

Part 1 General

1.1 MINIMUM STANDARDS

- .1 Conform to or exceed:
 - .1 CSA Standards.
 - .2 ASHRAE Standards.
 - .3 SMACNA Standards.
 - .4 Provincial Codes, Local Municipal By-Laws, all codes of utility authorities having jurisdiction.

1.2 REFERENCES

- .1 Material and installation standards:
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2006.
 - .2 SMACNA Duct Leakage Test Manual 1985.
 - .3 NFPA 90A-2012, Installation of Air Conditioning and Ventilating Systems.
 - .4 CAN/ULC-S110-07, Standard Methods of Test for Air Ducts.
 - .5 CAN/ULC-S112-10, Standard Method of Fire Test of Fire Damper Assemblies.
 - .6 CAN/ULC-S702-09, Standard for Mineral Fibre Thermal Insulation for Buildings.
 - .7 CAN/CSA-B52-05(R2009), Mechanical Refrigeration Code.
 - .8 CAN/CSA-B149.1-10, Natural Gas and Propane Installation Code.
 - .9 CGSB 51-GP-52Ma-89, Vapour Barrier Jacket and Facing Material.
 - .10 ASTM A653-10/A653M-10, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.
 - .11 ASTM B280-08, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - .12 ASTM C534-08/534M-08, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - .13 ASTM C547-11, Standard Specification for Mineral Fiber Pipe Insulation.
 - .14 ASTM C612-10, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .15 ASTM C919-08, Standard Practice for Use of Sealants in Acoustical Applications.
 - .16 ASTM C1071-05e1, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .17 ASTM F683-10, Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery.
 - .18 ASTM G21-09, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
 - .19 ASTM G22-76(1996), Standard Practice for Determining Resistance of Plastics to Bacteria.

1.3 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets in accordance with Sections 01 11 00, 01 33 00, 01 78 00 and 23 05 00 for the following:
 - .1 Fire dampers.
 - .2 Grilles and Diffusers.
 - .3 Make-up Air Unit.

- .4 Filters.
- .5 Controls and instrumentation Products

Part 2 Products

2.1 LOW PRESSURE DUCTWORK

- .1 Material: forming steel FS Type A steel with Z275 designation zinc coating to ASTM A653/A653M, minimum 30% recycled content.
- .2 Gauge and construction of ducts and fittings shall be in accordance with SMACNA HVAC Duct Construction Standards for rectangular ducts for positive and negative static pressure up to 500 Pa with leakage rate of 5% maximum.
- .3 Seal classification: All longitudinal and transverse joints and connections made airtight with sealant.
- .4 Hangers:
 - .1 Ducts shall be supported with 10 mm steel rods and 50 x 50 x 6 mm angles. Maximum spacing of hangers to be 2.5 m.
 - .2 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel deck or use powder actuated fasteners.
- .5 Radius of duct elbow shall be at least equal to the width of the elbow. Use square elbow with double thickness turning vanes when space is limited.
- .6 Provide balancing dampers at all branch ducts and as indicated. Each damper shall be fitted with locking type quadrant operator.
- .7 Duct leakage: in accordance with SMACNA HVAC Duct Leakage Test Manual.
- .8 Applications: supply air ducting downstream of Make-up Air Unit, all exhaust air ducting, and all return air ducting.

2.2 FLEXIBLE DUCTWORK

- .1 Factory fabricated Class 1 air duct to CAN/ULC- S110. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.
- .2 Duct must withstand 2.5 kPa internal pressure.
- .3 Material: triple lock flexible aluminum.
- .4 Do not lay ducts across any lighting fixtures or hot surfaces.
- .5 Maximum length of flexible duct connections: 1 m.
- .6 Make connections between flexible duct and terminal devices airtight with duct sealer.

2.3 ACOUSTIC DUCT LINING

- .1 Except noted otherwise, provide 25 mm thick rigid fibrous glass duct liner to ASTM C1071, density 48 kg/m³, with neoprene coating on air side.
- .2 Fasten duct liner to interior sheet metal surfaces with 100% coverage of an approved fire resistant bonding adhesive. Ductwork with any side greater than 300 mm shall have additional mechanical fasteners spaced at not more than 300 mm centres.
- .3 Seal edges, pin penetrations and joints with an approved fire resistant mastic. Protect leading and trailing edges with sheet metal edging.

