

1.01 GENERAL

- .1 Refer to Division 01 for the requirement regarding Commissioning.

1.02 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 78 00 - Closeout Submittals

1.03 EQUIPMENT LIST

- .1 Complete list of equipment and materials to be used on this project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.
- .2 Submit for approval at time of tender within 48 hours within 10 days after award of contract.

1.04 ALTERNATES

- .1 The equipment listed on the project equipment schedules is the "basis of design equipment", the Contactor is permitted to find alternates to this equipment that meet the technical and quality requirements of the project specifications. If there are necessary changes to the building systems to accommodate these alternates, the changes must be coordinated and provided by the Contractor at no additional cost to the Contract.

1.05 TRIAL USAGE

- .1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
 - .1 Trial usage to apply to systems only after prior approval of Departmental Representative.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12mm plywood board. Affix typewritten label beneath sample indicating service.

1.06 PROTECTION OF OPENINGS

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .2 Seal all ductwork openings with 6 mil plastic to protect it from dirt, dust, and foreign materials during the course of the day's installation. Further ensure that at the end of the day, all open joints are closed off. Tape all plastic with duct tape. Cover and protect all un-installed ductwork before it is installed.
- .3 Protect all existing ductwork to be re-used, closing off openings with 6 mil plastic.

1.07 PAINTING

- .1 To Section 09 91 00 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.08 SPARE PARTS

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One (1) set of belts for each piece of machinery.
 - .2 Three (3) sets of filters for each filter bank.
 - .3 Keys for vandal resistant outlets.

1.09 SPECIAL TOOLS

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

1.10 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting and servicing of

all systems and equipment during regular work hours, prior to acceptance.

- .2 Where specified elsewhere in Divisions 22 and 23, manufacturers to provide demonstrations and instructions.
- .3 In addition to where training is specified elsewhere in other divisions, factory trained personnel to provide on-site instruction in operation and maintenance as follows:
 - .1 Ventilation Systems - minimum eight (8) hours.
 - .2 Heating Systems - minimum eight (8) hours.
 - .3 Plumbing Systems - minimum four (4) hours.
 - .4 Control System - minimum eight (8) hours.
- .4 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.

1.11 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and maintenance manual to be approved and final copies deposited with the Departmental Representative before final inspection.
- .3 Operation data to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for each system and each component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and troubleshooting instructions for each item of equipment and parts list.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.

- .5 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 95 - Testing, Adjusting and Balancing.
- 6 Approvals:
 - .1 Submit copies of draft Operation and Maintenance Manual to the Departmental Representative for approval. Submission of individual data will not be accepted unless so directed by the Departmental Representative.
 - .2 Make changes as required and resubmit two (2) copies as directed by the Departmental Representative.
- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.

1.12 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings and product data to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances. eg. access door swing spaces.
 - .3 Installation requirements and procedures.
- .3 Shop drawings and product data to be accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify as to current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures. Identify section and paragraph number.

1.13 CLEANING

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

1.14 PROJECT RECORD DRAWINGS

- .1 Site records:
 - .1 Departmental Representative will provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of the work. Mark there on all changes as work progresses and as changes occur. This includes changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection at all times.
- .2 Project Record drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: "Project Record drawings: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .3 Submit to Departmental Representative for approval and make corrections as directed.
 - .4 TAB to be performed using Project Record drawings.
 - .5 Submit completed reproducible Project Record drawings with Operating and Maintenance Manuals.
- .3 Submit copies of Project Record drawings for inclusion in final TAB report.

1.15 WASTE MANAGEMENT AND DISPOSAL

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

1.16 ELECTRICAL

- .1 Electrical Work to conform to Division 26 including the following:
 - .1 Starters, motor protection and manual control devices are specified and indicated in Division 26 except where otherwise indicated or specified. Wiring to packaged mechanical equipment is indicated on electrical drawings. Coordinate as required.
 - .2 Supplier and installer responsibility is indicated on electrical drawings and related mechanical responsibility as indicated on mechanical equipment schedules on mechanical drawings or in specifications.
 - .3 Control wiring 50 V and greater, specified and installed by Division 26. Control wiring 50 V or less, is responsibility of EMCS contractor, except as indicated elsewhere in the specifications.

1.17 EQUIPMENT SUPPORTS

- .1 Equipment supports supplied by equipment manufacturer specified elsewhere in Divisions 22 and 23.
- .2 Mount base mounted equipment on chamfered edge housekeeping pads, minimum of 150mm high and 100mm larger than equipment dimensions all around. Concrete specified in Section 03 30 00 - Cast-in-Place Concrete.

1.18 MANUFACTURER'S REVIEW

- .1 For all major pieces of equipment, it will be the responsibility of the Contractor to have the equipment supplier or his representative review all proposed connections, clearances, sizes, valves, breakers, etc. including wire and pipe sizes to his equipment before installation commences. At that time, inform the Departmental Representative of any changes required to make the equipment function satisfactorily.
- .2 Departmental Representative will provide the Contractor with a letter accepting all connections as proposed and where required, recommend necessary changes.
- .3 If any changes or additional material and labour are required to make the equipment function properly to capacity and the manufacturer has not pointed out this Work prior to commencement of Work, do the additional and/or corrective work at the expense of the equipment supplier.

1.19 WARRANTIES

- .1 Make good all defects other than normal wear and tear during the life of the warranty period specified in the General Conditions of the contract. Warrant all Work and install equipment to work quietly and satisfactorily and to accomplish the work for which it was installed during the life of the warranty. At any time during this period, make any necessary changes and adjustments, or replacements, to accomplish this at no additional cost to the Contract.
- .2 Submit warranties in maintenance manuals as specified in Section 01 33 00 and Section 01 78 00.

1.20 TESTS

- .1 Notice of Tests: Give written notice for a minimum of four (4) working days prior to the date when tests will be made.
- .2 Prior Tests: Concealed or insulated work must remain uncovered until completely tested and approved, but if construction schedule requires, arrange for prior tests on parts of system as approved.
- .3 Acceptance Tests: Conduct in presence of the Departmental Representative or representative of the authorities having jurisdiction.
- .4 Costs: Bear all costs in connection with tests conducted.
- .5 Certificates: Obtain acceptance certificates from the authorities having jurisdiction. Work is not considered complete until certificates have been delivered to the Departmental Representative.
- .6 Water Systems: Fill with water and hydraulically test at 1 ½ times system operating pressure or at 125 psig, whichever is greatest. Unless otherwise noted, maintain test pressures without loss for a four (4) hour period. Use valves to isolate equipment not rated for these pressures.
- .7 Test plumbing sanitary sewer, storm sewer and vent piping as required by National Building Code, Canadian Plumbing Code and Municipal Regulations.
- .8 Rest sanitary, storm and vent piping by sealing outlets and filling the system to the highest point with water. The water level must remain constant for a minimum of two (2) hours.

.9 Hammer test all welded joints.

END OF SECTION

1 GENERAL

1.01 REFERENCES

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

2 PRODUCTS Not applicable.

3 EXECUTION

3.01 CONNECTIONS TO EQUIPMENT

- .1 Make connections in accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .4 Maintain all minimum clearances required by the Canadian Electrical Code.
- .5 Minimum 750mm in front of VAV terminal units.
- .6 Maintain equipment and valves a maximum of 900mm above ceilings.

3.02 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, components.

3.03 DRAINS

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

- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.
- .4 Drain valves: NPS 3/4 ball valves unless indicated otherwise, with hose end male thread, cap and chain.

3.04 AIR VENTS

- .1 Install manual air vents at high points in piping systems in areas within accessible mechanical spaces.
- .2 Install automatic air vent with isolating valve at each high point in finished areas.
- .3 Install drain piping on manual air vents to floor drain and terminate where discharge is visible.

