

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 07 84 00 - Firestopping.
- .2            Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

**1.2                REFERENCES**

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

**Part 2            Products**

**2.1                NOT USED**

- .1            Not Used.

**Part 3            Execution**

**3.1                CONNECTIONS TO EQUIPMENT**

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

**3.2                CLEARANCES**

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

**3.3                DRAINS**

- .1            Install piping with grade in direction of flow except as indicated.
- .2            Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3            Pipe each drain valve discharge separately to above floor drain. Discharge to be visible.

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

### **3.4 DIELECTRIC COUPLINGS**

- .1 General: Compatible with system, to suit pressure rating of system.
- .2 Locations: Where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: Isolating flanges.

### **3.5 PIPEWORK INSTALLATION**

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
  - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
  - .1 Install in accessible locations.

- .2 Remove interior parts before soldering.
  - .3 Install with stems above horizontal position unless otherwise indicated.
  - .4 Valves accessible for maintenance without removing adjacent piping.
  - .5 Install globe valves in bypass around control valves.
  - .6 Use gate valves at branch take-offs for isolating purposes except where otherwise specified.
  - .7 Use chain operators on valves NPS 2-1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .15 Check Valves:
- .1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow and elsewhere as indicated.
  - .2 Install swing check valves in horizontal lines on discharge of pumps and elsewhere as indicated.

### **3.6 SLEEVES**

- .1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.
- .2 Material: Schedule 40 black steel pipe.
- .3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.
- .4 Sizes: 6 mm minimum clearance between sleeve and 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: Provide space for firestopping. Maintain fire rating integrity.
  - .3 Sleeves installed for future use: Fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### **3.7 PREPARATION FOR FIRESTOPPING**

- .1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Firestopping.

- .2 Uninsulated unheated pipes not subject to movement: No special preparation.
- .3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

### **3.8 FLUSHING OUT OF PIPING SYSTEMS**

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

### **3.9 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

- .1 Advise Contract Administrator 48 hours minimum prior to performance of pressure tests.
- .2 Piping: Test as specified in relevant sections of Division 23.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Division 23.
- .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 Contract Administrator.
- .6 Pay costs for repairs or replacement, retesting, and making good. Contract Administrator to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Contract Administrator.

### **3.10 EXISTING SYSTEMS**

- .1 Connect into existing piping systems at times approved by Contract Administrator.
- .2 Request written approval 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.
- .4 Ensure daily clean-up of existing areas.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Electrical motors, drives and guards for mechanical equipment and systems.
- .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
- .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Submittals: in accordance with Section 013300 Submittal Procedures.
- .2 Closeout Submittals
  - .1 Provide maintenance data for motors, drives and guards for incorporation into manual.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 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/1/2 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W/1/2 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 575 V, unless otherwise indicated.

## **2.3 TEMPORARY MOTORS**

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

## **2.4 BELT DRIVES**

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

## **2.5 DRIVE GUARDS**

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
  - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.

- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.-
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
  - .2 Net free area of guard: not less than 80% of fan openings.
  - .3 Securely fasten in place.
  - .4 Removable for servicing.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

#### **3.2 INSTALLATION**

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

#### **3.3 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/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-1998, Power Piping.
  - .2 ANSI/ASME B31.3-2000, Process Piping Addenda A.
  - .3 ANSI/ASME B31.3-2001, Process Piping Addenda B.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C206-97, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
  - .1 AWS C1.1-2000, Recommended Practices for Resistance Welding.
  - .2 AWS Z49.1-1999, Safety Welding, Cutting and Allied Process.
  - .3 AWS W1-2000, Welding Inspection Handbook..
- .4 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.
- .5 Canadian Standards Association (CSA International)
  - .1 CSA W47.2-M1987(R1998), Certification of Companies for Fusion Welding of Aluminum.
  - .2 CSA W48 series-01, Filler Metals and Allied Materials for Metal Arc Welding.
  - .3 CSA B51-97, Boiler, Pressure Vessel and Pressure Piping Code.
  - .4 CSA-W117.2-01, Safety in Welding, Cutting and Allied Processes.
  - .5 CSA W178.1-02, Certification of Welding Inspection Organizations.
  - .6 CSA W178.2-01, Certification of Welding Inspectors.