- .4 Flame spread rating on interior lining shall not exceed 25, smoke development shall not exceed 50.
- .5 Duct sizes indicated on drawing are sizes of inside liner. Increase sheet metal sizes to suit.

2.4 DUCT SEALANTS AND TAPES

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

2.5 DUCT ACCESS DOOR

- .1 Provide for access to fire or other dampers and for service or inspection, and for cleanouts where required, panel type access doors, 300 x 300 mm unless otherwise stated, complete with two sash locks.

2.6 BALANCING DAMPERS

- .1 Approved units of thicknesses and type of construction in accordance with SMACNA HVAC Duct Construction Standards or as noted.
- .2 Splitter dampers: where indicated with control rod with locking device on exterior of duct. Damper to be single thickness one gauge heavier than duct.
- .3 Single blade butterfly dampers: where indicated with locking quadrant.
 - .1 Round butterfly dampers to be 1.6 mm thick in medium pressure ducts and 0.8 mm in low pressure ducts.
 - .2 Rectangular butterfly dampers to thicknesses indicated in SMACNA.
- .4 Multi-leaf opposed blade dampers: designed to SMACNA details with locking quadrant.

2.7 FIRE DAMPERS

- .1 Fire dampers: listed and bear label of ULC, and shall meet requirements of Federal Fire Commissioner (FFC), CAN/ULC-S112 "Test of Fire Damper Assemblies", and authorities having jurisdiction.
- .2 Factory fabricated for fire rating requirement to maintain integrity of membrane being pierced.
- .3 Fire dampers shall be single-blade, multi-blade or curtain type, sized to maintain full flow cross section as indicated.
- .4 Complete with frame and 40 x 40 x 3 mm steel angle on full perimeter of frame on both sides of barrier being pierced.
- .5 Provide at each fire damper an access door for access to fusible links.
- .6 Follow NFPA 90A and manufacturer's installation instructions including the installation of drywall filler pieces when installed in a gypsum board wall.

2.8 THERMAL INSULATION AND JACKETING

- .1 Insulate all supply air ducting.
- .2 Material:
 - .1 On exposed rectangular ducting: 25 mm thick rigid mineral glass fibre board to ASTM C612-04e1 and vapour barrier jacket to CGSB 51-GP-52Ma.

- .2 On concealed rectangular ducting: 25 mm thick glass fibre blanket to CAN/ULS-S702 and vapour barrier jacket to CAN/CGSB 51-GP-52Ma. 25 mm thick rigid mineral glass fibre board to ASTM C612-04e1 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .3 On round ducting: 25 mm thick glass fiber blanket to CAN/ULS-S702 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .4 On ductwork routing outside the building: 50 mm thick rigid mineral glass fibre board to ASTM C612-04e1 covered with water proof membrane and aluminum jacketing.
- .3 Fastenings on rectangular ducts:
- .1 Use 50% coverage of insulation adhesive. Flame spread 15, smoke development 0.
 - .2 If duct is over 635 mm wide, provide weld pins in addition to insulation adhesive. Place weld pins at not more than 200 mm centres, and not less than 2 rows per side.
- .4 Fastenings on round ducts: Use 100% coverage of insulation adhesive of flame spread 15, smoke development 0, and 100 mm wide self-adhesive tape rated under 25 for flame spread and under 50 for smoke development.
- .5 Vapour barriers: Use quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
- .6 Vapour barriers and insulation to be complete over the full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves.
- .7 Provide canvas cover over all insulated ducts in exposed areas. Canvas cover to be compact, firm, ULC listed heavy plain weave, cotton fabric at 272 g/m². Provide two coats of diluted fire retardant lagging adhesive over canvas covering.
- .8 Aluminum jacketing to ASTM B209 with moisture barrier, 0.5 mm thick, smooth finish, secured with stainless steel banding.

2.9 GRILLES, REGISTERS, TURNING VANVES, DAMPERS, ETC.

- .1 Supply and install all items as listed herein and as shown on schedule on drawings. Grilles registers, diffusers, etc., equivalent to E. H. Price, Titus, Krueger or Nailor.
- .2 At ends of runs and at other points in ductwork where 12 radius cannot be formed, duct turns equivalent to Duro Dyne shall be provided.
- .3 All dampers shall be provided as shown on drawings and as specified. Balancing dampers shall be provided as shown on drawings. Equip with manual lever and quadrant lock. On ducts smaller than 450 mm butterfly type dampers may be used. Blade shall be 16 gauge securely fastened to rod. Equip with lever and quadrant lock. All damper rod ends shall be slotted with the slot running parallel to the damper blade.