3.05 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape or pipe dope as recommended by manufacturer.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal

insulation of each pipe.

- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless otherwise indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball or butterfly valves at branch takeoffs for isolating purposes except where otherwise specified.
 - .7 Install butterfly valves on chilled water and related condenser water systems only.
 - .8 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .9 Install plug cocks or ball valves for glycol service.
 - .10 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .15 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.
- .16 Install pipe straight and parallel to building lines.

3.06 SLEEVES

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, dry-wall partitions and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe (sheet metal acceptable for non-rated dry wall partitions).

- .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 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
 - .4 All mechanical room walls and wet areas above ground slab.
- .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 Allow for no contact between copper pipe or tube and sleeve.

3.07 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, sills, floors, and ceilings in finished areas.
- .2 Construction: One piece type with set screws. Chrome or nickel plated brass or type 302 stainless steel.
- .3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.08 PREPARATION FOR FIRESTOPPING

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Fire Stopping.
- .2 Un-insulated unheated pipes not subject to movement: No special preparation.

- .3 Un-insulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.09 FLUSHING OUT OF PIPING SYSTEMS

- .1 Before start-up, clean interior of piping systems supplemented as specified in relevant sections of Division 22 and 23.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.10 PRESSURE TESTING OF EQUIPMENT

- .1 Advise the Departmental Representative 72 hours minimum prior to performance of pressure tests.
- .2 Pipework: pressure test piping at either the main pressure, or 1.5 times the normal operating pressure, whichever is greater. Also refer to testing requirements specified in relevant sections of Divisions 22 and 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Divisions 22 and 23.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Submit tests results to the Departmental Representative. Work to be carried out in off hours after 5 p.m., weekends or holidays.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after review of tests by the Departmental Representative.

3.11 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by the Departmental Representative. Work to be carried out off hours after 5 p.m., weekends or holidays.
- .2 Request written approval ten (10) days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Conduct daily clean-up of existing areas.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Cast-in-Place Concrete: Section 03 30 00
- .3 Structural Steel: Section 05 12 23

1.02 REFERENCES

- .1 American National Standards Institute/ American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2016, Power Piping, (SI Edition).
 - .2 ANSI/ASME B31.3-2016, Process Piping.
 - .3 ANSI/ASME B31.5-2016, Refrigeration Piping and Heat Transfer Components.
 - .4 ANSI/ASME B31.9-2014, Building Services Piping.
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A125-96(R2013), Specification for Steel Springs, Helical, Heat Treated.
 - .2 ASTM A307-2014, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-15, Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2009, Pipe Hangers and Supports Materials, Design and Manufacture.
- .5 Underwriter's Laboratories of Canada (ULC).

1.03 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, B31.3, B31.5, B31.9 or MSS SP58.
- .3 Do not allow that supports, guides or anchors to 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.

1.04 PERFORMANCE REQUIREMENTS

- .1 Design supports, platforms, catwalks, hangers to withstand seismic events for location as per the National Building Code.

1.05 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Submit shop drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.

1.06 CLOSEOUT SUBMITTALS

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

2 PRODUCTS

2.01 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.

2.02 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized painted with zinc rich paint after manufacture.
 - .2 Use electroplating galvanizing process or hot dipped

- galvanizing process.
- .3 Confirm steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 Upper attachment structural: Suspension from lower flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed, 13 mm FM approved.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed, FM approved where required to MSS SP58.
 - .3 Upper attachment structural: Suspension from upper flange of I-Beam.
 - .1 Cold piping NPS 2 maximum: Ductile iron top of beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved where required to MSS SP58.
 - .2 Cold piping NPS 2 1/2 or greater, all hot piping: Malleable iron top of beam jaw clamp with hooked rod, spring washer, plain washer and nut UL listed, FM approved where required.
 - .4 Upper attachment to concrete:
 - .1 Ceiling: Carbon steel welded eye rod, clevis plate, clevis pin and cotters with weld-less forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved where required to MSS SP58.
 - .5 Shop and field fabricated assemblies:
 - .1 Trapeze hanger assemblies: MSS SP58.
 - .2 Steel brackets: MSS SP58.
 - .3 Sway braces for seismic restraint systems: to MSS SP58.
 - .6 Hanger rods: threaded rod material to MSS SP58.
 - .1 Only subject hanger rods to tensile loading.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Do not use 22 mm or 28 mm rod.

- .7 Pipe attachments: material to MSS SP58.
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation saddles for hot pipework.
 - .4 Oversize pipe hangers and supports for insulated pipes.
- .8 Adjustable clevis: material to MSS SP58, UL listed FM approved, where required clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for riveting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP58.
- .10 U-bolts: carbon steel to MSS SP58 with two (2) nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black with formed portion plastic coated or epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP58.

2.03 RISER CLAMPS

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

2.04 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP58, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded

in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP58.

2.05 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with \pm spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
 - .1 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .2 Provide upper and lower factory set travel stops.
- .3 Provide load adjustment scale for field adjustments.
- .4 Total travel to be actual travel \pm 20%. Difference between total travel and actual travel 25 mm minimum.
- .5 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.06 VARIABLE SUPPORT SPRING HANGERS

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

2.07 EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05121. Submit calculations with shop drawings.

2.08 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.09 HOUSEKEEPING PADS

- .1 For base mounted equipment: Concrete, at least 100 mm high, 50 mm larger all around than equipment, and with chamfered edges.
- .2 Concrete: to Section 03 30 00.

2.10 OTHER EQUIPMENT SUPPORTS

- .1 From structural grade steel.
- .2 Submit structural calculations with shop drawings.

3 EXECUTION

3.01 INSTALLATION

- .1 Install in accordance with manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and elsewhere as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt tightening torques to be to industry standards.
 - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: Install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with four (4) minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:

- .1 Vertical movement of pipework is 13 mm or more.
- .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.02 HANGER SPACING

- .1 Plumbing piping: most stringent requirements of Canadian Plumbing Code
- .2 Fire protection: to the Canadian Fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Hydronic, steam, condensate, rigid, and flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

Maximum Pipe Size Copper Size: NPS	NPS Maximum Spacing:	Steel Maximum Spacing:
up to 1-1/4	2.2 m	1.8 m
1-1/2	2.1 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.1 m	3.0 m
3	3.1 m	3.0 m
3-1/2	3.1 m	3.3 m
4	4.1 m	3.6 m
5	4.1 m	
6	5.1 m	
8	5.1 m	
10	6.6 m	
12	6.9 m	

- .6 Within 300 mm of each elbow.
- .7 Pipework greater than NPS 12: to MSS SP58.

3.03 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. Comprised of angel iron or c-channel.

3.04 HORIZONTAL MOVEMENT

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

3.05 FINAL ADJUSTMENT

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

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Painting: Section 09 91 00

1.02 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA B149.1-2015, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB24.3-92, Identification of Piping Systems.
- .3 National Fire Protection Association
 - .1 NFPA 13-2013, Installation of Sprinkler Systems.
 - .2 NFPA 14-2013, Standpipe and Hose Systems.
- .4 CSA Z7396.1-2012, Medical Gas Piping Systems.

1.03 PRODUCT DATA

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

1.04 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00.
- .2 Samples to include nameplates, labels, tags, lists of proposed legends.

2 PRODUCTS

2.01 MANUFACTURER'S EQUIPMENT NAMEPLATES

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers to be 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.

2.02 SYSTEM NAMEPLATES

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

.3 Sizes:

- .1 Conform to following table:

#	mm	Lines	Letters(mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

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

.4 Locations:

- .1 Terminal cabinets, control panels: Use size # 5.
- .2 Equipment in Mechanical Rooms: Use size # 9.
- .3 Use maximum of 25 letters/numbers per line.