**1.2 QUALIFICATIONS**

- .1 Welders
  - .1 Welding qualifications in accordance with CSA B51.
  - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
  - .3 Furnish welder's qualifications to Contract Administrator.
  - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
  - .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors



- .1 Inspectors qualified to CSA W178.2.

### **1.3 QUALITY ASSURANCE**

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

## **Part 2 Products**

### **2.1 ELECTRODES**

- .1 Electrodes: in accordance with CSA W48 Series.

## **Part 3 Execution**

### **3.1 WORKMANSHIP**

- .1 Welding: in accordance with ANSI/ASME B31.1 B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, and special procedures specified elsewhere in Division 23 applicable requirements of provincial authority having jurisdiction.

### **3.2 INSTALLATION REQUIREMENTS**

- .1 Identify each weld with welder's identification symbol.
- .2 Backing rings:
  - .1 Where used, fit to minimize gaps between ring and pipe bore.
  - .2 Do not install at orifice flanges.
- .3 Fittings:
  - .1 NPS 2 and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.

### **3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Contract Administrator.
- .2 Formulate "Inspection and Test Plan" in co-operation with Contract Administrator.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.

### **3.4 DEFECTS CAUSING REJECTION**

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

**3.5 REPAIR OF WELDS WHICH FAILED TESTS**

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.

**1.2 REFERENCES**

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-04, Power Piping.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A125-1996(R2001), Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .6 Underwriter's Laboratories of Canada (ULC)

**1.3 SYSTEM DESCRIPTION**

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

- .4 Design hangers and supports to support systems under 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.

#### **1.4 SUBMITTALS**

- .1 Submittals: in accordance with Section 013300 - Submittal Procedures.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Manitoba, Canada.
- .3 Submit shop drawings and product data for following items:
  - .1 Bases, hangers and supports.
  - .2 Connections to equipment and structure.
  - .3 Structural assemblies.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

### **Part 2 Products**

#### **2.1 GENERAL**

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

#### **2.2 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized after manufacture.
  - .2 Use hot dipped galvanizing process.
  - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
    - .1 Rod: 9 mm UL listed.

- .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed FM approved to MSS-SP58 and MSS-SP69.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
  - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed FM approved to MSS SP69.
  - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed FM approved.
- .4 Upper attachment to concrete:
  - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
  - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed FM approved to MSS SP69.
- .5 Shop and field-fabricated assemblies:
  - .1 Trapeze hanger assemblies: in accordance with requirements of ASME B31.1 and MSS-SP-58.
  - .2 Steel brackets: in accordance with requirements of ASME B31.1 and MSS-SP-58.
- .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 Do not use 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel.
  - .2 Use insulation shields for hot pipework.
  - .3 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.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

### **2.3 RISER CLAMPS**

- .1 Steel or cast iron pipe: galvanized carbon 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.

### **2.4 INSULATION PROTECTION SHIELDS**

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> 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, galvanized carbon steel to comply with MSS SP69.

### **2.5 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.

### **2.6 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.

## **2.7 EQUIPMENT SUPPORTS**

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

## **2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

## **2.9 PLATFORMS AND CATWALKS**

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

## **2.10 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.

## **2.11 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.
- .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, but not less than one hanger at joints.
- .6 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.1 m	1.8 m
1-1/2	2.7 m	2.4 m
2	3.0 m	2.7 m
2-1/2	3.6 m	3.0 m
3	3.6 m	3.0 m
3-1/2	3.9 m	3.3 m
4	4.2 m	3.6 m
5	4.8 m	
6	5.1 m	
8	5.7 m	
10	6.6 m	
12	6.9 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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.
  - .2 Sustainable requirements for construction and verification.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Product Data:
- .2 Submittals: in accordance with Section 013300 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this section.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.
  - .2 Dispose of unused paint coating material at official hazardous material collections site approved by Contract Administrator.
  - .3 Do not dispose of unused paint coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

**Part 2 Products**

**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

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

**2.2 SYSTEM NAMEPLATES**

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

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

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

- .3 Equipment elsewhere: sizes as appropriate.

## **2.3 EXISTING IDENTIFICATION SYSTEMS**

- .1 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 Contract Administrator.

## **2.4 PIPING SYSTEMS GOVERNED BY CODES**

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

## **2.5 IDENTIFICATION OF PIPING SYSTEMS**

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
  - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
  - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
  - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 Other pipes: pressure sensitive plastic-coated cloth vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of

100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Contract Administrator.