2.10 EXHAUST FANS, CIRCULATION FANS

- .1 All fans throughout shall be as noted on schedule or as shown on drawings and shall have capacities at condition as noted on schedule or drawings. Specifications refer to Greenheck or Cook or as noted on schedule. Fans shall be internally mounted on isolation springs or rubber-in-shear.

- .2 All fans exhausting to the outside shall have backdraft dampers and shall have all ductwork insulated as specified.
- .3 Utility fans shall be complete with hoods to act as belt guard.
- .4 All belt drives shall have adjustable sheaves and detachable belt guards.
- .5 All fan parts shall be finished with factory primer.
- .6 Fans shall carry AMCA label.
- .7 Remote units to have disconnects in housing.
- .8 Propeller fans to have wire guards and inlets not ducted shall have wire guards.
- .9 All inline fans shall be provided acoustically insulated fan cabinets (minimum 25 mm thick fiberglass insulation with coating).

Part 3 Execution

3.1 EXISTING AND REUSED CONTROLS

- .1 Recalibrate and test existing and reused control devices shown on the drawings.
- .2 Report any inoperative control device to Departmental Representative immediately and obtain Departmental Representative's instructions.

3.2 INSTALLATION

- .1 Install material and equipment in accordance with referenced standards and manufacturer's written instructions.
- .2 Make good all existing insulation where previously damaged by others or damaged by work under this contract.

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 This Section covers items common to Division 23.
- .2 "Provide" shall mean "supply, install and connect".
- .3 Provide new materials, equipment and plant of proven design and quality, and of current models with published ratings for which replacement parts are readily available.

1.2 CODES, REGULATIONS, PERMITS, FEES AND INSPECTIONS

- .1 Conform to the latest edition and supplements of the following for all materials and installations:
 - .1 National Building Code of Canada, as amended by local Bylaws and Provincial Statutes.
 - .2 Codes, Standards, Bylaws, Statutes and Manufacturer's Association Specifications or instructions mentioned in Division 23 sections, refer to latest revisions thereof at time of calling of bids, unless specifically designated otherwise.
 - .3 In no instance shall the standard established by the drawings and specifications be reduced by Code or otherwise.
 - .4 Furnish all notices, obtain all necessary permits related to Division 23 works.
 - .5 Employ tradesmen fully qualified under Provincial and local regulations pertaining to licensing and qualifications for tradesmen for this work.

1.3 EQUIPMENT LIST

- .1 Complete list of equipment to be used on this project by adding manufacturer's name and model number. Submit for approval within one week of award of contract.
- .2 The Contractor is to complete the following list of equipment with manufacturer's name and model number:
 - .1 Make-up Air Unit.
- .3 It is the Contractor's responsibility to ensure that the equipment to be used will meet the performance specifications and will fit the spaces allocated.
- .4 Submit for approval within 48 h after Award of Contract.

1.4 CUTTING AND REMEDIAL WORK

- .1 Cutting and remedial work is specified in Section 01 11 00.
- .2 Assume full responsibility for laying out mechanical work and for any damage caused by incorrectly located equipment and mechanical services.
- .3 Set sleeves and mark openings in concrete forms and in masonry before placing of concrete and erection of masonry.

1.5 COORDINATION

- .1 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.

- .2 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials.

1.6 DRAWINGS

- .1 Working drawings, except where dimensioned, indicate general mechanical layouts only. Do not scale.
- .2 Existing equipment and services shown on the drawings:
 - .1 The information shown on the drawings is incomplete and is for reference only. Some of the existing equipment, ducts, pipes and other services are not shown on the drawings.
 - .2 The Contractor shall make arrangements to examine existing conditions, determine conditions affecting the work, and verify sizes and location of existing equipment, ducts, pipes and any other services. Refer to Section 01 11 00 and 01 45 00 for instructions regarding site visits.
 - .3 Unless the discrepancies are noted and reported to the Departmental Representative prior to close of the bid, the Contractor shall be responsible for the work to relocate existing equipment and to reroute existing ducts, pipes and any other services required for the installation of new work at no extra cost to the contract.
- .3 If required by Departmental Representative, provide field drawings to show relative positions of various services. Obtain approval before beginning work.

