

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals
- .4 Section 07 84 00 - Fire Stopping
- .5 Section 21 05 01 - Common Work Results for Mechanical
- .6 Section 23 05 29 - Hangers and Supports for Piping and Equipment
- .7 Section 23 07 13 - Insulation for Ducting

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by the responsible contractor and the GC.
 - .2 Indicate on drawings:
 - .1 fan, fan curves showing point of operation, motor drive, bearings, filters, dampers, coil, performance data.
 - .2 Mounting arrangements.
 - .3 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.3 CLOSEOUT SUBMITTALS

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

- .1 Operation and maintenance manual approved by, and final copies deposited with, Consultant before final inspection.
- .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
- .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless directed by Consultant.
 - .2 Make changes as required and re-submit as directed Consultant.
- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Consultant] will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information week to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:

- .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
- .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .3 Submit to Consultant for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish spare parts as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass.
 - .4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .3 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

Part 2 Products

2.1 MATERIALS

NOT USED

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

.1 Inform Consultant of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

3.2 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 90 00 - Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

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

3.4 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION

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

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

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.7 PROTECTION

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .2 Section 07 84 00 - Fire Stopping
- .3 Section 21 05 01 - Common Work Results for Mechanical
- .4 Section 21 07 20 - Thermal Insulation for Piping
- .5 Section 22 11 16 - Domestic Water Piping.
- .6 Section 22 13 17 - Drainage Waste and Venting Piping – Cast Iron and Copper
- .7 Section 22 13 18 – Drainage Waste and Venting Piping - Plastic
- .8 Section 23 05 29 - Hangers and Supports for Piping and Equipment
- .9 Section 23 05 00 – Common Work Results HVAC
- .10 Section 33 11 16 - Incoming Site Water Utility Distribution Piping

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .2 National Fire Code of Canada (NFCC 2010)
- .3 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007 Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products And Materials

2.1 MATERIAL

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
 - .1 Primers, Paints, Coating: in accordance with manufacturer's recommendations for surface conditions.
 - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11, to SCAQMD Rule 1113.
 - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11, to SCAQMD Rule 1113.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: maximum VOC limit to SCAQMD Rule 1168, to GSES GS-36.
- .3 Sealants: maximum VOC limit to SCAQMD Rule 1168, to GSES GS-36.
- .4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.
- .5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada, CSA B139.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer, CSA B139, as indicated without interrupting operation of other system, equipment, components.

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: DN 20 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install air vents to CSA B139 at high points in piping systems.
- .2 Install isolating valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 DN 50 and under: isolating unions or bronze valves.
- .4 Over DN 50: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Install pipework to CSA B139.
- .2 Screwed fittings jointed with Teflon tape.
- .3 Protect openings against entry of foreign material.
- .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .5 Assemble piping using fittings manufactured to ANSI standards.
- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.

- .11 Group piping wherever possible.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use gate or ball valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Use chain operators on valves DN 65 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

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

- .1 Provide space for fire-stopping.
- .2 Maintain fire rating integrity.
- .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
- .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

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

3.10 PREPARATION FOR FIRE STOPPING

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

3.11 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 00 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in [relevant mechanical sections].
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Consultant 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Consultant.
- .6 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.

- .7 Insulate or conceal work only after approval and certification of tests by Consultant.

3.13 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-07, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-1996(2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-07b, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
 - .2 MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
 - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .4 Underwriter's Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by the responsible contractor and the GC.
 - .2 Submit shop drawings for:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .4 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products And Materials

2.1 SYSTEM DESCRIPTION

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

2.2 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Ensure steel hangers in contact with copper piping are copper plated with an approved insulating tape or plastic coating.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:

- .1 Cold piping DN 50 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut carbon steel retaining clip.
 - .1 Rod: 9 mm UL listed, 13 mm FM approved.
- .2 Cold piping DN 65 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed, FM approved to MSS-SP58, MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping DN 50 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP69.
 - .2 Cold piping DN 65 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP69.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
 - .3 Sway braces for seismic restraint systems.
- .6 Hanger rods: threaded rod material to MSS SP58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.
 - .3 Use rod sizes recommended by the manufacturer.
- .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 shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: black epoxy coated with formed portion plastic coated.

- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

2.4 RISER CLAMPS

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

2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP69, 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 DN 300 and over, carbon steel to comply with MSS SP69.

2.6 CONSTANT SUPPORT SPRING HANGERS

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

2.7 VARIABLE SUPPORT SPRING HANGERS

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

2.8 EQUIPMENT SUPPORTS

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

2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

2.10 PLATFORMS AND CATWALKS

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

2.11 HOUSE-KEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.12 OTHER EQUIPMENT SUPPORTS

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:

- .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Provincial Code and authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to DN 15: every 1.8 m.
- .4 Copper piping: up to DN 15: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size : DN	Maximum Spacing Steel	Maximum Spacing Copper
up to 32	2.4 m	1.8 m
40	3.0 m	2.4 m
50	3.0 m	2.4 m
65	3.7 m	3.0 m
75	3.7 m	3.0 m
90	3.7 m	3.3 m
100	3.7 m	3.6 m
125	4.3 m	
150	4.3 m	
200	4.3 m	
250	4.9 m	
300	4.9 m	

- .7 Pipework greater than DN 300: to MSS SP69.