.2 Colours for legends, arrows: to following table:

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

.3 Background colour marking and legends for piping systems:

<b>Contents</b>	<b>Background colour marking</b>	<b>Legend</b>
Raw water	Green	RAW WATER
City water	Green	CITY WATER
Domestic hot water supply	Green	DOM. HW SUPPLY
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Storm water	Green	STORM
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Engine exhaust	Yellow	ENGINE EXHAUST
Lubricating oil	Yellow	LUB. OIL
Hydraulic oil	Yellow	HYDRAULIC OIL
Natural gas	to Codes	
Gas regulator vents	to Codes	
Compressed air (<700kPa)	Green	COMP. AIR kPa
Compressed air (>700kPa)	Yellow	COMP. AIR kPa
Fire protection water	Red	FIRE PROT. WTR

**2.6 IDENTIFICATION DUCTWORK SYSTEMS**

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

**2.7 VALVES, CONTROLLERS**

.1 Brass tags with 12 mm stamped identification data filled with black paint.

.2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

## **2.8 CONTROLS COMPONENTS IDENTIFICATION**

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

## **2.9 LANGUAGE**

- .1 Identification in English.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 TIMING**

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

### **3.3 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and or CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

### **3.4 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection:
  - .1 Do not paint, insulate or cover.

### **3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations such as walls, floors, partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

### **3.6 VALVES, CONTROLLERS**

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

### **3.7 CLEANING**

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

**1.3 PURPOSE OF TAB**



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

#### **1.4 EXCEPTIONS**

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

#### **1.5 CO-ORDINATION**

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

#### **1.6 PRE-TAB REVIEW**

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

#### **1.7 START-UP**

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

#### **1.8 OPERATION OF SYSTEMS DURING TAB**

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

#### **1.9 START OF TAB**

- .1 Notify Contract Administrator 7 days prior to start of TAB.

- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire, smoke, volume control dampers installed and open.
    - .6 Coil fins combed, clean.
    - .7 Access doors, installed, closed.
    - .8 Outlets installed, volume control dampers open.
  - .3 Liquid systems:
    - .1 Flushed, filled, vented.
    - .2 Correct pump rotation.
    - .3 Strainers in place, baskets clean.
    - .4 Isolating and balancing valves installed, open.
    - .5 Calibrated balancing valves installed, at factory settings.
    - .6 Chemical treatment systems complete, operational.

#### **1.10 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 Laboratory HVAC systems: plus 10 %, minus 0 %.
  - .2 Other HVAC systems: plus 5 %, minus 5 %.
  - .3 Hydronic systems: plus or minus 10 %.

#### **1.11 ACCURACY TOLERANCES**

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

#### **1.12 INSTRUMENTS**

- .1 Prior to TAB, submit to Contract Administrator list of instruments used together with serial numbers.

- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Contract Administrator.

### **1.13 SUBMITTALS**

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

### **1.14 PRELIMINARY TAB REPORT**

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

### **1.15 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit 6 copies of TAB Report to Contract Administrator for verification and approval, in English in D-ring binders, complete with index tabs.

### **1.16 VERIFICATION**

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

### **1.17 SETTINGS**

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

**1.18 COMPLETION OF TAB**

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

**1.19 AIR SYSTEMS**

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC NEBB SMACNA ASHRAE.
- .2 Do TAB of all new exhaust and supply air systems.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC or NEBB qualified to standards of AABC or NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by 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).

**1.20 OTHER TAB REQUIREMENTS**

- .1 General requirements applicable to work specified this paragraph:
  - .1 Qualifications of TAB personnel: as for air systems specified this section.
  - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions during winter summer design conditions at all times.
- .3 Zone pressure differences:
  - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.

**Part 2            Products**

**2.1                NOT USED**

.1                Not used.

**Part 3            Execution**

**3.1                NOT USED**

.1                Not used.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

**1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS**

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

**1.3 GASEOUS FUEL SYSTEMS**

- .1 Operation tests:
  - .1 Measure gas pressure at gas meter outlet and at burner manifold.
  - .2 Verify details of temperature and pressure compensation at meter.
  - .3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.
  - .4 Check terminals of vents for gas pressure regulators.