1.7 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets for major equipment listed in each section.
- .2 Submit early enough to permit Project Schedules to be met.
- .3 Show materials; sizes, dimensions, performance ratings, curves and operating characteristics, compliance with codes and standards, wiring, controls, piping diagrams, installation instructions, fabrication, assembly and installation details.
- .4 For additional requirements pertaining to shop drawings and product data refer to Section 01 11 00 and 01 33 00 and 01 78 00.

1.8 OPERATION AND MAINTENANCE DATA

- .1 Supply operating and maintenance instructions complete with names and addresses of spare parts suppliers in accordance with requirements of Section 01 11 00 and 01 78 00.

1.9 EQUIPMENT DESIGN AND INSTALLATION

- .1 Uniformity:
 - .1 For equipment or material of same type or classification, use product of one manufacturer.
- .2 Installation:
 - .1 Install equipment to manufacturer's recommendations with adequate and easy access for inspection, servicing and lubrication.
 - .2 Install equipment to permit maintenance and disassembly with minimum disturbance to connecting piping and duct systems and without interference with building structure or equipment.
 - .3 Provide screwdriver stops on supplies to plumbing fixtures.
 - .4 Provide support brackets, bases, and all necessary fastenings.

1.10 ELECTRIC MOTORS AND CONTROLS

- .1 Electrical equipment shall bear CSA label. Obtain inspection labels required by Provincial authority having jurisdiction.
- .2 Use high efficiency motors. Minimum acceptable motor efficiency levels shall be based on the latest table of motor efficiency levels in accordance with CSA C390-10, Test methods, marking requirements, and energy efficiency levels for three-phase induction motors.
- .3 Unless otherwise specified or indicated, motors ½ HP and larger shall be 3 phase.
- .4 Refer to Electrical Division regarding specifications of power wiring (i.e. wiring carrying the full load current), conduits, starters, disconnect switches, etc., for mechanical equipment specified in Mechanical Divisions. Unless noted and specified in Electrical Divisions to be provided by Electrical Divisions, all field installed power wiring, conduit, starters, disconnect switches, etc., shall be provided by Mechanical Divisions.
- .5 Provide motors, control wiring and controls together with associated relays, signalling devices, thermostats, control transformers, firestats, pressure switches, electric- pneumatic switches, required to form a complete control system for the equipment specified in Mechanical Divisions.

1.11 EQUIPMENT SUPPORTS

- .1 Provide vibration free guards on exposed drives and rotating parts to meet safety requirements of Provincial Ministry of Labour and local authorities having jurisdiction.
- .2 Provide 20 mm mesh wire screen on inlet or outlet of exposed fan blades.
- .3 Provide restraining chains and fasteners to hold access doors open when doors close in direction of air pressure.

1.12 PIPING SUPPORTS

- .1 Unless noted otherwise, fabricate equipment supports from structural grade steel. Submit structural calculations with shop drawings.

1.13 PIPING INSTALLATION

- .1 Conform to requirements of ASME B31.1-2012, Power Piping.
- .2 Provide dielectric couplings where piping of dissimilar metals are joined.
- .3 Provide easily accessible unions close to equipment, to permit easy removal of equipment with minimum disturbance to piping systems.
- .4 Valves:
 - .1 Provide easy access for servicing and operation. Install access doors where concealed.
 - .2 Install with stems above horizontal.
- .5 Drainage:
 - .1 Provide easily accessible drain valves at low points to permit complete drainage of piping systems.
 - .2 Extend equipment drain piping to discharge into floor or hub drain.
 - .3 Provide drain piping from drain pan of air handling units, full size of outlet connection and equip with deep-seal trap.
- .6 Expansion and Contraction:
 - .1 Make adequate provision for expansion and contraction of piping systems.

- .2 Use expansion joints and compensators, flexible connections, pipe loops and offsets as indicated and required.
- .3 Support piping to prevent any stress or strain from occurring at connections to equipment.
- .4 Install and guide expansion joints in accordance with manufacturer's recommendations.
- .5 Provide steel anchors welded to piping, fastened to building structure or embedded in concrete pier so that forces acting on anchor points are restrained without causing damage to structure or systems.
- .6 Base design axial traverse on temperature difference between -18°C ambient and corresponding fluid temperature plus 25% safety factor.