2.03 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting Work, obtain written approval of identification system from Departmental Representative.

2.04 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Propane gas: to CSA/CGA B149.1 authority having jurisdiction.
 - .2 Sprinklers: to NFPA 13.
 - .3 Standpipe and hose systems: to NFPA 14.

2.05 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, to 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 All other pipes: Pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100%RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows, to following

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

.3 Background colour marking and legends for piping systems:

<u>Contents</u>	<u>Background colour</u>	<u>Legend</u>
** Add design temperature		
++ Add design temperature and pressured		
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS

2.06 DUCTWORK IDENTIFICATION

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Black, or coordinated with base colour to ensure strong contrast.
- .3 Identify system : e.g. Supply AHU1, Exhaust F7.

2.07 VALVES, CONTROLLERS

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

2.08 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this Section. If no EMCS included in project, identification as per this section.
- .2 Inscriptions to include function and (where appropriate)

failsafe position, component ID name.

2.09 LANGUAGE

- .1 Identification to be in English.
- .2 Use one nameplate, label, etc. for each language.

3 EXECUTION

3.01 TIMING

- .1 Provide identification only after all painting specified in Section 09 91 00 - Painting, has been completed.

3.02 INSTALLATION

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

3.03 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 in any way.

3.04 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, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification to be 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.

3.05 VALVES, CONTROLLERS

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

END OF SECTION

1 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this Section.
- .3 TAB agency will be present to assist the commissioning authority during the commissioning of HVAC systems. TAB agency will be responsible for measuring entering and leaving air temperature at all coils to calibrate EMCS and for setting the DHW balancing valves.

2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel certified to AABC or NEBB to perform TAB to the Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience. TAB contractor shall have a minimum of five (5) years' experience to AABC, NEBB or SMACNA.
- .3 Perform TAB 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.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
- .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 the 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 SMACNA), requirements and recommendations contained in these procedures and requirements are mandatory.

3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
- .2 Adjust and regulate equipment and systems 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 equipment to regulate flow rates to match load requirements over full operating ranges.

4 EXCEPTIONS

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

5 CO-ORDINATION

- .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.

6 PRE-TAB REVIEW

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

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 other Divisions.

8 OPERATION OF SYSTEMS DURING TAB

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

9 START OF TAB

- .1 Notify the Departmental Representative seven (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 Pressure, leakage, other tests specified elsewhere in other Divisions.
 - .4 Provisions for TAB installed and operational.

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

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%.

11 ACCURACY TOLERANCES

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

12 INSTRUMENTS

- .1 Prior to TAB, submit to the 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 three (3) months of TAB. Provide certificate of calibration to the Departmental Representative.

13 SUBMITTALS

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

14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of the 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.

15 TAB REPORT

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit three (3) copies of TAB Report to the Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs. Submit electronic copy that includes the same information.

16 VERIFICATION

- .1 Reported results subject to verification by the 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 the Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of the Departmental Representative.

17 SETTINGS

- .1 After TAB is completed to satisfaction of the 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.

18 COMPLETION OF TAB

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

19 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC or NEBB.
- .2 Do TAB of systems, equipment, components, controls specified in other Divisions.
- .3 Qualifications: personnel performing TAB to be qualified to standards of AABC or NEBB.
- .4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC or NEBB.
- .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration, amperage and volts for each stage of electrical heating coils.
- .6 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.
- .7 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).

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 23 05 29 - Bases, Hangers and Supports.
- .3 Section 23 05 53 - Mechanical Identification.

1.02 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B209M-2014, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-2010e1, Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C449-07(R2013), Standard Specification for Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C553-2013, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .5 ASTM C612-2014, Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .6 ASTM C921-10(2015), Standard Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51GP52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .3 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-2010, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S701-2011, Thermal Insulation Polystyrene, Boards and Pipe Covering.

1.03 DEFINITIONS

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

1.04 SHOP DRAWINGS

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

1.05 SAMPLES

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

1.06 MANUFACTURERS' INSTRUCTIONS

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

1.07 QUALIFICATIONS

- .1 Installer: specialist in performing work of this section and qualified to standards of TIAC.

1.08 DELIVERY, STORAGE AND HANDLING

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

2 PRODUCTS

2.01 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULCS102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.02 INSULATION

- .1 Mineral fiber: as specified includes glass fiber, 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 C1: Rigid mineral fiber board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51GP52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C2: Mineral fiber blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51GP52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fiber: to ASTM C553.
 - .2 Jacket: to CGSB 51GP52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.03 JACKETS

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

- .2 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.40 mm sheet.
 - .3 Finish: Stucco embossed or corrugated.
 - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

- .3 Stainless steel:
 - .1 Type: 304 or 316 where additional corrosion protection is required.
 - .2 Thickness: 0.25 mm sheet.
 - .3 Finish: Corrugated or stucco embossed.
 - .4 Jacket banding and mechanical seals: 12mm wide, 0.5 mm thick stainless steel.

- .4 Self-adhesive weather barrier membrane:
 - .1 Flexible SBS modified membrane impermeable to air, moisture vapour and water. UV light resistant, flame free adhesion.

2.04 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.

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

- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921. 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, 75 mm wide minimum.

- .6 Contact adhesive: quick-setting.

- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .10 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .11 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation.

3 EXECUTION

3.01 PRE-INSTALLATION REQUIREMENTS

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

3.02 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and as indicated.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers in accordance with Section 23 05 29 Bases, Hangers and Supports.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

3.03 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: Conform to following Table:

	<u>TIAC Code</u>	<u>Vapour Retarder</u>	<u>Thickness (mm)</u>
Rectangular cold and dual temperature supply air ducts (exposed)	C1	Yes	50
Round cold and dual temperature supply air ducts (concealed)	C2	Yes	50
Rectangular warm air ducts (exposed)	C1	No	25
Round warm air ducts (exposed)	C1	No	25
Rectangular cold and dual temperature supply air ducts (concealed)	C2	Yes	25
Round cold and dual temperature supply air ducts (exposed)	C1	Yes	50
Rectangular warm air ducts (concealed)	C2	No	25
Round warm air ducts (concealed)	C2	No	25
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing Plenum	C1	Yes	50
Intake and exhaust plenums	C1	Yes	50
Exhaust duct between dampers and louvers	C1	No	50
Rectangular ducts outside	C1	special	75
Round ducts outside	C1	special	75

- .2 Jackets: Exposed round ducts 600mm and larger, smaller sizes where subject to abuse:
 - .1 Use TIAC code C1 insulation, scored to suit diameter of duct.
 - .2 Finishes: Conform to following table:

	TIAC Code	
	<u>Rectangular</u>	<u>Round</u>
Indoor, concealed	None	None
Indoor, exposed within mechanical room	CRF/ Canvas	CRD/ Canvas
Indoor, exposed elsewhere	CRF/ Aluminum CRF/Self	CRD/ Aluminum CRD/Self
Outdoor, exposed	adhesive weather barrier membrane	adhesive weather barrier membrane

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Joint Sealants: Section 07 92 00
- .3 Mechanical Identification: Section 23 05 53

1.02 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM B209M-2014, Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335-10e1, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation
 - .3 ASTM C449/C449M-07(R2013), Standard Specification for Mineral Fibre Hydraulic Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C533-2013, Standard specification for Calcium Silicate Insulation Block and Pipe.
 - .5 ASTM C534-2016, Standard Specification for Preformed Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - .6 ASTM C547-2015, Standard Specification for Mineral Fibre Pipe Insulation.
 - .7 ASTM C921-10(R2015), Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 51GP52Ma-1989, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .3 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S701-11 Thermal Insulation, Polystyrene,

- Boards and Pipe Covering.
- .3 CAN/ULC S702-09, Thermal Insulation, Mineral Fiber, for Buildings

1.03 DEFINITIONS

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

1.04 SHOP DRAWINGS

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

1.05 SAMPLES

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

1.06 MANUFACTURER'S INSTRUCTIONS

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

1.07 QUALIFICATIONS

- .1 Installer to be specialist in performing work of this Section and qualified to standards of TIAC.