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

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

3.6 FINAL ADJUSTMENT

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

3.7 FIELD QUALITY CONTROL

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

3.8 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Vibration isolation materials and components and their installation.

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Building Code of Canada (NBC) – 2010.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by a professional engineer registered or licensed in Province of Manitoba, Canada.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Provide detailed drawings of seismic control measures for equipment and piping.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.4 QUALITY ASSURANCE

- .1 The materials and systems specified in this Section shall be purchased from a single vibration isolation materials manufacturer to assure single source responsibility for the performance of isolation materials used.

1.5 DELIVERY, STORAGE, AND HANDLING

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

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

1.6 DESCRIPTION OF SYSTEM

- .1 The work under this section shall include furnishing all labor, materials, tools, appliances and equipment, and performing all operations necessary for the complete execution of the installation of vibration isolation devices and systems as shown, detailed, and/or scheduled on the drawing and/or specified in this section of the specifications. This work in general shall include but not necessarily be limited to the following:
 - .1 All motor driven mechanical equipment shall be isolated from the building structure by means of vibration isolators.
 - .2 All piping connected to isolated equipment shall be supported on the first three support points by spring hangers.
 - .3 All ductwork connected to isolated equipment shall be isolated using flexible duct connectors, provided under Section 23 31 00.

1.7 SYSTEM DESIGN

- .1 The isolation materials manufacturer shall be responsible for the proper selection of isolators to accomplish the specified minimum static deflections, for all isolators, based on the actual weight distribution of the equipment and pipe to be isolated, and the piping layout.
- .2 The sub-contractor shall furnish to the vibration isolation supplier, a complete set of approved shop drawings of all mechanical equipment to receive vibration isolation devices to the vibration isolation materials manufacturer, based upon which the selection of vibration isolators will be completed. The shop drawings to be furnished shall include operating weights of the equipment to be isolated and the distribution of weight at the support points.
- .3 The sub-contractor shall furnish to the vibration isolation supplier, a complete layout of the piping to be isolated, showing the size and/or weight, and the support points of the piping system.
- .4 It is a requirement of this Specification that the Mechanical equipment be designed and installed so that the average noise criteria curves as outlined in the latest edition of the ASHRAE guide for this type of project are not exceeded. Where objectionable noise or vibration is encountered due to faulty equipment or inefficient vibration reduction

devices, as determined by the Engineer, make necessary tests, change and provide additional equipment as may be required and approved, without extra charge.

- .5 Give consideration to side loading of equipment when calculating maximum loads on isolators; provide pairs of side snubbers and/or restraining springs where side torque or thrust may develop. When properly adjusted, the equipment shall be level when operating.
- .6 Provide all spring isolators with height and levelling adjustment and set on neoprene anti-sound pads 6 mm (1/4") or thicker. Do not use sponge rubber for side snubbers.
- .7 All hardware shall be corrosion resistant.

Part 2 Products

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.
- .2 All vibration isolation materials shall be provided by a single manufacturer to assure single source responsibility for the proper performance of materials used.
- .3 Materials and systems specified herein and as detailed or scheduled on the drawings are based on materials manufactured by Kinetics Noise Control, Inc.

2.1 ISOLATOR TYPES

- .1 Type 1, Floor-Mounted Equipment:
 - .1 Vibration isolation pads shall be pre-compressed molded fiber glass pads individually coated with a flexible, moisture impervious elastomeric membrane. Vibration isolation pads shall be molded from glass fibers with fiber diameters not exceeding 0.006858 mm and with a modulus of elasticity of 72.4 million kPa. Natural frequency of fiberglass vibration isolation pads shall be essentially constant for the operating load range of the supported equipment. Vibration isolation pads shall be color coded or otherwise identified to indicate the load capacity. Vibration isolation pads shall be Model KIP, as manufactured by Kinetics Noise Control, Inc.

- or -
 - .2 Vibration isolators shall be as described above but bonded to a steel load transfer plate and a formed steel bolt-down bracket, and shall also include an equipment mounting bolt with an anti-short-circuit neoprene grommet. Anchored vibration isolators shall be Model AC as manufactured by Kinetics Noise Control, Inc.

- or -

- .3 Vibration Isolators shall be neoprene, molded from oil-resistant compounds, with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs. Neoprene vibration isolators shall have minimum operating static deflections not exceeding published load capabilities. Neoprene vibration isolators shall be Model RD, as manufactured by Kinetics Noise Control, Inc.

.2 Type 1, Suspended Equipment:

- .1 Vibration isolators with maximum static deflection requirements under operating load conditions not exceeding 10 mm shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap.
- .2 The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color-coded to indicate load capacity and selected to operate within its published load range.
- .3 The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30 degree arc without metal-to-metal contact or other short circuit.
- .4 Vibration isolation hanger assembly shall be Model RH, as manufactured by Kinetics Noise Control, Inc.

.3 Type 2, Floor-Mounted Equipment:

- .1 Vibration isolators shall be free standing, unboxed, laterally stable steel springs wound from high strength spring steel. Springs shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be selected to provide operating static deflections not exceeding published load capabilities. Springs shall be color coded or otherwise identified to indicate load capacity.
- .2 Springs shall be assembled between a top and bottom steel load plate. The upper load plate shall be provided with a steel leveling bolt lock-nut and washer for attachment to the supported equipment.
- .3 The lower load plate shall have a non-skid noise isolation pad bonded to the bottom and have provisions for bolting the isolator to the supporting structure.
- .4 Spring isolation mounts for floor mounted equipment shall be Model FDS, as manufactured by Kinetics Noise Control, Inc.

