .5 AMCA 301-90, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-1999, Ready-Mixed Organic Zinc-Rich Coating.

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, static pressure, BHP, HP, 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.
 - .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210.

1.4 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 11 55 – General Instructions. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data in accordance with Section 01 11 55 – General Instructions.
- .3 Provide:
 - .1 Fan performance curves showing point of operation, BHP and efficiency.
 - .2 Sound rating data at point of operation.
- .4 Indicate:
 - .1 Motors and sheaves details.
- .5 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
 - .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.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 11 55 – General Instructions.

1.5 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Waste Management and Disposal:
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 11 55 – General Instructions.

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 where specified.
 - .3 Sizes as specified.
- .2 Accessories and hardware: as specified.
- .3 Scroll casing drains: as indicated.
- .4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .5 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for Ductwork Piping and Equipment.
- .6 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 Centrifugal Fans

- .1 Fan wheels:
 - .1 welded steel construction.
 - .2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.
 - .3 Air foil or backward inclined blades, as indicated.
- .2 Bearings: heavy duty grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life (L50) of 200,000 hours.
- .3 Housings:
 - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, steel, 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 or latched airtight access doors with handles.
- .4 Provide belt driven sets with adjustable motor bed plate and variable pitch driver sheave.

2.3 Cabinet Fans – General Purpose

- .1 Fan characteristics and construction: as centrifugal fans.
- .2 Cabinet hung single wheel with centrifugal fan in factory fabricated, acoustically insulated casing complete with vibration isolators and seismic control measures, motor and other accessories as noted.
- .3 Fabricate casing of zinc coated or phosphate treated steel of 18 gauge 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.

2.4 In-Line Centrifugal Fans

- .1 Characteristics and construction: as for centrifugal fan wheels.
- .2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

2.5 Roof-Mounted Centrifugal Exhaust Fans

- .1 General: Spun aluminum, roof-mounted, centrifugal exhaust ventilator as scheduled:
- .2 Construction: Bolted and welded construction with corrosion resistant fasteners. Spun aluminum structural components, minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. Aluminum base with one piece inlet spinning, continuously welded curb cap corners. Discharge baffle and/or windband with rolled bead. Two piece top cap with stainless steel quick release latches. Integral conduit chase into motor compartment. Lifting lugs.
- .3 Wheel: centrifugal backward inclined, all aluminum construction, cast aluminum hub, aerodynamic aluminum inlet cone. Balanced in accordance with AMCA Standard 204.
- .4 Motor: heavy duty type with permanently lubricated sealed bearings.
- .5 Discharge: upblast or downblast as schedule.
- .6 Drive: direct or belt drive as scheduled.
- .7 Belt drive units shall have motor, bearings and drives mounted on a minimum 14 gauge steel power assembly, isolated from the unit structure with rubber vibration isolators. Enclosed in a weather-tight compartment, separated from the exhaust airstream.
 - .1 Bearings - Heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
 - .2 Drives - Precision machined, cast iron type, keyed and securely attached to the wheel and motor shafts. Sized for 150 percent of the installed motor horsepower.
- .8 Roof curb: pre-fabricated 18 gauge galvanized steel, insulated, continuously welded corners, wood nailer, minimum height to meet RCABC standard, damper tray.
- .9 Accessories: aluminum backdraft damper, disconnect switch.

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 Ductwork, 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 in Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment. Provide seismic bracing for suspended equipment as specified in Section 23 05 48.

3.4 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 Field Quality Control

- .1 Commissioning:
 - .1 In accordance with Section 01 91 13 – Commissioning, and Section 23 08 00 – Commissioning of Mechanical Systems.

END OF SECTION

PART 1 GENERAL

1.1 Related Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results – Mechanical
- .4 Section 23 31 10 Cleaning of Mechanical Duct Systems

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 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 11 55 – General Instructions. Include product characteristics, performance criteria, and limitations.
 - .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 11 55 – General Instructions.
 - .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.

1.4 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .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 11 55 – General Instructions.