1.08 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic.

- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

2 PRODUCTS

2.01 FIRE AND SMOKE RATING

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

2.02 INSULATION

- .1 Mineral fiber specified includes glass fiber, 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 A2: Rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: to ASTM C533.
 - .2 Maximum "k" factor: to 0.075 W/m°C @ 500°C.
 - .3 Design to permit periodic removal and reinstallation.
- .4 TIAC Code A3: Rigid moulded mineral fiber with factory applied vapour retarder jacket.
 - .1 Mineral fiber: to CAN/ULCS702 and ASTM C547.
 - .2 Jacket: to CGSB 51GP52Ma.
 - .3 Maximum "k" factor: to CAN/ULCS702.
- .5 TIAC Code A6: Flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket to ASTM C534.
 - .2 Jacket: to CGSB 51GP52Ma.
 - .3 Maximum "k" factor: 0.039 W/m - °C.
 - .4 To be certified by manufacturer to be free of potential stress corrosion cracking corrodants
 - .5 Flame spread index less than 25, and smoke developed index less than 50.
- .6 TIAC Code C2: Mineral fiber blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fiber: to CAN/ULCS702.

- .2 Jacket: to CGSB 51GP52Ma.
- .3 Maximum "k" factor: to CAN/ULCS702.

2.03 INSULATION SECRETMENT

- .1 Tape: Self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

2.04 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or air drying on mineral wool, to ASTM C449/C449M.

2.05 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.
- .2 For Type A6 insulation to manufacturer's recommendation.

2.06 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 For Type A6 insulation to manufacturer's recommendation.

2.07 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 For Type A6 insulation to manufacturer's recommendation.
- .3 Reinforcing fabric: Fibrous glass, untreated 305 g/m2.

2.08 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One piece moulded type and sheet to CAN/CGSB51.53 with preformed shapes as required.
 - .2 Colours: to Section 23 05 53.
 - .3 Minimum service temperatures: 20 degrees C.

- .4 Maximum service temperature: 65 degrees C.
- .5 Moisture vapour transmission: 0.02 perm.
- .6 Thickness: 1.0 mm.
- .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .8 Special requirements:
 - .1 Indoor: flame spread rating 25, smoke developed rating 50.
 - .2 Outdoor: UV rated material at least 1.0 mm thick.
- .2 Canvas:
 - .1 220gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: Compatible with insulation.
 - .3 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.40 mm sheet.
 - .3 Finish: Stucco embossed or corrugated.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die shaped fitting covers with factory attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
 - .4 Stainless steel:
 - .1 Type: 304 or type 316 where additional corrosion protection is required.
 - .2 Thickness: 0.25 mm.
 - .3 Finish: Smooth corrugated or stucco embossed.
 - .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die shaped fitting covers with factory attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.09 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

- .1 Caulking: to Section 07 92 00 - Joint Sealants.

3 EXECUTION

3.01 PRE-INSTALLATION REQUIREMENT

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

3.02 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two (2) layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.03 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: Aluminum, SS, PVC high temperature fabric.

3.04 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.

3.05 PIPING INSTALLATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A2.
 - .1 Insulation securements: 18 ga SS wire or 12 mm x 0.51 mm SS bands at 300 mm oc.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501H.
- .3 TIAC Code: A3.
 - .1 Securements: Tape at 300 mm oc.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501C.
- .4 TIAC Code: A6.
 - .1 Insulation securements: as per manufacturer's recommendation.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501CA.
- .5 TIAC Code: C2 with vapour retarder jacket.
 - .1 Insulation securements: 18 ga SS wire or 12 mm x 05 mm ss bands at 300 mm oc.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501C.
- .6 Have thickness of insulation listed in the following table:
 - .1 Runouts to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application thickness(mm)	Temp °C	TIAC code	Pipe sizes (NPS) and insulation					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8&over
Roof Drain Body		C2	25	25	25	25	25	25
Domestic HWS		A-3	25	25	25	38	38	38
Domestic CWS		A-3	25	25	25	25	25	25
Refrigerant Hot Gas, Liquid, Suction	4-13	A-6	25	25	25	25	25	25
Refrigerant Hot Gas, Liquid, Suction	below 4	A-6	25	25	25	25	25	25
Cooling Coil cond. Drain		A-3	25	25	25	25	25	25
HWS and HWR		A-3	25	25	25	25	25	25

.7 Finishes:

- .1 Exposed indoors: PVC jacket.
- .2 Exposed in mechanical rooms: PVC jacket.
- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Use vapour retarder jacket on TIAC code A3 insulation compatible with insulation.
- .5 Outdoors: Waterproof Aluminum or SS jacket.
- .6 Finish attachments: SS screws or bands, at 150 mm oc. Seals: wing or closed.
- .7 Installation: To appropriate TIAC code CPF/1 through CPF/5.

END OF SECTION

1 GENERAL

1.01 REFERENCES

- .1 American Society for Testing and Materials
 - .1 ASTM E202-2012, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

2 PRODUCTS

2.01 CLEANING SOLUTIONS

- .1 Low foaming detergent at all temperatures.
- .2 No pH neutralization required.
- .3 Designed for use on most metals including aluminium.
- .4 Biodegradable.
- .5 Phosphate Free.
- .6 Nitrite Free.

3 EXECUTION Not applicable.

END OF SECTION

1 GENERAL

1.01 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-2016, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-2013, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-2013, Refrigeration Piping and Heat Transfer Components.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A 307-2014, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B 280-2016, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B52-2013, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.02 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Submit WHMIS MSDS in accordance with Section 01 33 00. Indicate VOC's for adhesive and solvents during

application and curing.

- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.03 DELIVERY, STORAGE AND HANDLING

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

2 PRODUCTS

2.01 TUBING

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

2.02 FITTINGS

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, 15% Ag-80% Cu-5%P or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.03 PIPE SLEEVES

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

2.04 VALVES

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

3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

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

3.02 GENERAL

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

3.03 BRAZING PROCEDURES

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

3.04 PIPING INSTALLATION

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

3.05 PRESSURE AND LEAK TESTING

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

3.06 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:

- .2 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 h.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 h.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to the Departmental Representative.
- .7 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements to the Departmental Representative.

3.07 CLEANING

- .1 Perform cleaning operations in accordance with manufacturer's recommendations.

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

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

1.02 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A480/A480M-16a, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-15, Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Carbon, Hot Rolled.
 - .3 ASTM A653/A653M-15E1, Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .2 National Fire Protection Agency (NFPA)
 - .1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2015, Installation of Warm Air Heating and Air Conditioning Systems.
 - .3 NFPA 91-2015, Standard for Exhaust System for Air Conveying of Vapours, Gases, Mists, and Noncombustible Particle Solids.
 - .4 NFPA 96-2014, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
 - .2 SMACNA HVAC Duct Leakage Test Manual.

1.03 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate following:
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary Joints.

1.04 CERTIFICATE OF RATINGS

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

1.05 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with municipal regulations and Section 01 74 21.