.4 Type 2, Suspended Equipment, Piping, Ductwork:

- .1 Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding 10 mm, shall be hangers consisting of a free-standing

laterally stable steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket.

The spring element shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be selected to provide operating static deflections not exceeding published load capabilities. Springs shall be color coded or otherwise identified to indicate load capacity.

Vibration isolation hangers shall be Model SH, as manufactured by Kinetics Noise Control, Inc.

- or -

- .2 Vibration isolators for suspend equipment with minimum static deflection requirement exceeding 10 mm, and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a pre-compressed molded fiberglass insert, complete with load transfer plates and assembled in a stamped or welded steel bracket.

The fiberglass insert element shall be molded from glass fibers with fiber diameters not exceeding 0.006858 mm and with a modulus of elasticity of 72.4 million kPa. Natural frequency of fiberglass vibration isolation pads shall be essentially constant for the operating load range of the supported equipment. Vibration isolation pads shall be color coded or otherwise identified to indicate the load capacity.

The spring element shall have a lateral stiffness greater than 0.8 times the rated vertical stiffness and shall be designed to provide up to 50% overload capacity. Springs shall be selected to provide operating static deflections not exceeding published load capabilities. Springs shall be color coded or otherwise identified to indicate load capacity.

The stamped or welded hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30 degree arc without metal-to-metal contact or other short circuit.

The combination isolation hanger assembly with fiberglass inserts shall be Model SFH, as manufactured by Kinetics Noise Control, Inc

2.2 VIBRATION ISOLATOR SELECTION

- .1 Selection of vibration isolator types, and minimum operating static deflections, shall be the responsibility of the isolation materials manufacturer/supplier.
- .2 Vibration isolator types and minimum operating static deflections for suspended or floor mounted piping shall be as follows:

- .1 Types 1 and 2 hangers, or Type 2 floor mounts, with minimum operating static deflections equal to 50% of connected equipment isolator deflection, or 25 mm, whichever is greater, shall be used to support all piping for a minimum of three support locations.
- .3 Vibration isolator types and minimum operating static deflections for suspended air distribution elements shall be as follows:
 - .1 Type 2 hangers, or Type 2 floor mounts with minimum operating static deflections equal to 50% of connected equipment isolator deflection.
- .4 Isolator types are scheduled to establish minimum standards. At the contractor's option, labor saving accessories can be an integral part of the isolators supplied, to provide initial lift of equipment to operating height, to hold piping at fixed elevations during installation and initial system filling operations, and for similar installation advantages, provided the isolators supplied incorporate the specified isolator type, and do not degrade the noise and vibration isolation of the equipment.

Part 3 Execution

3.1 GENERAL

- .1 Isolator natural frequency to be 40% of the lowest equipment operating speed.
- .2 Provide HSR thrust restraints for air moving equipment operating at 2.1" static pressure and above.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

- .1 On completion of the installation of all isolation materials, and before start-up of isolated equipment, all debris shall be cleared from the areas surrounding, and from beneath, all isolated equipment, leaving the equipment free to move on the isolation supports.
- .2
- .3 No rigid connections between the equipment and the building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

- .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at [25]% and [60]% completion stages.
 - .4 Upon completion of installation.
- .3 Submit manufacturer's reports to Consultant within 3 days of manufacturer representative's review.
- .4 Make adjustments and corrections in accordance with written report.
- .2 Inspection and Certification:
 - .1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .2 Take vibration measurements for equipment
 - .3 Provide Consultant with notice 24 h in advance of commencement of tests.
 - .4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
 - .5 Submit complete report of test results including sound curves.

3.5 CLEANING

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

END OF SECTION

Part 1 General

1.1 SUMMARY

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB Consultant within 60 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems – Latest Edition.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing- Latest Edition.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 CO-ORDINATION

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

1.5 PRE-TAB REVIEW

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

1.6 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.7 OPERATION OF SYSTEMS DURING TAB

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

1.8 START OF TAB

- .1 Notify Consultant 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 weatherstripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23.
 - .4 Provisions for TAB installed and operational.

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

1.9 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Air inlet and outlet air quantities shall be within +/- 10% of specified values.
 - .2 Fan air quantities shall be +/- 5% of specified values.

1.10 ACCURACY TOLERANCES

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

1.11 INSTRUMENTS

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

1.12 ACTION AND INFORMATIONAL SUBMITTALS

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

1.13 PRELIMINARY TAB REPORT

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

1.14 TAB REPORT

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit 3 copies of TAB Report Consultant for verification and approval, complete with index tabs.

1.15 VERIFICATION

- .1 Reported results subject to verification by Consultant.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results if requested.
- .3 Number and location of verified results as directed by Consultant.
- .4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.16 SETTINGS

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

1.17 COMPLETION OF TAB

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

1.18 AIR SYSTEMS

- .1 Standard: TAB to most stringent standards of AABC, SMACNA, ASHRAE.
- .2 Do TAB of systems, equipment, components, following systems, equipment, components, controls:
 - .1 Test all fire dampers.
 - .2 Balance the Air Volumes for all Air Handling Units including motorized mixed air damper systems.
 - .3 Balance the air volumes for all Fan-Coil Units.
 - .4 Balance the air volumes for the Exhaust Fans.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC, NEBB or prove qualified to standards of AABC or NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by or to standards of AABC or NEBB.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.19 OTHER TAB REQUIREMENTS

- .1 General requirements applicable to work specified this paragraph:
 - .1 Qualifications of TAB personnel: as for air systems specified this section.
 - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions during winter design conditions or as otherwise noted or specified.