1.14 PIPE HANGERS AND SUPPORTS

- .1 Fabricate hangers, supports and sway braces in accordance with ASME B31.1-2012.
- .2 Provide adjustable clevis type hangers on all sizes of pipe except where roller type hangers are required.
- .3 Minimum 150 mm hanger rod length.
- .4 Provide hangers on piping with heated or cooled contents as follows:
 - .1 Rigid hangers when rod length is 300 mm or more, pipe expansion to hanger rod length ratio is less than 1:24 and hanger is supported from top of structural steel.
 - .2 Swing hangers when rod length is 300 mm or more, pipe expansion to hanger rod length ratio is less than 1:6 and hanger is supported from top of structural steel.
 - .3 Roller hangers when rod length is less than 300 mm or pipe expansion to hanger rod length ratio is more than 1:6 or hanger is not supported from top of structural steel.
- .5 On uninsulated copper piping, ensure steel hangers in contact with copper piping are copper plated. Copper pipe shall not contact steel, iron or cinder materials. Covered 12 mm diameter copper pipe may be supported on copper straps.

1.15 SLEEVES, ESCUTCHEONS AND PLATES

- .1 Sleeves:
 - .1 Provide schedule 40 steel pipe sleeves where pipes pass through masonry or concrete walls or floors. Apply watertight caulking compound between pipe and sleeve in exterior walls.
- .2 Escutcheons and plates:
 - .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
 - .2 Use chrome or nickel plated brass, solid type, with set screws for ceiling or wall mounting. For equipment rooms, use cast-iron type.

1.16 TESTS

- .1 Give 48 hours notice of date when tests will be made.
- .2 Conduct tests in presence of Departmental Representative and representatives of agencies having jurisdiction.
- .3 Bear all costs in connection with all tests.
- .4 Obtain acceptance certificates from authorities have jurisdiction. Work shall not be considered complete until certificates are delivered to the Departmental Representative.

- .5 Piping pressure tests:
 - .1 Test natural gas systems with nitrogen gas at 690 kPa for 24-hour period without loss.
 - .2 Repair leaks and defects. Retest until approved by Departmental Representative.
- .6 Testing and balancing of heating, ventilating, and air-conditioning systems:
 - .1 Use qualified personnel approved by the Departmental Representative to test and balance systems and keep records of operating results.
 - .2 After systems balanced and tests concluded, submit test and balance report showing relevant operating data of equipment and systems.
 - .3 Report shall certify compliance with requirements of drawings and specifications.

1.17 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.18 ACCESS DOORS

- .1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm for body entry and 300 x 300 mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
 - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Departmental Representative.
 - .2 Remaining areas: use prime coated steel.
- .4 Installation:
 - .1 Locate so that concealed items are accessible.
 - .2 Locate so that hand or body entry (as applicable) is achieved.

1.19 IDENTIFICATION

- .1 Existing identification systems:
 - .1 Apply existing identification system to new work.
 - .2 Where existing identification system does not cover for new work, use identification system specified this section.
 - .3 Before starting work, obtain written approval of identification system from Departmental Representative.
- .2 Identification of piping systems:
 - .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB- 24.3-92 except where specified otherwise.
 - .2 Pictograms:
 - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.

- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3-92.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: To following table:

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

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

Colour	Marking	Legend
Natural gas	to Codes	
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

- .4 Identification ductwork systems:
 - .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
 - .2 Colours: black, or co-ordinated with base colour to ensure strong contrast.
- .5 Valve tags: brass tags with 12 mm stamped identification data filled with black paint.
- .6 Location of identification on piping and ductwork systems:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: At not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
 - .2 Adjacent to each change in direction.
 - .3 At least once in each small room through which piping or ductwork passes.
 - .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of separations such as walls, floors, partitions.
 - .6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.
 - .7 At beginning and end points of each run and at each piece of equipment in run.
 - .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc.

1.20 INSTRUCTION OF OPERATION STAFF

- .1 Furnish competent instructors to fully instruct operating staff in care, adjustment and operation of mechanical systems. Use factory trained instructors.
- .2 Instruct during regular work hours before systems accepted and turned over to operating staff for regular operation.
- .3 Where significant changes or modifications in equipment are made under terms of guarantee, instruct operating staff about changes or modifications.

1.21 DEMOLITION

- .1 As shown on drawings, some mechanical equipment and material is to be removed. Owner has first claim on all salvaged material. All material not claimed by the Owner shall become the property of the Subcontractor and shall be removed from the site.