2 PRODUCTS

2.01 SEAL CLASSIFICATION

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

2.02 SEALANT

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

2.03 TAPE

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

2.04 DUCT LEAKAGE

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

2.05 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows:
 - .1 Rectangular: Centreline radius: 1.5 times width of

- duct.
- .2 Round: smooth radius or five piece. Centreline radius:
1.5 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.5
times width of duct or 450 entry on branch.
 - .2 Round main and branch: enter main duct at 450 with
conical connection.
 - .3 Provide volume control damper in branch duct near
connection to main duct.
 - .4 Main duct branches: with volume control damper.
- .5 Transitions:
 - .1 Diverging: 200 maximum included angle.
 - .2 Converging: 300 maximum included angle.
- .6 Offsets:
 - .1 Full short radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full crosssectional area.
Maximum included angles: as for transitions.

2.06 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire
separation only if required by authority having
jurisdiction.
- .2 Firestopping material and installation must not distort
duct.

2.07 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653, G90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA or proprietary manufactured duct joint.
Proprietary manufactured flanged duct joint to be
considered to be a class A seal.

2.08 STAINLESS STEEL

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: No 4. finish on exposed side of duct in finished area's, No. 3 finish or lower where concealed.
- .3 Thickness, fabrication and reinforcement: to SMACNA.
- .4 Joints: to SMACNA and be continuous inert gas welded.

2.09 ALUMINUM

- .1 To SMACNA. Aluminum type: 3003H14.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA and be continuous weld.

2.10 BLACK STEEL

- .1 To ASTM A635/A635M.
- .2 Thickness: 1.2 mm
- .3 Fabrication: ducts and fittings or SMACNA.
- .4 Reinforcement: to SMACNA.
- .5 Joints: continuous weld.

2.11 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: 500 mm.
- .2 Hanger configuration: to SMACNA.
- .3 Hangers: galvanized steel angle with black steel rods to ASHRAE or SMACNA following table:

Duct Size	Angle Size	Rod Size
(mm)	(mm)	(mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10

2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.
 - .1 Acceptable manufacturers Myatt, Grinnell, Hunt.
 - .2 For steel joist: manufactured joist clamp steel plate washer.
 - .1 Acceptable manufacturers Myatt, Grinnell, Hunt.
 - .3 For steel beams: manufactured beam clamps:
 - .1 Acceptable manufacturers Myatt, Grinnell, Hunt.

3 EXECUTION

3.01 GENERAL

- .1 Do work in accordance with NFPA 90A, NFPA 90B, and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with SMACNA.
- .4 Install breakaway joints in ductwork on sides of fire separation. Do not place fire stopping material in expansion space between damper sleeve and fire partition.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.02 HANGERS

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

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

3.03 WATERTIGHT DUCT

- .1 Provide watertight duct for:
 - .1 Fresh air intake.
 - .2 Minimum 3000 mm from duct mounted humidifier in all directions.
 - .3 As indicated.
- .2 Form bottom of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards fume hoods served. Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and NPS 1 ½ drain connected, with deep seal trap and valve and discharging to open funnel drain or service sink or as approved by Departmental Representative.

3.04 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. Sealant and tape to be applied to full perimeter of duct.

3.05 LEAKAGE TESTS

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Install no additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degree elbows.
- .6 Complete test before insulation or concealment.

END OF SECTION

1 GENERAL

1.01 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A653/A653M-2015E1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C423-09a, Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM E90-09, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .4 ASTM E477-2013, Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- .3 National Building Code of Canada (NBC), 2010.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.02 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide separate shop drawings for each piece of attenuation equipment complete with product data.

1.03 PERFORMANCE RATING DATA

- .1 Provide performance rating data, certified by a professional engineer or accredited test laboratory and supported by calculations and verified by test results in accordance with referenced standards as follows:
 - .1 Silencer: insertion loss, pressure drop at design conditions, generated noise level.
 - .2 Acoustic plenums: transmission loss and acoustical absorption.

- .3 Acoustical performance measurements to be made in accordance with ASTM E477, ASTM E90 and ASTM C423, except where specified otherwise.

2 PRODUCTS

2.01 ABSORPTION AND INSULATING MEDIA

- .1 Acoustic quality, glass fiber, free of shot and odour; bacteria and fungus resistant; free of corrosion causing or accelerating agents; packed to density to meet performance requirements; and meet NBC fire requirements or requirements of authority having jurisdiction for duct lining.

3 EXECUTION

3.01 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Noise flanking: where indicated, install in wall sleeve with uniform clearance around to ensure no contact of silencer with wall sleeve. Pack with flexible, non-hardening caulking on both sides of sleeves.
- .3 Instrument test ports: install at inlet and outlet to permit measurement of insertion loss and pressure loss.
- .4 Suspension: to manufacturer's instructions.

3.02 SITE VISIT

- .1 Arrange for the supplier of equipment to visit site to confirm installation is in accordance with manufacturer's instructions and submit report to the Departmental Representative.
- .2 Make adjustments and corrections in accordance with written report.
- .3 Provide Departmental Representative with notice 24 h in advance of visit.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

1.02 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards Metal and Flexible.

1.03 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.04 CERTIFICATION OF RATINGS

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

2 PRODUCTS

2.01 GENERAL

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

2.02 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at minus 400C to plus 900 degrees C, density of 1.3 kg/m2.

2.03 ACCESS DOORS IN DUCTS

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

2.04 TURNING VANES

- .1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.05 INSTRUMENT TEST PORTS

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

2.06 SPIN-IN COLLARS

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

standards.

3 EXECUTION

3.01 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Allow for slack material in flexible connection.
- .2 Access doors and viewing panels:
 - .1 Size:
 - .1 600 mm x 600 mm for person size entry.
 - .2 450 mm x 450 mm for servicing entry.
 - .3 300 mm x 300 mm for viewing.
 - .4 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument test ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations.
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.

- .3 Main and submain ducts.
- .4 And as indicated.

- .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Department Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.

- .4 Turning vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00

1.02 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

1.03 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following: dimensions, materials.

2 PRODUCTS

2.01 GENERAL

- .1 Manufacture to SMACNA standards.

2.02 SINGLE BLADE DAMPERS

- .1 Of same material as duct, 0.8 mm up to 450 mm wide, 1.6 mm maximum up to 1200 mm wide, V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon or bronze end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.03 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and

construction to recommendations of SMACNA.

- .3 Maximum blade height: 100 mm.
- .4 Bearings: pin in bronze bushings or self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage: 2 % at 500 Pa.

3 EXECUTION

3.01 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- .4 Runouts to registers and diffusers: located as close as possible to main ducts.
- .5 All dampers must be vibration free.
- .6 Confirm damper operators are observable and accessible.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00
- .3 Duct Accessories: Section 23 33 00

1.02 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A653M-15E1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.03 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Performance data.
 - .2 Specifications.

1.04 CLOSEOUT SUBMITTALS

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

1.05 CERTIFICATION OF RATINGS

- .1 Catalogue or published ratings must be those obtained from tests carried out by manufacturer or those from an independent testing agency.

2 PRODUCTS

2.01 MULTI-LEAF DAMPERS

- .1 Opposed or parallel blade type as indicated.
- .2 Structurally formed steel or extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, structurally formed and welded galvanized steel or extruded aluminum frame.

- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .5 Performance:
 - .1 Leakage: in closed position to be less than 2% of rated air flow at 500 Pa differential across damper.
 - .2 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.
- .6 Insulated aluminum dampers:
 - .1 Frames: insulated with extruded polystyrene foam with RSI factor of 5.0.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI factor of 5.0.

2.02 DISC TYPE DAMPERS

- .1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A 653M.
- .2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A 653M.
- .3 Gasket: extruded neoprene, field replaceable, with ten (10) year warranty.
- .4 Bearings: roller self-lubricated and sealed.
- .5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc aluminum foundry alloy casting cam follower.
- .6 Performance:
 - .1 Leakage: in closed position to be less than 2 % of rated air flow at 500 Pa pressure differential across damper.
 - .2 Pressure drop: at full open position to be less than 25 Pa differential across damper at 10 m/s.