Part 2 Products NOT USED

Part 3 Execution NOT USED

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals
- .4 Section 21 05 01 - Common Work Results for Mechanical
- .5 Section 23 05 00 - Common Work Results for HVAC
- .6 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .7 Section 23 31 00 - Air Distribution
- .8 Section 33 11 16 - Incoming Site Water Utility Distribution Piping

1.2 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces, walls, shafts or cavities.
 - .2 "EXPOSED" - means "not concealed" as previously defined. Work behind doors, in closets or cupboards, or under counters is considered exposed. Work in Mechanical and Boiler Rooms is considered exposed.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ASTM International Inc.
 - .1 ASTM B209M 07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335-05, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

- .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C547-07e1, Standard Specification for Mineral Fiber Pipe Insulation.
- .6 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .8 ASTM C795-03 Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .9 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36-00, Commercial Adhesives.
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .7 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.
- .3 Samples:
 - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .2 Mount sample on 12 mm plywood board.
 - .3 Affix typewritten label beneath sample indicating service.

- .4 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations. and special handling criteria, installation sequence, cleaning procedures.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Acoustic Duct Lining:
 - .1 Provide acoustic lining in all ductwork where indicated on the drawings at a thickness of 25 mm (1").
 - .2 The use of fiberglass liner is not allowed. All acoustic duct liner must be constructed of closed-cell, polymer sheet insulation materials.
 - .3 Product must be cleanable and have a zero perm rating and zero water absorption.
 - .4 Installation shall not include any tapes, fabrics, cements or other materials which are not cleanable or which offer opportunity for mold growth.
 - .5 Installation shall be to Manufacturer's standards and shall withstand air velocities of 7.6 m/s (1500 feet per minute).
 - .6 Duct sizes shown on the drawings are clear inside dimensions. Sheet metal sizes shall increase as required to accommodate the thickness of the internal insulation, to maintain the equivalent free area noted on the drawings.
- .2 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.

- .3 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .4 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .5 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to ASTM C553.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

- .1 Canvas:
 - .1 170 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Location:
 - .1 Indoor where exposed to mechanical damage ie. Mechanical rooms.
- .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
 - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Smooth or Stucco embossed.
 - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.
 - .5 Location:
 - .1 Outdoor use.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 170 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, plain reinforced, 50 mm wide minimum.

- .7 Contact adhesive: quick-setting
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5mm stainless steel.
- .10 Banding: 19mm wide, 0.5 mm thick stainless steel.

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers' instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	25
Round cold and dual temperature supply air ducts	C-2	yes	25
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-2	no	25

Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing plenum	C-1	yes	75
Mixing plenums	C-1	yes	75
Relief Air Ductwork	C-1	yes	50
Exhaust ducts (concealed) between dampers and louvres	C-1	yes	50
Exhaust ducts (exposed) 3000mm back of penetration of the exterior building surface	C-1	yes	50
Condensate Drain Pans	C-1	yes	25
Rectangular ducts outside	C-1	yes	75
Round ducts outside	C-1	yes	75
Acoustically lined ducts	As per Part 2		

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

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

3.5 CLEANING

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

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

.2 Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Thermal insulation for piping and piping accessories in commercial type applications.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals
- .4 Section 07 84 00 - Fire Stopping
- .5 Section 21 05 01 - Common Work Results for Mechanical
- .6 Section 22 05 00 - Common Work Results for Plumbing
- .7 Section 22 11 16 - Domestic Water Piping
- .8 Section 23 05 05 - Installation of Pipework
- .9 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment
- .10 Section 33 11 16 - Incoming Site Water Utility Distribution Piping

1.3 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .3 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
 - .5 ASTM C547-2003, Mineral Fiber Pipe Insulation.
 - .6 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
 - .7 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)

- .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701[01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.4 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces, walls, shafts or cavities.
 - .2 "EXPOSED" - will mean "not concealed" as previously defined. Work behind doors, in closets or cupboards, or under counters is considered exposed. Work in Mechanical and Boiler Rooms is considered exposed.
 - .3 "COLD PIPING" refers to the following systems: Domestic Cold Water, Plumbing Vents, and Condensate Drip Drains.
 - .4 "HOT PIPING" refers to Domestic Hot Water Supply and Recirculation piping.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.5 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 in accordance with Section 01 33 00 - Submittal Procedures]. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

- .3 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 label beneath sample indicating service.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.

1.6 QUALITY ASSURANCE

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards, member of TIAC.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102.