**1.4 POTABLE WATER SYSTEMS**

- .1 When cleaning is completed and system filled:
  - .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
  - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
  - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

**1.5 SANITARY AND STORM DRAINAGE SYSTEMS**

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

**Part 2            Products**

**2.1                NOT USED**

.1                Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1                Not Used.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.

**1.2 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 013300 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions.

**Part 2 Products****2.1 CLEANING SOLUTIONS**

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

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

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

**3.2 CLEANING**

- .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 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation procedures for electric heating and ventilation controls.
  - .2 General Description and Sequence of Operations
- .2 General Scope and Related Work
  - .1 All Work required by these Controls Specifications, Schedules, Point Lists and Drawings shall be coordinated and provided by the single Contractor referenced in these Specifications as the Controls Contractor.
  - .2 If the Controls Contractor believes there are conflicts or missing information in the Contract Documents then the Contractor shall promptly request clarification and instruction from the Contract Administrator before proceeding.
  - .3 The Controls Contractor shall have visited the Project site and obtained information as necessary prior to submittal of the bid to ensure that prevailing physical conditions and Project arrangements that may be material to the performance of the Work have been ascertained and accommodated in the bid. No claims for additional payments will be accepted due to the Contractor's failure to complete this survey.
  - .4 If, in order to complete the Work of the Controls Contract, private and/or public telephone lines and connections, including ISDN lines and/or LAN/WAN support and connections, are required then these shall be provided by the City to the Controls Contractor, at the City's direct cost, in a timely manner.
  - .5 The City has an existing central monitoring system in place. Where DDC points are identified as centrally monitored points, controls contractor shall provide and install required hardware and software to interface to the City's Digital Control System.

**1.2 REFERENCES**

- .1 Application Acts, Regulations, Codes and Standards
  - .1 The following Acts, Codes, Regulations and Standards apply to the design installation and/or operation of Ventilation Systems at Hydro One Remote Community Diesel Generating Stations.
    - .1 CSA 22.1 Canadian Electrical Code
    - .2 National Building Code of Canada
    - .3 National Fire Code of Canada
- .2 Works
  - .1 The Controls Contractor's work shall consist of the provision of all labor, materials, special tools, equipment, enclosures, power supplies, interfaces, wiring, tubing, installation, labeling, calibration, documentation, submittals,

testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required by the Contract that are required for the functional turn-key operation of the complete and fully functional Controls Systems.

- .2 Provide a complete, neat and workmanlike installation. Use only employees who are qualified, skilled, experienced, manufacturer trained and familiar with the specific equipment, software and configurations to be provided for this Project.
- .3 The Controls Contractor shall employ qualified and experienced Controls Systems, Software, Application Design, Installation and Project Supervision personnel to provide the specific solutions required to meet the Project requirements and who are available to undertake this work as scheduled.
- .4 Manage and coordinate the Controls Systems work in a timely manner in consideration of the Project master schedules. Coordinate cooperatively with the associated work of the other trades so as to assist the progress and not impede or delay the work of associated trades.
- .5 Controls Systems as provided shall incorporate, at minimum, the following integral features, functions and services:
  - .1 Interfaces between individual elements and the systems and networks provided by the City and other trades as required by the Contract Documents.
  - .2 All other Controls Systems functions as required by the Contract Documents.
- .6 The Controls System as provided shall comprise, at a minimum, the following primary elements:
  - .1 Field Devices.
  - .2 Control wiring.

### **1.3 QUALITY ASSURANCE**

- .1 General Requirements:
  - .1 All devices shall be CSA certified and UL or FM listed and labeled for the specific use, application and environment to which they are applied.
  - .2 All electronic equipment shall conform to the requirements of FCC regulations, part 15, section 15, governing radio frequency electromagnetic interference, and be so labeled.
- .2 Workplace Safety And Materials Management
  - .1 Provide a safety program in compliance with the Contract Documents.
  - .2 The Controls Contractor shall have a comprehensive Safety Manual and a designated Safety Supervisor for the Project.
  - .3 The Contractor and its employees and sub trades shall comply with Federal, Provincial and local safety regulations.
  - .4 The Contractor shall ensure that all subcontractors and employees have written safety programs in place that cover their scope of work.
  - .5 Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.