2.03 BACK DRAFT DAMPERS

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

2.04 RELIEF DAMPERS

- .1 Automatic multi-leaf steel or aluminum dampers with ball bearing center pivoted and Counterweights set to open as indicated.

3 EXECUTION

3.01 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00.
- .5 Confirm dampers are observable and accessible.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00
- .3 Duct Accessories: Section 23 33 00

1.02 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 ANSI/NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S112-10, Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC S112.2-07, Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC S505-1974, Fusible Links for Fire Protection Service.

1.03 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Smoke dampers.
 - .3 Fire stop flaps.
 - .4 Operators.
 - .5 Fusible links.
 - .6 Design details of breakaway joints.

1.04 CLOSEOUT SUBMITTALS

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

1.05 EXTRA MATERIALS

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

- .2 Provide following:
 - .1 Six (6) fusible links of each type.

1.06 CERTIFICATE OF RATINGS

- .1 Catalogue or published ratings must be those obtained from tests carried out by manufacturer or those ordered by them from an independent testing agency signifying adherence to codes and standards.

2 PRODUCTS

2.01 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B or C, blades out of air stream listed and bear label of ULC, meet requirements of provincial fire authority and ANSI/NFPA 90A. Fire damper assemblies to be fire tested in accordance with CAN/ULC S112. Minimum rating 1 ½ hours, dynamically rated.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .3 Top hinged: offset, round or square; multi-blade hinged or interlocking type; roll door type; or guillotine type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator spring closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 Retaining angle iron frame, 40 mm x 40 mm x 3 mm, on full perimeter of fire damper, on both sides of fire separation being pierced.

2.02 SMOKE DAMPERS

- .1 ULC or UL listed and labelled.
- .2 Normally closed reverse action smoke vent (S/DRASV): folding blade type, opening by gravity upon detection of smoke, and/or from remote alarm signalling device actuated by an electro thermal link. Two flexible stainless steel blade edge seals to provide required constant sealing pressure.

- .3 Normally open smoke/seal (S/DSSSD): folding blade type, closing when actuated by means of electro thermal link and/or from remote alarm signalling device. Blade edge seals of flexible stainless steel shall provide required constant sealing pressure. Stainless steel negator springs with locking devices shall ensure positive closure for units mounted horizontally in vertical ducts.
- .4 Motorized (S/DM): folding blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled.
- .5 Electro thermal link (S/DETL): dual responsive fusible link which melts when subjected to local heat of 74 °C and from external electrical impulse of low power and short duration; ULC or UL listed and labelled.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

- .1 Damper: similar to smoke dampers specified above.
- .2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.

2.04 FIRE STOP FLAPS

- .1 Fire smoke flaps: ULC listed and labelled and fire tested in accordance with CAN/ULC-S112.2.
- .2 Construct of minimum 1.5 mm thick sheet steel 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 S505V and close at 74 °C.

3 EXECUTION

3.01 INSTALLATION

- .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals

of complete installation from authority having jurisdiction.

- .4 Install access door adjacent to each damper. See Section 23 33 00.
- .5 Co-ordinate with installer of fire stopping.
- .6 Confirm access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

END OF SECTION

1 GENERAL

1.01 REFERENCES

- .1 Section 01 33 00 - Submittal Procedures.

1.02 REFERENCES

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-2015, Installation of Warm Air Heating and Air Conditioning Systems.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA 1966-2006, HVAC Duct Construction Standards Metal and Flexible.
- .3 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULCS110, Fire Tests for Air Ducts.
 - .2 UL 181-2013, Factory Made Air Ducts and Connectors.

1.03 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.

1.04 CERTIFICATION OF RATINGS

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

1.05 SAMPLES

- .1 Submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

2 PRODUCTS

2.01 GENERAL

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

2.02 METALLIC - ACOUSTIC INSULATED

- .1 Non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible glass fibre acoustic insulation and encased in aluminum foil and Mylar laminate vapour barrier.
- .2 Performance:
 - .1 Factory tested to 3 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

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

3 EXECUTION

3.01 DUCT INSTALLATION

- .1 Install in accordance with: NFPA 90A and NFPA 90B SMACNA.
- .2 Do trial test to demonstrate workmanship.
- .3 Use for minimum 0.9m and maximum 1.5m between ceiling mounted diffusers and branch ducts on supply duct systems only. Do not use for exhaust air duct systems.

- .4 Flexible duct to have no more than a 15 degree offset and have a minimum of two (2) hangers.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 General Commissioning Requirements: Section 01 91 13
- .2 Duct Accessories: Section 23 33 00

1.02 REFERENCES

- .1 AMCA 99-2010, Standards Handbook.
- .2 ANSI/AMCA 210/ASHRAE 51-2007, Laboratory Methods of Testing Fans for Rating.
- .3 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
- .4 ANSI/AMCA 301-2014, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5 CGSB 1.181M-99, Coating, Zinc Rich, Organic, Ready Mixed.
- .6 NEMA ICS 7.1-2006, Safety Standard for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .7 American Bearing Manufacturers Association (ABMA).

1.03 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide:
 - .1 Fan performance curves showing point of operation, BHP and efficiency.
 - .2 Sound rating data at point of operation.
 - .3 Dimensional data.
 - .4 Installation procedures.
- .3 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
 - .2 Minimum performance achievable with variable speed controllers and variable inlet vanes as appropriate, dimensions, installation procedure.

1.04 CLOSEOUT SUBMITTALS

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

1.05 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Spare parts to include:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.06 MANUFACTURED ITEMS

- .1 Catalogued or published ratings must be those obtained from tests carried out by manufacturer or from independent testing agency signifying adherence to codes and standards in force.

1.07 WARRANTY

- .1 Provide warranty for parts and labour for one (1) year following project Substantial Completion.

2 PRODUCTS

2.01 FANS GENERAL

- .1 Capacity: flow rate, static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit must bear AMCA

certified rating seal, except for propeller fans smaller than 300 mm diameter.

- .5 Open drip proof outside of air stream.
- .6 Motors: sizes as specified.
- .7 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards, fan inlet and/or outlet safety screens as indicated.
- .8 Factory primed before assembly in colour standard to manufacturer.
- .9 Scroll casing drains: as indicated.
- .10 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .11 Flexible connections: to Section 23 33 00 Duct Accessories.

2.02 CENTRIFUGAL FANS

- .1 Fan wheels:
 - .1 Welded steel or aluminum construction.
 - .2 Maximum operating speed of centrifugal fans not more than 40 % of first critical speed.
 - .3 Air foil or backward inclined blades, as indicated.
- .2 Bearings: air handling quality, heavy duty, split pillow block, flange mounted grease lubricated ball or roller self-aligning type with oil retaining, dust excluding seals and a certified minimum rated life to ABMA L10 of 100,000 hours.
- .3 Housings:
 - .1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, cast iron, or 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 nonflammable material.
 - .3 Provide bolted latched airtight access doors with handles.