- .1 Maximum flame spread rating: 25.
- .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Maximum "k" factor: at 24oC (75oF) mean temperature and be capable of use on service from -40oC to 260oC (-40oF to 500oF) to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Jacket: to CGSB 51-GP-52Ma.
 - .2 Maximum "k" factor: to 0.035 035 at 24oC (75oF) mean temperature; and be capable of use on service from -40oC to 260oC (-40oF to 500oF); and with factory applied vapour all service jacket of paper with reinforcing of open mesh glass fibre CAN/ULC-S702.
- .5 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Jacket: to CGSB 51-GP-52Ma.
 - .2 Maximum "k" factor: 0.27 at 24oC (75oF) mean temperature and be capable of use on service from -40oC to 260oC (-40oF to 500oF) to ASTM C 177 or ASTM C518.
 - .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Air drying to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

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

2.7 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: Default white or to match adjacent finish paint as selected by Consultant.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.5 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .2 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: smooth 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, 0.5mm thick at 300 mm spacing.
 - .7 On exposed outdoor piping only.
- .3 Canvas:
 - .1 170 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
 - .3 Location:
 - .1 Indoor where exposed to mechanical damage ie. Mechanical rooms.
- .4 Miscellaneous Applications:
 - .1 Provide 'Trap-Wrap' or equal insulation on all P-traps on all Lavatories, whether noted as handicap accessible or not.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

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

3.3 INSTALLATION

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

3.4 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers' instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.
- .3 Finishes:
 - .1 Exposed outdoors: Two coats of compatible paint.
 - .2 Indoors: None.

3.5 PIPING INSULATION SCHEDULES

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

- .1 Securements: Tape at 300 mm on centre.
- .2 Seals: VR lap seal adhesive, VR lagging adhesive.
- .4 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (DN) and insulation thickness (mm)					
			Run out	to 25	32 to 50	65 to 100	125 to 150	200 & over
	up to 175	A-1	38	50	65	75	90	90
Domestic HWS		A-1	25	25	25	38	38	38
Domestic CWS		A-3	25	25	25	25	25	25
Domestic CWS with vapour retarder		C-2	25	25	25	25	25	25
Refrigerant hot gas, liquid, suction	4 - 13	A-6	25	25	25	25	25	25
Refrigerant hot gas, liquid, suction	below 4	A-6	25	25	38	38	38	38
RWL and RWP		A-3	25	25	25	25	25	
Cooling Coil cond. drain		A-3	25	25	25	25	25	

- .5 Equipment and Miscellaneous Applications:
 - .1 Roof Drain bodies: 25 mm (1")
 - .2 P-traps: Refer to 'Miscellaneous Applications' in Part 2 of this Specification Section.
- .6 Finishes:
 - .1 Exposed indoors: canvas or PVC jacket.
 - .2 Exposed in mechanical rooms: canvas jacket.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on code A-3 insulation compatible with insulation.
 - .5 Outdoors: water-proof, aluminum jacket.
 - .6 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.6 FIELD QUALITY CONTROL

- .1 Contractor's Verification], include:

- .1 Materials and resources.
- .2 Storage and collection of recyclables.
- .3 Construction waste management.
- .4 Resource reuse.
- .5 Recycled content.
- .6 Local/regional materials.
- .7 Certified wood.
- .8 Low-emitting materials.

3.7 CLEANING

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Provision of all required equipment, piping, and chemicals, for the flushing, cleaning and degreasing of all piping systems.
- .2 Section 21 05 01, Common Work Results for Mechanical.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .2 Submit shop drawings on all equipment and piping arrangements, and provide a list of chemicals.
- .3 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Qualifications: Execute work of this section only by skilled tradesman, technicians, and manufacturers regularly employed in the administration of piping system chemical treatment.

1.1 START-UP AND COMMISSIONING

- .1 Provide the Equipment, Personnel, Material and Information necessary to assist the Mechanical Contractor in completing the Commissioning Process.
- .2 Complete the required forms.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 WATER TREATMENT

- .1 Domestic Water Piping:
 - .1 Thoroughly flush and disinfect all new Domestic Water Piping Systems as per Municipal Standards.
 - .2 Use Chlorine (gas or liquid). Calcium or Sodium Hypochlorite, or other approved disinfectant may also be used.
- .2 Provide welding sockets where required or shown on the drawings, and piping from there to the equipment required for water treatment such as pumps, chemical storage tanks, etc. Include all necessary piping, valves, accessories and control wiring.
- .3 Use only chemicals and methods that comply with local health codes and do not have a detrimental effect on non-metallic materials such as rubber, neoprene, etc., used in the systems.
- .4 Test equipment: Provide all test apparatus which shall include all required chemicals, comparator, titration equipment, test tubes, etc. to provide a complete testing facility for the treated systems, and turn over to the Departmental Representative.

2.1 CLEANING SOLUTIONS

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 GENERAL

- .1 Clean and disinfect systems only after all pipes, valves, fittings, fixtures and other components have been installed, tested, and proven ready for operation.
- .2 If at any time during the treatment, test results prove unsatisfactory, treatment shall be stopped and redone until results prove satisfactory.

3.2 PROCEDURE FOR OPEN SYSTEMS

- .1 Remove screens from faucets.
- .2 Flush systems with clean potable water to remove dirt and other contaminants.
- .3 Replace screens in faucets.
- .4 Inject the disinfectant at a service cock and ensure all sections of piping are treated.
- .5 Open each outlet at least twice during injection.
- .6 Test chlorine concentration before and after retention. Initial Chlorine concentration shall be not less than 50 ppm, and shall be retained in the system for a minimum of 24 hours. Concentration after retention shall be no less than 5 ppm.
- .7 Flush system with clean potable water until residual chlorine concentration is no greater than that of the incoming water supply. Test Chlorine concentration.
- .8 Submit a written report showing methods, tests and results.
- .9 Submit a written report of the system start-up showing water analysis test. Include copies in the O & M manuals.