1.6 Maintenance

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 01 50 – General Instructions.
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

PART 2 PRODUCTS

2.1 General

- .1 Size as indicated.
- .2 Capacity, pressure drop, terminal velocity, throw, noise level, neck velocity shall conform to intended performances of specified materials.
- .3 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board and as specified on architectural reflected ceiling plans.
 - .3 Concealed fasteners.
- .4 Where balancing damper is scheduled, damper shall be of opposed blade type.
- .5 Diffusers, grilles and registers in areas with high humidity shall be of aluminum construction.
- .6 Provide neck transition as required.

2.2 Manufactured Units

- .1 Grilles, registers and diffusers of same generic type, product of one manufacturer.

2.3 Supply Grilles and Registers

- .1 Supply grille, Type SG-1: fixed louvre, steel, 32 mm border, 19 mm o.c. blade spacing, double deflection, front blades parallel to long dimension. Finish: silver baked enamel.
- .2 Supply register, Type SR-1: fixed louvre, steel, 32 mm border, 19 mm o.c. blade spacing, double deflection, front blades parallel to long dimension. Provide opposed blade damper for volume control. Finish: silver baked enamel.

2.4 Return, Exhaust, and Transfer Grilles and Registers

- .1 Exhaust grille, Type EG-1: fixed louvre, aluminum, 32 mm border, 45 degree deflection, 19mm blade spacing, front blades parallel to long dimension. Finish: white baked enamel.
- .2 Return air transfer grille, Type RTG-1: egg crate, steel, 13 mm x 13 mm x 13 mm aluminum grid core, lay-in. Finish: white baked enamel.
- .3 Return air transfer grille, Type RTG-2: egg crate, steel, 13 mm x 13 mm x 13 mm aluminum grid core, surface mounted. Finish: white baked enamel.

2.5 Diffusers

- .1 Supply diffuser, Type SD-1: square cone diffuser, 3-cones, four-way throw, steel, having fixed pattern, round inlet collar, lay-in or with dry-wall ceiling frame. Finish: white baked enamel.

2.6 Undercut and Door Grilles

- .1 Type A: 20 mm undercut.
- .2 Type B: door grille, 508 mm x 305 mm, aluminum, 32 mm border, both sides, countersunk screw hole fastening, sight proof. Finish: silver baked enamel.
- .3 Type C: door grille, 508 mm x 406 mm, aluminum, 32 mm border, both sides, countersunk screw hole fastening, sight proof. Finish: silver baked enamel.
- .4 Type D: door grille with fire damper, 457 mm x 356 mm. Finish: silver baked enamel.

2.6 Security Grilles, Diffusers, and Products

- .1 Return air grille , Type RG-S1 / Exhaust air grille, Type EG-S1 / Transfer air grille, Type TG-S1 / Return air transfer grille, Type RTG-S1:

Minimum security lattice faceplate grille. 14 gauge hot rolled steel faceplate with 21mm x 21mm [13/16" x 13"x16"] square holes and 5mm [3/16"] frets. Faceplate to be attached with tamperproof screws in countersunk holes. For drywall ceiling installation, provide rear angle frame. For transfer air grille and return air transfer grille applications, provide rear plate with weld nuts. Provide tamperproof screws. Finish: white baked enamel.
- .2 Return air grille, Type RG-S2 / Exhaust air grille, Type EG-S2 / Supply air grille, Type SG-S2 / Transfer air grille, TG-S2 / Return air transfer grille, Type RTG-S2:

Medium security straight louvers grille. 14 gauge hot rolled steel faceplate. 3mm x 13mm [1/8" x 1/2"] cold rolled steel louvers on 13mm [1/2"] centre, 0° deflection through 14 gauge vertical support on 152mm [6"] centre. 10 gauge, 10mm [3/8"] wire mesh secured by angles behind core. 14 gauge hot rolled steel sleeve, stitch welded seams. 25mm x 25mm x 3mm [1" x 1" x 1/8"] hot rolled steel angle, 4-sided mounting frame shipped loose for field welding. Finish: white baked enamel.
- .3 Return air grille, Type RG-S3 / Exhaust air grille, Type EG-S3 / Supply air grille, Type SG-S2 / Transfer air grille, TG-S3 / Return air transfer grille, Type RTG-S3:

Maximum security grille with steel rod. 5mm [3/16"] hot rolled steel frame. 3mm x 38mm [1/8" x 1-1/2"] hot rolled steel bars on 6mm [1/4"] centre at 15° deflection with hardened steel rod mullion. 12 gauge hot rolled steel sleeve, stitch welded seams. 38mm x 38mm x 3/16mm [1-1/2" x 1-1/2" x 3/16"] hot rolled steel angle, 4-sided mounting frame shipped loose for field welding. Finish: white baked enamel.

- .4 Return air grille, Type RG-S4 / Exhaust air grille, Type EG-S4 / Supply air grille, Type SG-S4 / Transfer air grille, TG-S4 / Return air transfer grille, Type RTG-S4:

Maximum security risk resistant perforated grille. 5mm [3/16"] hot rolled steel faceplate with 5mm [3/16"] perforated staggered 60° on 7mm [9/32"] centre. 5mm [3/16"] hot rolled steel sleeve, stitch welded seams. 38mm x 38mm x 3/16mm [1-1/2" x 1-1/2" x 3/16"] hot rolled steel angle, 4-sided mounting frame shipped loose for field welding. Finish: white baked enamel.

- .5 Supply diffuser, Type SD-S1:

Minimum security lattice face diffuser. 12 gauge hot rolled steel faceplate with 21mm x 21mm [13/16" x 13"x16"] square holes and 5mm [3/16"] frets, countersunk holes. Inner core assembly consisting of fixed louvre face diffuser, four-way throw, steel, square inlet collar. Complete with rear angle frame with weldnuts and tamper-proof bolts. Finish: white baked enamel.

- .6 Supply diffuser, Type SD-S2:

Maximum security risk resistant diffuser. 12 gauge hot rolled steel construction faceplate. Fixed louvre blades spaced for 5/16" channel width at diffuser face, zigzag pattern, with a 35 degree discharge angle, 4-way throw (unless otherwise noted on plan). 12 gauge hot rolled steel sleeve, stitch welded seams. 25mm x 25mm x 5mm [1" x 1" x 3/16"] hot rolled steel angle, 4-sided mounting frame shipped loose for field welding. Finish: white baked enamel.

- .7 Security Bars, duct/barrier grille:

13mm [1/2"] hot rolled steel bars on maximum 152mm x 305mm [6" x 12"] centre. 5mm [3/16"] sleeve with two (2) 25mm x 25mm x 5mm [1" x 1" x 3/16"] 4-sided mounting frames (one frame welded, one frame shipped loose for field welding). Finish: white baked enamel.

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.
- .2 Install with flat head screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.
- .4 Paint matte black behind all diffusers, grilles and registers so that no metallic part will be visible from the exposed side.
- .5 Provide tamperproof screws for security grilles/diffusers located in inmate accessible areas. For grilles/diffusers supplied with sleeve and angle frame, stitch weld to metal duct. The use of flexible duct connection to security grilles/diffusers is not acceptable.
- .6 Stitch weld steel angles shipped loose with security grilles/diffusers.
- .7 Provide security joint sealant on all medium and maximum security grilles/diffusers.
- .8 Provide security bars at transfer air openings above ceiling in inmate accessible areas.

- .9 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms.

3.3 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 23 05 00 Common Work Results – Mechanical
- .4 Section 23 05 48 Vibration and Seismic Controls for Ductwork, Piping and Equipment
- .5 Section 23 31 10 Cleaning of Mechanical Duct Systems

1.2 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
- .3 Air Movement and Control Association (AMCA)

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.

1.4 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 01 50 – General Instructions. Include product characteristics, performance criteria, and limitations.
 - .1 Indicate following:
 - .1 Pressure drop.
 - .2 Face area
 - .3 Free area.
 - .4 Beginning point of water penetration.
 - .2 Quality assurance submittals: submit following in accordance with Section 01 11 55 – General Instructions.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .3 Test Reports:

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

1.5 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .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 11 55 – General Instructions.