1.22 EXISTING SYSTEMS

- .1 Carefully dismantle existing mechanical equipment to be removed or relocated together with reusable materials. Existing equipment, piping, ductwork, conduit, light fixtures which interfere with the new installation shall be temporarily disconnected, remove that which the Owner does not wish to retain which shall become the Subcontractor's property and removed from the site when so directed, relocate and reconnect as required. Where noted, this existing equipment shall be reused in new work after first repairing and reconditioning any defective items. Permanently disconnected mechanical and electrical connections shall be safely capped and sealed flush within finished surfaces. Remove existing inactive services which interfere with work execution.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

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

1.2 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.
 - .2 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Saskatchewan.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals: Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial /Territorial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:

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

Part 2 Products

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

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

2.3 TEMPORARY MOTORS

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

2.4 DRIVE GUARDS

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

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 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 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 Factory Mutual (FM)
- .4 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.
- .5 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 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 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 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.

Part 2 Products

2.1 SYSTEM DESCRIPTION

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

2.2 GENERAL

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

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Ensure steel hangers in contact with copper piping are copper plated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut.
- .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.
- .5 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.

- .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel black.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP69, 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.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .9 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: black.
- .10 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: black carbon steel to MSS SP58, type 42.
- .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 NPS 12 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 ANCHOR BOLTS AND TEMPLATES

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

Part 3 Execution**3.1 MANUFACTURER'S INSTRUCTIONS**

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more,
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.

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

3.3 HANGER SPACING

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

Maximum Pipe Size : NPS	Maximum Spacing	
	Steel	Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .7 Pipework greater than NPS 12: to MSS 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 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Fire Protection Association (NFPA).
 - .1 NFPA 13-2007, Standard for the Installation of Sprinkler Systems.
- .3 National Building Code of Canada (NBC) – 2010.

1.2 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.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Saskatchewan, Canada.
 - .2 Provide system shop drawings complete with performance and product data.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 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.

Part 2 Products

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 ELASTOMERIC PADS

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.
- .4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Colour code springs.

2.5 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.
- .6 Performance: as indicated.

2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with pre-compression washer and nut with deflection indicator.
- .6 Performance: as indicated.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

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

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 vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 GENERAL

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section.
- .2 Standard: TAB to be to most stringent of TAB standards of AABC, NEBB, SMACNA and ASHRAE.
- .3 Do TAB of all systems, equipment, components, controls specified in Mechanical Divisions.
- .4 TAB shall be performed by an independent TAB agency engaged by the Contractor.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Names of all personnel proposed to perform TAB are to be submitted to and approved by Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 Qualifications: personnel performing TAB to be current member in good standing of AABC, NEBB, or NBCTA.
- .4 Quality Assurance: perform TAB under direction of supervisor qualified by AABC, NEBB, or NBCTA.

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 so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

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

1.6 PRE-TAB REVIEW

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

1.7 START-UP

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

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB only when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Divisions 21, 22, 23 and 25.
 - .4 All provisions for TAB installed and operational.
 - .5 Start-up, verification for proper, normal and safe operation of all 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 All outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Hydronic systems: plus or minus 10%.
 - .2 All other HVAC systems: plus 5%, minus 5%.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

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

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

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

1.15 TAB REPORT

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show all results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
 - .3 Measured and design airflows for all grilles and diffusers.
 - .4 Fan performance report.
- .3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

- .1 All reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 30% of all reported results.
- .3 Number and location of verified results to be at discretion of Departmental Representative.

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

1.17 SETTINGS

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.18 COMPLETION OF TAB

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

1.19 AIR SYSTEMS

- .1 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

- .1 Refer to other mechanical specification sections for additional requirements.

1.21 POST- OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, in occupied areas.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22-01, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1-96, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M-99(2004), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B75M-99, Standard Specification for Seamless Copper Tube Metric.
 - .4 ASTM B837-01, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1-03, Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1HB-00, Natural Gas and Propane Installation Code Handbook.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

Part 2 Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS2 1/2 and over, plain end.
- .2 Copper tube: to ASTM B837.

2.2 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Brazing: to ASTM B837.

2.3 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.

2.4 VALVES

- .1 Provincial Code approved, ball type.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install in accordance with applicable Provincial Codes, CAN/CSA B149.1, supplemented as specified.
- .2 Install drip points:

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

3.3 VALVES

- .1 Install valves with stems upright or horizontal unless otherwise approved by Departmental Representative.
- .2 Install valves at branch take-offs to isolate pieces of equipment, and as indicated.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
 - .1 Test system in accordance with CAN/CSA B149.1 and requirements of authorities having jurisdiction.