- .6 Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the City within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

## **1.4 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
  - .2 Provide at minimum the following basic submittals:
    - .1 Individual System Schematics including sequences of operation.
    - .2 Complete Bill of Materials.
    - .3 Damper Schedules.
    - .4 Descriptions and/or product data sheets for all equipment, materials, software, firmware components and items to be furnished and provided. Information shall be Project specific and not general advertising.
  - .2 Operation and Maintenance Manuals
    - .1 At the completion of the project the Controls Contractor shall submit three sets of as-built documentation for the City's Operation and Maintenance Manuals which shall include the following as a minimum:
      - .1 Name and address of installing contractor along with 24-hour emergency service telephone number.
      - .2 As-built version of Shop Drawings.
      - .3 Licenses, Guarantees and warranty documents for all equipment and systems.

## **1.5 WARRANTY**

- .1 Standard Material and Labor Warranty:
  - .1 Provide a one-year labor and material Warranty on Controls Contract work provided under this Contract.
  - .2 If within twelve (12) months from the date of acceptance of the Controls Contract work and following receipt of written notice from the City the product is found to be defective in operation, workmanship or materials, then the product shall be promptly replaced, repaired or adjusted at the option of the Controls Contractor at the cost of the Controls Contractor.
  - .3 Maintain an adequate supply of materials available directly to the Project site such that replacement of key parts, including programming, may be promptly carried out. Warranty work shall be done during the Controls Contractor's normal business hours.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

- .2 Waste Management and Disposal:
  - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling.

## **Part 2 Materials**

### **2.1 DAMPERS**

- .1 Refer to appropriate section.

### **2.2 DAMPER OPERATORS**

- .1 Damper operators shall be electric and be provided for each automatic damper and shall be of sufficient capacity to operate the damper under all conditions as specified.
- .2 Damper operators shall be direct drive and equal to those manufactured by Belimo. Provide sufficient quantity of damper operators to provide a minimum of 5 in-lbs of torque for every square foot of damper area.
- .3 Each central system damper shall be provided with spring-return for normally closed or normally open position for fail safe operation to account for fire, low temperatures, or power interruption as indicated or as appropriate.

### **2.3 DIFFERENTIAL PRESSURE SENSORS**

- .1 Refer to Section 29 50 01.

### **2.4 GAS DETECTION DEVICES**

- .1 Refer to Section 29 50 01.

### **2.5 AIR FLOW PROVING SWITCHES**

- .1 Low differential pressure switch, rated for Class 1, Division II sensing. Full load: 15A at 120V. Maximum ambient temperature: 82 degrees C (180 degrees F.). Operating range: 17 to 54 Pa (0.07 to 0.22" W.C.).
- .2 Acceptable Products: Dwyer 1950 G series.

### **2.6 THERMOSTAT (LINE VOLTAGE, HEATING)**

- .1 Line voltage wall mounted integral electric heating thermostat with:
  - .1 Full load rating: 22A at 120V.
  - .2 Temperature setting range: 5 degrees C to 30 degrees C.
  - .3 Double pole.
  - .4 Thermometer range: 5 degrees C to 30 degrees C.
  - .5 Scale markings: Off-5-10-15-20-25 degrees C.
- .2 Acceptable Products: Johnson Controls T26 series, or approved equal in accordance with B6.

## **2.7 TEMPERATURE SENSING DEVICES**

- .1 Refer to Section 29 50 01.
- .2 Duct Type Temperature Transmitter shall be a general purpose RTD sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of + 1% over the full range. The output shall be compatible with the panel it serves.
- .3 Duct Averaging Type Temperature Transmitter shall be a general purpose RTD sensing element, moisture resistant transmitter for mounting into a duct. The operating range shall be as indicated with an accuracy of + 1% over the full range. The output shall be compatible with the panel it serves. The sensing element shall be of sufficient length to provide a minimum of one (1) foot of element for every two (2) square feet of coil area.
- .4 Space Temperature Transmitter: Refer to Section 29 50 01.
- .5 Low Limit Thermostats shall be of manual reset type, with setpoint adjustment. The sensing element shall be of sufficient length to provide a minimum of one (1) foot of element for every two (2) square feet of coil area. The element shall run fully across the coil on each pass. When any one foot of the element senses a temperature as low as the setpoint, the thermostat contacts shall open. These shall contain double pole switches for simultaneous remote alarms or as desired.
- .6 Acceptable Products: Johnson Controls TE series.