3.2 CLEANING

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

END OF SECTION

General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 - Submittal Procedures
- .2 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
- .3 Section 01 78 00 - Closeout Submittals
- .4 Section 21 05 01, Common Work Results for Mechanical.

1.2 WORK PERFORMED UNDER THIS SECTION

- .1 The mechanical subcontractor shall provide all labour, materials, equipment and services necessary for and reasonably incidental to the supply and installation of the ductwork for the air conditioning systems as shown on the drawings and hereinafter specified.
- .2 Provide a complete installation of all ventilation systems including fans, ductwork, grilles, diffusers, louvres, dampers, filters, etc.
- .3 Provide Equipment, Personnel and Material necessary to assist with Air Balancing.

1.3 START-UP AND COMMISSIONING

- .1 Start-up and Commissioning shall be undertaken prior to the Occupancy stage of each Construction Phase.
- .2 Provide the Equipment, Personnel and Material necessary to put the Air Distribution Systems into Operation.
- .3 Provide the Equipment, Personnel, Material and Information necessary to assist the Mechanical Contractor in completing the Commissioning Process.
- .4 Complete the required forms.

1.4 QUALITY ASSURANCE

- .1 Execute work of this Section only by skilled tradesmen regularly employed in the manufacture and installation of sheet metal ductwork and air handling equipment.

1.5 SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:

- .1 Submit drawings stamped and signed by the responsible contractor and the GC.
- .2 Submit shop drawings on fans, grilles, diffusers, louvres, fire dampers, fire/smoke dampers, filters, and filter gauges.

PART 2 Products

2.1 FANS

- .1 The following are general specifications. Refer to the Individual Fan Specifications on the Drawings for operating characteristics, specific requirements, and any deviations.
- .2 In-line Cabinet Fans:
 - .1 Galvanized steel housing c/w access panel(s)
 - .2 Internal acoustic lining
 - .3 Horizontal in-line configuration
 - .4 Double strength mounting flanges/brackets
 - .5 Permanently lubricated, 115V/1 phase, motor
 - .6 Motor suitable for use with speed controller
 - .7 Motor directly connected to fan wheel
 - .8 Motor/fan assembly to be mounted with vibration isolation/rubber grommets
 - .9 Plug-in power cord
 - .10 Motor assembly to be removeable through access panel without disturbing housing
 - .11 Integral chatter-proof backdraft damper
 - .12 When specified: roof or wall cap
 - .13 When specified: time delay, wall-mounted, on-off switch
 - .14 When specified: 115V/1 phase, variable (infinite) speed controller, suitable for wall mounting
 - .15 Rated in accordance with CAN/CSA-C260-M and conforming to CSA C22.2

2.2 FILTER GAUGES

- .1 Across the filter bank of each air handling unit, and each air-to-air heat exchanger provide magnehelic differential pressure gauges, Dwyer series 2000 range 0 to 2" w.c. (0 to 50 mm w.c.).

2.3 FILTERS

- .1 General:
 - .1 Equipment manufacturer to provide filters in filter sections provided with equipment.
 - .2 Filter supplier to provide all other filters.
 - .3 This section shall fabricate filter sections not provided with equipment. Provide hinged access panels with latching handles. Filter sections shall be sized for maximum 500 fpm through media.
 - .4 Provide one spare set of media for each filter bank.

- .5 Some filter frames are specified without filters. During cold winter periods some filters can be relocated by the Departmental Representative or their forces to the discharge side of heating equipment to prevent the frosting of filters.
 - .6 All filter media used during "temporary heating" shall be replaced by new media at regular intervals during equipment use. Contractor shall allow for two (2) complete filter changes after substantial completion, ie. one set installed immediately prior to opening, and a spare set handed over to Departmental Representative. The Contractor shall coordinate with the Departmental Representative regarding timing. Install a new set of filter media and hand one spare set of media (for each filter) to the Departmental Representative at substantial completion. Obtain written statement from the Departmental Representative acknowledging the receipt of the spare sets. Forward one copy of the written statement from the Departmental Representative to the Consultant.
- .2 Filter Media:
 - .1 High capacity pleated panel, 100 mm depth.
 - .2 Value of MERV 8 and MERV-A when evaluated under ASHRAE Testing Standard 52.2.
 - .3 Recommended final pressure drop: 1.0" w.g. when operated at 500 fpm.
 - .4 Standard of Acceptance: Equal to Camfil Farr 30/30.

2.4 MOTORIZED DAMPERS

- .1 Unless noted otherwise, motorized dampers are to be provided on equipment, or supplied by the controls contractor and installed by the sheet metal contractor.
- .2 Where motorized dampers are to be provided by the sheet metal contractor, they shall be opposed blade style, with neoprene edge and blade seals, and rated for maximum 5% leakage.
- .3 Dampers for Outside Air, Exhaust Air, Relief air and all uses where the indoors are isolated from the outdoors shall be ultra-low leakage, opposed blade style, thermally broken with neoprene edge and blade seals; equal to TAMCO 9000.

2.5 FIRE DAMPERS AND FIRE STOP FLAPS

- .1 Provide where shown on the drawings and required to maintain fire separations, type 'B' or 'C', gravity or spring type, U.L.C. labeled and listed, curtain type fire dampers. Use type "A" only where mounted directly behind supply or return grilles.
- .2 Do not use asbestos in any form in the construction of fire dampers or fire stop flaps.