PART 2 PRODUCTS

2.1 Gravity Roof Outside Air Intake and Relief Vents –Spun Aluminum Type

- .1 Factory manufactured spun aluminum, roof mounted gravity ventilator.
 - .1 Spun aluminum construction. Heavy gauge aluminum windband with rolled bead construction. Rigid galvanized steel internal components. Heavy-gauge aluminum curb cap with spun venture. Anti-condensate coating.
 - .2 The base shall have continuously welded curb cap corners.
 - .3 Birdscreen: 12mm [1/2"] galvanized mesh screen.
 - .4 Roof curb: galvanized steel construction, minimum 18 gauge. Complete with damper tray,
 - .5 Accessories: as scheduled or indicated.

2.2 Gravity Roof Outside Air Intake and Relief Vents –Hood Type

- .1 Factory manufactured aluminum hooded, roof mounted gravity ventilator.
 - .1 Bolted and welded construction utilizing corrosion resistant fastener. Minimum 18 gauge aluminum, bolted to minimum 8 gauge aluminum support structure. Complete with lifting lugs, rain gutter, anti-condensate coating.
 - .2 The base shall have continuously welded curb cap corners.
 - .3 Birdscreen: 12mm [1/2"] galvanized mesh screen.
 - .4 Roof curb: galvanized steel construction, minimum 18 gauge. Complete with damper tray,
 - .5 Accessories: as scheduled or indicated.

2.3 Louvres

- .1 Louvres shall have free areas as scheduled, be of extruded aluminum sections and have all welded assemblies. Fitted with removable aluminum 12mm (1/2") mesh, 16 gauge bird-screen on interior. Louvre flanges shall be suitable for type of construction encountered, caulked and weather-tight.

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 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking around to ensure weather tightness.

3.3 Anchor Bolts and Templates

- .1 Gravity Ventilator: Size anchor bolts to withstand seismic acceleration and velocity forces as specified in Section 23 05 48 – Vibration and Seismic Controls for Ductwork, Piping and Equipment.

3.4 Cleaning

- .1 Proceed in accordance with Section 01 11 55 – General Instructions, and Section 23 31 10 - Cleaning of Mechanical Duct Systems.
- .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 Sections

- .1 Section 01 11 55 General Instructions
- .2 Section 01 35 33 Health and Safety Requirements
- .3 Section 01 91 00 Commissioning (Cx) Plan
- .4 Section 23 08 00 Commissioning of Mechanical Systems

1.2 References

- .1 National Electrical Manufacturer's Association (NEMA)
- .2 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No.46-2013, Electric Air-Heaters.

1.3 Submittals

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 11 55 – General Instructions. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data in accordance with Section 01 11 55 – General Instructions.
- .3 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 11 55 – General Instructions.

1.4 Quality Assurance

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 33 - 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 11 55 – General Instructions.
 - .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 11 55 – General Instructions.

PART 2 PRODUCTS

2.1 Electric Duct Heater

- .1 Heater: open coil duct heater.
- .2 Capacity: as scheduled.
- .3 Clearance to combustible: CSA approved for zero clearance from combustible materials.
- .4 Duct connection: flanged casing or invert type as scheduled.
- .5 Frame: constructed of corrosion protected galvanized heavy gauge steel.
- .6 Provide automatic and manual reset thermal cut outs as required by CSA and pressure differential air flow proving device. Heaters shall have factory wired SCR controls for modulating control, "silent" contactors, disconnect switch, and 24 volt control transformer, modulating duct thermostat with remote adjuster. All factory wiring shall be brought to clearly identified terminals.
- .7 Division 26 (electrical) shall provide power to the coil disconnect switch. Control wiring between the room thermostat and the duct heater will be provided by Division 25.

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 Field Quality Control

- .1 Commissioning:
 - .1 In accordance with Section 01 91 00 – Commissioning, and Section 23 08 00 – Commissioning of Mechanical Systems.

END OF SECTION