## **Part 3 Execution**

### **3.1 HVAC System Operation**

- .1 The new ventilation system for the Perimeter Road Pumping Station will operate as described in the following sections.
- .2 The document is divided according to the main building systems or areas. A general description is provided for each, followed by a sequence of operation which is subdivided by the type of control inputs.
- .3 All input and output signals external to the devices mentioned herein will be from/to the City's existing Digital Control System (DCS), which will be programmed accordingly by the City.

### **3.2 NEW MAKE UP AIR UNIT (M609-AHU)**

- .1 General Description
  - .1 The new unit will provide tempered air into the Dry Well and main open area of L400. Area distribution will be controlled by VAV units.
  - .2 The MUA unit will:
    - .1 Be indirect fired natural gas heated
    - .2 Have a variable flow rate from approximately 1750LPS to 3920LPS (3,600 CFM to 8,000 CFM).

- .3 Have a modulating burner
  - .4 Provide a maximum 27C (80F) temperature rise at maximum flow rate.
  - .5 Modulate discharge air temperature based on building management 0-10VDC signal.
- .2 Sequence of Operation
- .1 Upon signal from DCS to start
    - .1 The unit's main inlet damper will open.
    - .2 The unit will operate continuously at minimum speed, providing approximately 1750LPS (3,600 CFM) into the building.
    - .3 When outdoor temperature is below 10C (50F), the burner will modulate to provide a discharge air temperature of approximately 15C (60F)
    - .4 The DCS will provide a signal to increase airflow and temperature in response to inputs for heating or for additional ventilation from various locations as listed below.
    - .5 A pressure sensor in the discharge of M609-AHU, provided by AHU manufacturer will provide internal signal to the unit's integral VFD to maintain constant discharge plenum pressure regardless of VAV position.

### 3.3 DRY WELL VENTILATION (L100,200,300):

- .1 General Description
- .1 The Dry Well is physically separated from the Wet Well and will be electrically unclassified by the use of pressurization. (2003 NPFA 820, Table 4.2 Row 17D, and 9.2.4, and NFPA 496 , 7.4.1 ), thus not requiring exhaust fans.
  - .2 Existing M606-MAF (also identified as F6), which provides both combustion and cooling air for the engine on L300 will now also provide room cooling air flow if called for by ambient Dry Well temperature even if engine is not running.
  - .3 L300 of the Dry Well will be monitored for flammable and explosive gases.
  - .4 The differential pressure between the Dry Well and Wet Well will be monitored on Level 300.
  - .5 The differential pressurization of 25Pa (0.1" w.c.) relative to the Wet Well, and a minimum 60 fpm through any open door(s) will be achieved by the AHU and modulation of main relief damper M632-MD.
  - .6 The AHU will provide up to 6 ach (air changes per hour), approximately 3000 LPS (6300 cfm) to these levels. This will meet NFPA 820 requirements for 6 ach if the pressure falls below 25Pa, or if any explosive gases exceed 10% of the LEL/LFL. Airflow to level 300 will also be increased if temperature exceeds 25C.
- .2 Sequence of Operation
- .1 Differential Pressure:
    - .1 Differential pressure detectors M613-DPT continuously monitors differential pressure on L300.
    - .2 If M613-DPTs senses differential pressure less than 25Pa, (0.1"W.C.) it will send a signal to the DCS.

- .3 The DCS will either reduce opening of M632-MD if the air volume is over 1 ACH, and not required for gas or temperature controls, or will increase the VAV airflow, until the differential pressure reaches 25Pa (0.1"W.C.), or to a maximum of 6 ACH for those level(s).
- .4 If differential pressure at M613-DPT exceeds 30Pa in any of the 3 levels, at the required air flow volume, the DCS will signal Damper M632-MD- to open further to allow relief venting.
- .5
- .2 Gas Detection:
  - .1 Gas Detectors M932-GD monitors level 300 for accumulation of natural gas.
  - .2 Upon reaching 10% of the LEL, a signal will be sent to the DCS to increase ventilation to that level.
  - .3 The DCS will signal the VAV for the appropriate level(s) to increase flow to 6 ACH until the gas level drops to below 10% of the LEL.
- .3 Airflow Control:
  - .1 The DCS will send a signal to VAV for L300, or VAV for L200 & L100, to increase air flow until 25 Pa (0.1"W.C.) differential pressure is achieved.
  - .2 A flow sensor in each of the VAVs will monitor airflow and provide a signal to the DCS. The DCS will control the VAV to provide a maximum of 6 air changes per hour (ACH) for the space it supplies.
  - .3
- .4 Temperature Control
  - .1 A temperature sensor on L300 (M619-TT) will provide a signal to the DCS if room temperature exceeds 25C (77F).
  - .2 The DCS will signal M616-VAV to increase airflow to L300 to provide additional ventilation to cool the space. If space temperature reaches 28C (80F), the DCS will send a signal to start existing fan M606-MAF, which will run at full speed.
  - .3 As the temperature drops to below 25C (77F), the DCS will provide a signal to M616-VAV to reduce airflow from M609-AHU.
  - .4 Upon attaining 20C (68F), M606-MAF will turn off, and M616-VAV will provide the minimum set airflow.
  - .5 L200 and L100 will not be monitored for temperature.