2.6 COMBINATION FIRE/SMOKE DAMPERS

- .1 Provide where shown on the drawings, and where required to maintain smoke separations, combination fire/smoke dampers meeting all requirements of ULC, UL, NBC and NFC.
- .2 Dampers shall be equipped with fusible linkages for fire operation.

- .3 Dampers shall be equipped with 120V (spring close) damper motors mounted outside of the airstream and wired to the fire alarm system. Motors shall be c/w an end switch, suitable for wiring to a test switch and light.
- .4 Motors shall be Honeywell Model ML-4115, or Belimo FS-NF-120-S, with no alternates or equals.

2.7 FLEXIBLE CONNECTIONS

- .1 General HVAC System: provide where indicated, at fans and at air handling units, neoprene coated glass fabric, factory fabricated, flexible connections, as approved by the Authorities Having Jurisdiction.
- .2 Except where noted otherwise, connections up to 750 mm (30") in the largest dimension shall be 100 mm (4"). Connections larger than 750 mm to be 150 mm (6").

2.8 TURNING VANES

- .1 Use in duct elbows which have a throat radius of 1-1/2 times the diameter.
- .2 Where use of above item is precluded by space limitations, use duct elbows fabricated with square throats and backs and fitted with "Rovane", single thickness turning vanes with trailing edge.

2.9 DUCTWORK

- .1 Provide all ductwork including all appurtenances, hangers, dampers, turning vanes, etc.
- .2 All ductwork shall be constructed of new, prime material free of imperfections, which is guaranteed to bend and flatten without fracture.
- .3 Low and Medium Pressure Ductwork:
 - .1 Except as noted above, provide ductwork constructed of galvanized steel sheets as follows:
 - .1 Round spiral 4 ply seam
 - .1 Up to 450 mm (18") 26 Ga.
 - .2 457 to 750 mm (19" to 30") 24 Ga.
 - .3 Slip joint with 3 @ #8 screws evenly spaced.
 - .2 Rectangular with Longitudinal seam
 - .1 Up to 300 mm (12") S and Drive cleat 26 Ga.
 - .2 325 to 750 mm (13" to 30") S and Drive cleat 24 Ga.
 - .3 775 to 1275 mm (31" to 50") 22 Ga.
25 mm (1") bar slip or standing T @ 1.5 m (60") o.c. (max).
 - .4 1300 to 1500 mm (51" to 60") 20 Ga.
40 mm (1-1/2") bar slip or standing T @ 1.5 m (60") o.c. (max).

.3 Cross break all rectangular ductwork greater than 600 mm (24") wide.

.2 Flexible, insulated duct may be used for diffuser connections. Maximum length: 1800mm (6'-0").

2.10 ACOUSTIC INSULATION

.1 In accordance with Section 23 07 13.

2.11 DUCT ACCESS DOORS

.1 Access doors shall be latched and gasketed, constructed of 22 gauge materials with flat iron or angle iron stiffening forms, so constructed that the door can be operated without twisting or distortion.

.2 Doors in insulated ductwork: double panel construction with a 25 mm (1") insulating filler.

2.12 REGISTERS, GRILLES, DIFFUSERS

.1 Refer to Grille and Diffuser Schedule on the Drawings.

.2 Air extractors shall be provided where indicated and/or where supply outlets are directly connected to a trunk duct.

.3 All supply diffusers shall be equipped with manufactured balancing dampers where branch duct dampers are not shown.

2.13 LOUVRES

.1 Louvres shall be 100mm (4") thick, extruded aluminum, c/w bird screen.

2.14 SPLITTER AND QUADRANT DAMPERS

.1 Provide splitter and quadrant dampers where shown on the drawings and as directed by the air balancing contractor.

.2 Construct dampers of not less than 22 gauge material. Where installed in ducts up to 300 mm (12") high, provide single blade dampers. Where installed in ducts greater than 300 mm (12") high, provide multi-blade dampers, each blade being not higher than 228 mm (9").

2.15 DRIP PANS

.1 Field installed drip pans shall be constructed of galvanized steel one gauge heavier than indicated in duct gauge schedule, with all joints soldered. Line inside with two coats of mastic and insulate exterior.

- .2 Pans shall have 50 mm (2") high sides and shall be 150 mm (6") larger in both directions than the size of the device or opening requiring the pan.
- .3 Provide soldered drain fitting and 25mm (1") drain line to nearest floor drain, or to location noted on the drawings.

2.16 SECURITY BARS

- .1 Provide in all ductwork and openings penetrating exterior walls and roofs that are 300mmx300mm (12"x12") in size and over.
- .2 Security bars to be steel rods of 13 mm diameter at 150 mm on center in both directions, securely anchored to the structure.
- .3 Coordinate the installation with all trades.

PART 3 Execution

3.1 FANS

- .1 Comply with manufacturers requirements.
- .2 Ensure vibration free installation.
- .3 Leave access for servicing.
- .4 Install belt guards and weather proof covers as required.

3.2 MOTORIZED DAMPERS

- .1 Install automatic dampers free from distortion and binding of linkages.
- .2 Thoroughly caulk around damper frame.