2.03 CEILING FANS

- .1 As shown on drawings and in schedule.
- .2 Sustainability Characteristics: fan to possess the ENERGY STAR Most Efficient 2015 designation. The bamboo fan assembly, as a system, must be built pursuant to environmental and sustainability standards of the Forest Stewardship Council.
- .3 Quality: fan to display good workmanship in all aspects of its construction. Field balancing of the airfoils must not be necessary.
- .4 Colors and Materials: Airfoil materials and colors to be selected by the Departmental Representative.
- .5 Optional Accessories:
 - .1 Wall-mounted controller (in addition to the standard remote control).
- .6 Universal Mounting system:
 - .1 Universal mount must be suitable for flat or sloped ceilings.
 - .2 Equip the fan with a mounting bracket, canopy, mounting ball and wedge, extension tubes, wiring cover, motor hub, and mounting hardware.
 - .3 Include an extension tube with the fan as indicated.
 - .4 Fan to be available with a diameter of 1.3 m (52"), 1.5 m (60"), or 2.1 m (84") as indicated.
- .7 Equip the fan with three (3) airfoils spanning a total diameter of 1.3 m (52"), 1.5 m (60"), or 2.1 m (84"), as indicated. Airfoils to be available in the following materials: Bamboo or Aluminum polished finish. Aluminum airfoils must be damp-rated for use in covered outdoor spaces.
- .8 Motor:
 - .1 Fan to have an electronically commutated motor (ECM) rated for 100-240 VAC, single-phase.
 - .2 Motor to draw 1.41-52 watts depending on the speed at which the fan is operated and if a light is installed.
 - .3 Provide fan designed for continuous operation in ambient temperatures of 32-104°F (0-40°C), and a humidity range of 20-90% (non-condensing).
 - .4 Fan's motor unit and motor unit trim to be available

- in the following finishes:
- .1 Fans with Caramel Bamboo airfoils: White, black, satin nickel, or oil-rubbed bronze.
 - .2 Fans with Cocoa Bamboo airfoils: Black, satin nickel, or oil-rubbed bronze.
 - .3 Fans with aluminum airfoils: Black or white.
- .9 Safety Cable:
- .1 Equip fan with a safety cable that provides an additional means of securing the fan assembly to the building structure. Safety cable to be 1.5 mm in diameter and fabricated of aircraft steel. Field construction of safety cables is not permitted.
- .10 Wall Control:
- .1 Equip fan with a wireless wall control in addition to the standard remote control, as specified by the Departmental Representative.
 - .2 Wall Control to include temperature, humidity, and motion sensors.
 - .3 The user must be able to group the wall control with one or more fans for simultaneous control of fan speed.
 - .4 Wall control buttons to control the fan (on/off and variable speed).

3 EXECUTION

3.01 CEILING FAN PREPARATION

- .1 The fan location must have an appropriate ceiling-mounted outlet box marked, "Acceptable for Fan Support." If there is not an appropriate outlet box already installed at the location, one must be installed on a ceiling joist or beam and be properly wired. Additional mounting options may be available. Consult the installation guide for additional details.
- .2 The fan location must be free from obstacles such as lights, cables, or other building components.
- .3 Check the fan location for proper electrical requirements. Consult the installation guide for appropriate circuit requirements.

3.02 CEILING FAN INSTALLATION

- .1 Install the fan according to the manufacturer's installation guide, which includes acceptable mounting methods.
- .2 Required Distances:
 - .1 For 1.5 m and 1.3 m fans, the airfoils must be at least 2.1 m above the floor.
 - .2 For 2.1 m fans, the airfoils must be at least 2.4 m above the floor.
 - .3 The airfoils must have at least 0.6 m clearance from all obstructions.
 - .4 The fan must be within a 9.1 m radius of where the mobile digital device will be used for control. (Line-of-sight obstructions may create a smaller maximum range.)
 - .5 Do not locate fan where it will be subjected to rain or continuous wind gusts, or in close proximity to the outputs of HVAC systems or radiant heaters. Consult the installation guide for additional details.

3.03 FAN INSTALLATION

- .1 Install fans as indicated, complete with flexible electrical leads and flexible connections in accordance with Section 23 33 00 - 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.
- .5 Provide installation in strict accordance with manufacturer's recommendations.
- .6 Grease fan bearing prior to operation.

3.04 COMMISSIONING

- .1 Do commissioning in accordance with Section 01 91 13 - Commissioning General Requirements.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Closeout Submittals: Section 01 78 00

1.02 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.03 SAMPLES

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

1.04 CERTIFICATIONS

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

1.05 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

2 PRODUCTS

2.01 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity.

- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames where set into plaster or gypsum board.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators as indicated.
- .4 Colour: standard or as directed by the Departmental Representative.

2.02 MANUFACTURED UNITS

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

2.03 SUPPLY GRILLES AND REGISTERS

- .1 See Schedule.

2.04 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 See Schedule.

2.05 DIFFUSERS

- .1 See Schedule.

2.06 LINEAR GRILLES

- .1 See Schedule.

3 EXECUTION

3.01 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with flat head stainless steel or cadmium plated screws in countersunk holes where fastenings are visible.
- .3 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms and elsewhere.

END OF SECTION

1 GENERAL

1.01 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Construction/Demolition Waste Management and Disposal:
Section 01 74 21
- .3 Closeout Submittals: Section 01 78 00
- .4 Commissioning: Section 01 91 13
- .5 Duct Accessories: Section 23 33 00
- .6 Dampers - Operating: Section 23 33 15

1.02 REFERENCES

- .1 (ANSI/NFPA)
 - .1 ANSI/NFPA 90A-2015, Standard for the Installation of
Air Conditioning and Ventilating Systems.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 1.181-99, Ready Mixed Organic Zinc Rich Coating.
- .3 Sheet Metal and Air Conditioning Contractors' National
Association (SMACNA).
- .4 Canadian Standards Association
 - .1 CSA B52-13 Package, Mechanical Refrigeration Code
- .5 American Bearing Manufacturer's Association
 - .1 ANSI/ABMA 9-08, Load Ratings and Fatigue Life for Ball
Bearings
 - .2 ANSI/ABMA 11-08, Load Ratings and Fatigue Life for
Roller Bearings.
- .6 Air Movement and Control Association
 - .1 AMCA 300-08, Reverberant Room Method for Sound Testing
of Fans.
- .7 American Society of Heating Refrigeration and Air
Conditioning Engineers.
 - .1 ASHRAE 68-1997, Laboratory Method of Testing to
Determine the Sound Power in a Duct.

- .8 National Electrical Manufacturer's Association
 - .1 NEMA MG1-2014, Motors and Generators
 - .2 NEMA ICS 7.1-06, Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .9 Provincial Boiler Pressure Vessel and Compressed Gas Regulations.

1.03 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate following: fan, bearings, motor, damper, VAV control, air volume, total cooling, sensible cooling, EDB, EWB, OAT.

1.04 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Include following: fan, bearings, motor, damper, VAV control, air volume, total cooling, sensible cooling, EDB, EWB, OAT.

1.05 WASTE MANAGEMENT AND DISPOSAL

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

1.06 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide one (1) spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .4 Spare filters: in addition to filters installed for startup and commissioning. Immediately prior to acceptance by the Departmental Representative, supply one (1) complete set of filters for each filter unit or filter bank.

2 PRODUCTS

2.01 GENERAL

- .1 Factory assembled components to form units supplying air at design conditions as indicated.
- .2 Certify ratings: to ARI 430 with ARI seal.
- .3 Horizontal and vertical type, as indicated, having air tight components, consisting of fan section with motor and drive, filter section, dampers, heating coil, cooling coil, economizer.

2.02 CASING

- .1 Galvanized or phosphate treated steel outer casing reinforced and braced for rigidity.

2.03 DRAIN PANS

- .1 Construction: stainless steel, plastic or FRP, rounded corners, double wall.
- .2 Drain connection: in bottom at low point.
- .3 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.

2.04 FANS

- .1 Cabinet hung or frame mounted AMCA rated for sound and performance, centrifugal fans with backward inclined or airfoil wheels, selected to operate in stable part of performance curve and heavy duty L10 100,000 hour's minimum service self-aligning or split pillow block bearings.
 - .1 Provide internally mounted motor as indicated complete with adjustable V-belt drive and guard.
 - .2 Motor: see schedule.
- .2 Maximum sound power levels, as indicated.

2.05 VIBRATION ISOLATION

- .1 Flexible connections at inlet and outlet of fan section: to Section 23 33 00 - Air Duct Accessories.
- .2 Vibration isolators on fan section.