3.5 ADJUSTING

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

3.6 CLEANING

- .1 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 REFERENCES

- .1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 52.2 (ANSI Approved).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Underwriters' Laboratories of Canada
 - .1 ULC -S111-95, Standard Method of Fire Tests for Air Filter Units.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:

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

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.
 - .3 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank in accordance with section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 GENERAL

- .1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 50 degrees C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities as shown on drawings.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

2.2 ACCESSORIES

- .1 Holding frames: permanent channel section construction of galvanized steel, 1.6 mm thick, except where specified.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: from upstream face of filter bank.

2.3 FIBROUS GLASS PANEL FILTERS

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with hinged wire mesh screen.
- .3 Performance: to ASHRAE 52.2 MERV rating of 8.
- .4 Fire rated: to ULC -S111.
- .5 Nominal thickness: 50 mm.

2.4 FILTER GAUGES - DIAL TYPE

- .1 Diaphragm actuated, direct reading.

- .2 Range: 0 to 250 Pa.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION GENERAL

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.3 REPLACEMENT MEDIA

- .1 Replace media with new upon acceptance.
- .2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

3.4 FILTER GAUGES

- .1 Install type as indicated across each filter bank (pre-filter and final filter) in approved and easy readable location.
- .2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

3.5 CLEANING

- .1 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 REFERENCES

- .1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)
 - .1 ARI 270-95, Sound Rating of Outdoor Unitary Equipment.
- .2 ANSI/UL 1995 B-1998, Standard for Heating and Cooling Equipment.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA C22.1 HB-02, Canadian Electrical Code Handbook.
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association
 - .1 NFPA 90A-02, Standard for the Installation of Air Conditioning and Ventilating Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for packaged rooftop HVAC units.
- .3 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout and dimensions; indicate:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
 - .2 Piping, valves, fitting shipped loose showing final location in assembly.
 - .3 Control equipment shipped loose, showing final location in assembly.
 - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
 - .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices of ancillaries, accessories, controllers.
 - .6 Fan performance curves.
 - .7 Details of vibration isolation.

- .8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.
- .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .6 Instructions: submit manufacturer's installation instructions.
- .7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals include data as follows:
 - .1 Indicate: brief description of unit, indexed, with details of function, operation, control, and service for components.
 - .2 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.3 QUALITY ASSURANCE

- .1 Pre-Installation Meeting:
 - .1 Convene pre-installation meeting four weeks prior to beginning on-site installations.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety Requirements.

1.4 WARRANTY

- .1 For Work of this Section 23 74 00 Packaged Outdoor HVAC Equipment, 12-month warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 24 months.
- .2 Contractor hereby warrants that packaged rooftop HAVC units and refrigeration compressors will function and operate in accordance with GP&S (PWGSC General Procedures and Standards).

Part 2 Products

2.1 GENERAL

- .1 Roof mounted, self-contained single zone unit with gas burner and bear label of CSA, CGA, ULC.

- .2 Units to consist of cabinet and frame, supply fan, heat exchanger, burner, air filter, coil, motorized outside air damper, return damper, motorized exhaust damper.

2.2 CABINET

- .1 Cabinets: weatherproofing tested and certified to AGA rain test standards and soundproofing tested to ARI 270.
- .2 Framing and supports: 2 mm thick welded steel, galvanized after manufacture, with lifting lugs.
- .3 Outer casing: weathertight 1.6 mm thick galvanized steel with baked enamel finish.
- .4 Access: hinged doors with locking door handle type fasteners.
- .5 Insulation: neoprene coated glass fiber on surfaces where conditioned air is handled, 50 mm thick, 24 kg/m³ density.

2.3 FANS

- .1 Centrifugal, forward curved impellers, statically and dynamically balanced. V-belt drive, fan and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators.

2.4 AIR FILTERS

- .1 50 mm thick, MERV 8 efficiency per ASHRAE 52.2, rated U.L. Class 2 metal framed, throwaway.