3.3 FIRE DAMPERS AND FIRE STOP FLAPS

- .1 Locate in fire assemblies and where indicated on the Drawings.
- .2 Install to U.L.C. requirements. Refer to detail drawings.
- .3 Seal around fire damper assembly.
- .4 After completion, have installation approved prior to concealment.

3.4 FILTER GAUGES

- .1 Sensing Points: Locate as directed by the manufacturer and carefully clip tubing to avoid damage and interference with filter removal or servicing.

- .2 Mount gauges for convenient observation.

3.5 DUCT INSTALLATION

- .1 Install ductwork in accordance with SMACNA duct construction standards.
- .2 Ground across flexible connectors with No. 2/0 braided copper strap.
- .3 Install balancing dampers at branch ducts.
- .4 Seal all ductwork joints with high velocity duct sealer - maximum leakage 5%.
- .5 Hangers: Galvanized steel angle with supports rods, locking nuts and washers to the following table. For ducts up to 600mm (24") diameter, 25mm (1") x 20 ga strap hangers may be substituted. Strap hangers to be screw fastened at 100mm (4") o.c. along sides and with at least one screw through the bottom of the duct. Space strap hangers at 2400mm (8'-0") o.c.

<u>Duct Size</u>	<u>Angle Size</u>		
<u>Rod Size</u>	<u>Spacing</u>		
Up to 750mm 3000mm (30") (10'-0")	25mm x 25mm x 3mm (1" x 1" x 1/8")	6mm	(1/4")
755mm to 1000mm 3000mm (31" to 40") (10'-0")	40mm x 40mm x 3mm (1-1/2" x 1-1/2" x 1/8")	6mm	(1/4")
1005mm to 1500mm 3000mm (41" to 60") (10'-0")	40mm x 40mm x 3mm (1-1/2" x 1-1/2" x 1/8")	10mm	(3/8")

- .6 During installation, protect open ends of ducts to prevent debris and dirt from entering.
- .7 Where ducts are shown alongside of partitions, place tight to the surface.
- .8 Provide baffles, where required to reduce problems of air stratification, as directed by the Engineer.
- .9 Provide flashings and counter-flashings to suit individual locations.

3.6 VIBRATION AND OBJECTIONABLE NOISES

- .1 Install ductwork free from pulsation, chatter, vibration or objectionable noises. Should any of these defects appear after the system is in operation, correct same by either removing, replacing or reinforcing the work as directed by the Engineer.

3.7 PLENUMS AND CASINGS

- .1 Install hinged doors to swing outward on the suction side of the fan and inward where a positive pressure may exist in the plenum.
- .2 Provide gasketing around all doors and seal all seams and joints with high velocity duct sealer.
- .3 Construct coil mounting racks to ensure capability of future removal.
- .4 Provide two coats of mastic compound on inner surface of drip trays.
- .5 Seal all joints in filler pieces to prevent by-pass and install filter banks for easy servicing.

3.8 GRILLES, REGISTERS AND DIFFUSERS

- .1 Set squarely in place parallel to adjacent building lines.
- .2 Floor grilles to be set flush with floor coverings except carpet. Frame to lap over carpet.
- .3 Ensure devices are set rigidly in place and properly secured.

3.9 FRESH AIR AND EXHAUST LOUVRES

- .1 Caulk all joints at louvre connection and make duct connection water tight.
- .2 Provide 6 mm mesh screen to prevent foreign matter from entering duct work. .

3.10 DUCT AND PLENUM CLEANING

- .1 Responsibility: it is the responsibility of the sheet metal sub-trade to ensure that all ductwork installed or modified under this contract is internally and externally clean when handed over to the Departmental Representative. It includes all ductwork whether lined or not, all plenums and all equipment within duct and plenums.
- .2 Installation Procedure: Wipe or brush ducts clean immediately before installation. Close all dampers immediately following installation thus checking the operation and retarding movement of contaminants through the system. Seal all openings at the end of each day and at such other time as site conditions dictate. Floor opening to be capped with sheet metal or floor grilles plus 0.15 mm thick poly. Other openings to be covered with 0.15 mm thick poly sheet taped so as to be air tight. The ducts must remain sealed until the systems area is ready to be started up and must be resealed if subsequent construction creates a risk of dust entering the ductwork.
- .3 Cleaning Procedure:

- .1 On completion of the duct and plenum installation and prior to the installation of grilles, registers and diffusers and the use of air systems:
- .2 Vacuum clean all plenums.
- .3 Install air filters of the specified performance.
- .4 Blow-out all supply ducts by operating the supply fan.
- .5 Install grilles, registers and diffusers.
- .6 Prior to balancing the air systems, but not until authorized by the Design Authority.
- .7 Vacuum clean all supply and return air ducts, all plenums and all coils.
- .8 Submit a report that certifies all specified air systems have been cleaned. The Design Authority will inspect for cleanliness of ductwork at Substantial Performance.
- .9 The cleaning shall be to the satisfaction of the Design Authority and Departmental Representative.

3.11 AIR BALANCING

- .1 In accordance with Section 23 05 93.

3.12 START UP AND COMMISSIONING

- .1 Prior to the Occupancy Stage of each Construction Phase:
 - .1 Start up the Equipment and Systems.
 - .2 Calibrate and adjust all items provided under this contract.
 - .3 Assist in the Commissioning Process as required
 - .4 Provide instructions to Departmental Representative as required.

END OF SECTION