2.06 VARIABLE VOLUME DEVICES

- .1 Variable speed drives as indicated: motors to be suitable for variable speed drive. Variable speed drives in accordance with Section 26 29 10 - Motor Starters to 600 V.

2.07 FILTERS

- .1 50MM MERV 8.

2.08 MIXING BOX

- .1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 oc of design across face of outlet.
- .2 Dampers:
 - .1 Dampers for mixing boxes: to Section 23 33 15 - Dampers - Operating.

2.09 COILS

- .1 Capacity: see schedule.
- .2 Ratings: ARI certified.
- .3 Construction:
 - .1 Casings: 1.5 mm thick galvanized sheet steel.
 - .1 Supports of galvanized steel channel or double

- angle frames.
- .2 Blank-off plates. Insulated sandwich construction.
- .2 Direct expansion refrigerant coils:
 - .1 Serpentine type, arranged to prevent trapping of oil.
 - .1 Liquid distributors to ensure even distribution of liquid refrigerant to all circuits.
 - .2 Silver solder or braze joints in refrigerant tubing.
 - .3 Evacuate and charge coil with nitrogen and seal before sending to site.
 - .2 Tubes: copper.
 - .3 Fins: aluminum, plate or spiral wound.
 - .4 Headers: copper.
 - .5 Pressure tests: CSA B52 and carry a Canadian Refrigeration Number. Dehydrated. Sealed with nitrogen charge.

3 EXECUTION

3.01 INSTALLATION

- .1 Install units in accordance with manufacturer's instructions and as indicated.
- .2 Install with adequate clearance for servicing and maintenance.

3.02 FANS

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.03 DRIP PANS

- .1 Install deep seal P-traps and trap seal primer on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.04 COMMISSIONING

- .1 Conduct commission in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements. Allow for one (1) day per unit for startup and one (1) day for commissioning.

END OF SECTION

1 GENERAL

1.01 SUMMARY

- .1 Materials and installation for HVAC condensing units.

1.02 RELATED SECTIONS

- .1 Submittal Procedures: Section 01 33 00
- .2 Health and Safety Requirements: Section 01 35 29.06
- .3 Quality Control: Section 01 45 00
- .4 Construction/Demolition Waste Management and Disposal:
Section 01 74 21
- .5 Closeout Submittals: Section 01 78 00
- .6 General Commissioning Requirements: Section 01 91 13
- .7 Cleaning and Startup of Mechanical Piping Systems: Section
23 08 02

1.03 REFERENCES

- .1 American National Standards Institute (ANSI)/Air
Conditioning and Refrigeration Institute (ARI)
 - .1 ANSI/ARI 210/240-2008, Unitary Air-Conditioning and
Air-Source Heat Pump Equipment.
 - .2 ARI 270-2008, Sound Rating of Outdoor Unitary
Equipment.
- .2 ANSI/UL 1995B-2015, Standard for Heating and Cooling
Equipment
- .3 Canadian Standards Association (CSA):
 - .1 CSA B52-13 Package, Mechanical Refrigeration Code.
 - .2 CSA C22.1-2015, Canadian Electrical Code.
- .4 Health Canada / Workplace Hazardous Materials Information
System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS)
- .5 National Roofing Contractors Association (NRCA).
- .6 National Fire Protection Association (NFPA):

- .1 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
- .7 American Bearing Manufacturer's Association (ABMA)
 - .1 ANSI/ABMA 9:2015, Load Ratings and Fatigue Life for Ball Bearings.
 - .2 ANSI/ABMA 11:2014, Load Ratings and Fatigue Life for Roller Bearings.
- .8 Air Movement and Control Association (AMCA):
 - .1 AMCA 300-2014, Reverberant Room Method for Sound Testing of Fans.
- .9 National Electrical Manufacturer's Association
 - .1 NEMA MG1-2014, Motors and Generators
 - .2 NEMA ICS 7.1-06, Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
- .10 Provincial Boiler Pressure Vessel and Compressed Gas Regulations.

1.04 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet.
- .3 Submit WHMIS MSDS. Indicate VOC's for adhesive and solvents during application and curing.
- .4 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout and dimensions; indicate:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Piping, valves, fittings shipped loose showing final location in assembly.

- .3 Control equipment shipped loose, showing final location in assembly.
 - .4 Complete internal panel pneumatic tube piping and wiring and external panel pneumatic tube piping and wiring, both as schematics and as actually assembled.
 - .5 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .6 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .7 Pump and fan performance curves.
 - .8 Details of vibration isolation.
 - .9 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
 - .10 Type of refrigerant used.
- .5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .6 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .7 Instructions: submit manufacturer's installation instructions.
 - .8 Manufacturer's Field Reports: manufacturer's field reports specified.
 - .9 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals. Include data as follows:
 - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.

- .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.05 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one (1) week prior to beginning work of this Section and on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Coordination with other building sub trades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Conduct waste management and disposal in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal including:
 - .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .2 Collect and separate for disposal, paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).
 - .3 Separate for reuse and recycling and place in designated containers steel, metal, plastic waste in accordance with Waste Management Plan (WMP).
 - .4 Handle and dispose of hazardous materials in accordance with Canadian Environmental Protection Act (CEPA), Transportation of Dangerous Goods Act (TDGA), Regional and Municipal, regulations.
 - .5 Divert unused metal materials from landfill to metal recycling facility as approved by the Departmental Representative.

2 PRODUCTS

2.01 GENERAL

- .1 Units to consist of cabinet and frame, control, refrigerant cooling coil, compressor, condenser coil and fans.
- .2 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW nominal.

2.02 CABINETS

- .1 Cabinets: weatherproofing tested and soundproofing tested to ARI 270, dbA at 3 m free field.
- .2 Framing and supports: 2 mm thick welded steel, galvanized after manufacture, with lifting lugs at top of unit and/or fork lift slots at bottom.
- .3 Outer casing: weathertight galvanized steel with baked enamel finish, to Section 09 91 00 - Painting.

2.03 REFRIGERATION

- .1 Conform to CSA B52 and ANSI/UL 465 requirements.
- .2 Compressor/condenser section:
 - .1 Semi-hermetic or hermetic compressors, vibration isolated with flexible suction and discharge connections, oil sight glass, oil pressure switch, crankcase heater, and automatic pump down system with control to liquid line solenoid valve.
 - .2 Fans: propeller type with single piece spun venturi outlets and zinc plated guards. Motors shall be sequenced for head pressure control.
 - .3 Electrical system shall have operating controls, oil and refrigerant pressure protection, motor overload protection, weatherproof electrical wiring with weatherproof, rain tight disconnect.
 - .4 Include refrigerant piping with, sight glass, filter drier and valves.
 - .5 Condenser: staggered copper tube, aluminum fin coil assembly with sub-cooling rows to provide 6 0C sub-cooling.

- .6 Capacity reduction: cylinder unloading. Provide flooding for head pressure control for low ambient operation down to 0 °C ambient temperature.
- .7 Refrigerant: as indicated.

2.04 CAPACITY

- .1 Capacity: see schedule.

3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

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

3.02 INSTALLATION

- .1 Install and perform start-up as per manufacturers' instructions.
- .2 Manufacturer's representative to certify installation, supervise start-up and commission unit.

3.03 FIELD QUALITY CONTROL

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

carried out.

- .2 Obtain reports within three (3) working days of review and submit immediately to the Departmental Representative.
- .3 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .4 Verify accessibility, clean ability.
- .5 Commissioning Reports:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports supplemented as specified herein. Include:
 - .1 Report forms as specified Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.

3.04 DEMONSTRATION

- .1 Training: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel, supplemented as specified.

3.05 CLEANING

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

END OF SECTION