2.5 GAS HEAT SECTION

- .1 General
 - .1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.
 - .2 Operating natural gas pressure at unit(s) manifold shall 14" w.c. (3500 Pa).
 - .3 Gas fired units shall be approved for operation in -40°F (-40°C). Packaged controls to allow operation below -40°F (-40°C) that shutdown at -40°F (-40°C) by control package is not acceptable.
- .2 Heat Exchanger / Burner Assembly
 - .1 Heat exchanger shall be a primary cylindrical drum of welded titanium stainless steel with multi-tube stainless steel secondary complete with multi-plane metal turbulators. Heat exchanger must utilize a floating suspension system to allow free thermal expansion and contraction without stress. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1"(25 mm) of insulation between the outer cabinet and heat reflective galvanized steel inner liner. Diamond shaped heat exchangers are not acceptable. Dual or triple blower assemblies shall be provided, as required, to ensure even air distribution across the heat exchangers. Blower location shall be engineered to improve the required

- air flow pattern around the heat exchanger. Using duct type furnaces and closed coupled blowers are not acceptable.
- .2 The heat exchanger/burner assembly shall be a blow through positive pressure type. Units incorporating the G-TRAC module shall have an interrupted pilot ignition system to provide a high seasonal efficiency. Units incorporating continuous or intermittent pilots are not acceptable.
 - .3 Flame surveillance shall be with a solid state programmed flame relay complete with flame rod. The burner and gas train shall be in a cabinet enclosure. Atmospheric burners or burners requiring power assisted venting are not acceptable.
 - .4 Heat exchanger / burner assembly shall have a 20:1 turndown.
- .3 Factory Testing of Indirect Fired Gas Heating Section
- .1 The minimum test requirements on all cabinet / fan size / fan type / fan orientation / heat exchanger / outlet configuration combinations previously built are listed below.
 - .1 Tests shall be performed after complete final unit assembly, just prior to shipping to job site. The tests shall be performed in accordance with the equipment standard that the gas heating section is certified.
 - .4 Heat exchanger shall be clogged with a dedicated calibrated gas meter to insure proper set up of the gas manifold.
 - .5 High and Low input flue gas combustion analysis using a calibrated combustion analyzer including O₂ and CO to provide proper air fuel ratio throughout the entire operating range.
 - .6 Venting: Installation and venting provisions must be in accordance with CAN/CSA Standard B149.1, ANSI Z223.1-NFPA 54, and local authorities having jurisdiction.

2.6 CONTROLS

- .1 Electronic G-TRAC (Modulating Fuel w/ Modulating Combustion Air) complete with proportional and integral control and with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Controllers shall include the following standard features:
- .2 Service analyzer with diagnostic lights for ease of set-up and service. Self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances to make sure air switches are not shorted or jumpered.
 - .1 -40°F(-40°C) minimum operating ambient temperature
 - .2 built in pre-purge
 - .3 maintained purge to decrease temperature cycles
 - .4 built in post purge
 - .5 interrupted pilot
 - .6 low fire start
 - .7 inlet damper control
 - .8 economizer enable control

- .9 built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation using a single room thermostat
 - .10 damper contact that allows fan to start after dampers opens, damper to close after fan stops and damper to close on flame failure
 - .11 ambient reset and night setback features
 - .12 non-recycling auto bypass low limit with alarm contacts and built in sensor checking
 - .13 blower contact that starts fan after burner pre-purge
 - .14 controlled burner start-up and shut down
 - .15 built in electronic linearization of the combustion air damper and gas valve producing higher efficiencies and reduced inputs
 - .16 separate gas and air actuators independently controlled to give the correct air to fuel ratio though out the entire firing range. Single operator with mechanical linkage is not acceptable.
- .3 Heating control function shall be modulating discharge air complete with sensor and remote selector.
 - .4 Controllers for heating only units to incorporate low limit feature.
 - .5 Discharge air sensor shall be field mounted in supply ductwork.

2.7 FACTORY SUPPLIED CONTROLS / WIRING

- .1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.
- .2 Gas fired units shall also include high limit and combustion airflow switch.
- .3 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.
- .4 Factory installed and wired non-fused disconnect switch in CEMA/NEMA 1 configuration.
- .5 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.
- .6 Remote Panel - Provide for each air handling unit a NEMA 12 remote mounted control panel for the purpose of switching and visual indication of operations. Each panel to include the following items:
 - .1 Engraved lamincoid faceplate
- .7 System ON/OFF switch
System ON light
Heat ON light
Damper open light
Discharge air temperature selector
Seven-day timer-clock

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 as per manufacturers' instructions on site fabricated structural steel stand.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
 - .3 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
 - .2 Upon completion of work, after cleaning is carried out.
- .2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .3 Verify accessibility, serviceability of components including motorized dampers, filters, fans, motors, operators, sensors, electrical disconnects.

3.4 CLEANING

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

END OF SECTION