### **3.4 SUPERSTRUCTURE (L400)**

- .1 General Description:
  - .1 The main floor will be physically separated from the Wet Well.
  - .2 The inside stair case to lower levels will be enclosed at the top level with a vestibule and door, thus separating the Superstructure from the Drywell.
  - .3 The existing control room, will use its existing dedicated air handling unit to provide existing levels of pressurization. This unit will receive standby power.
  - .4 The room housing the new generator will be treated separately.
  - .5 The remaining areas of L400 are not classified electrically. These main areas will normally receive 1 ACH from the AHU. If the space temperature varies



from the specified minimum and maximums, airflow to these areas will increase to provide more heated air, or more outside air to cool the room. A supplementary wall supply air fan will provide additional cooling air when required.

.2 Sequence of Operation:

.1 Temperature - Heating

- .1 Regardless of L400 temperature, priority will be given to providing necessary air flow to maintain Dry Well pressure, or to evacuate any Dry Well gas detected by the monitors.
- .2 Gravity back draft damper M633-DP provides relief from L400. It is adjusted to open with 25Pa at approximately 560 LPS (1200 CFM).
- .3 Room sensor M618-TT monitors L400 temperature and provides a signal to the DCS
- .4 If room temperature drops below 10C (50F), the DCS will send a signal to the AHU to provide heat.
- .5 If the room temperature setting is not achieved, the DCS will send a signal to M615-VAV to gradually increase the airflow into L400, from 1 ACH to a maximum of 6 ACH for heating requirements.

.2 Temperature - Cooling

- .1 If room temperature increases above 25C (77F), the DCS will send a signal to M615-VAV to gradually increase air flow into L400.
- .2 Airflow to L400 will increase as required to provide cooling provided Dry Well differential pressure is not compromised and Dry Well flammable gas levels remain at less than 10% of LEL/LFL.
- .3 If room temperature increases above 28C (83F), the DCS will send a signal to west wall supply air fan M6xx-EF to provide additional air directly from outside. Air will exhaust via gravity damper M633-DP. Fan will stop upon reaching 25C(77F).

**3.5 NEW EXTERIOR STAIRCASE(S)**

1. The new east side staircase will not be mechanically ventilated. Some leakage from the pressurized Dry Well is anticipated.
2. Electric baseboard heaters with line thermostats will be installed to allow heating as required..

**3.6 STANDBY GENERATOR AND ROOM**

.1 General Description

- .1 Ventilation air into the room will normally be brought in by the two existing electrically heated air handling units. Room temperature will normally be 20C (68F).
- .2 When the generator is operating, combustion and room cooling air, controlled by damper M621-MD, M625-MD, will be brought in through an outside air duct through the new Wet Well staircase.
- .3 Airflow from the radiator fan will discharge into a shroud and duct which will either recirculate the air in the room, or discharge it to the outside.

- .2 Sequence of Operation:
  - .1 Generator Start-Up
    - .1 Recirculation damper M624-MD is normally open.
    - .2 Upon power failure or start signal from the DCS the electrically closed, spring opened outside air damper M625-MD opens to provide combustion air.
    - .3 The generator starts.
    - .4 The generator radiator fan starts
    - .5 Radiator discharge air damper M623-MD remains closed.
    - .6 Outside air damper M621-MD remains closed.
    - .7 Air recirculates through radiator core and back to generator end of engine.
  - .2 Temperature
    - .1 Temperature sensor M625-TT provides a signal to the DCS.
    - .2 If room temperature reaches 21C (70F), DCS signals outside air supply damper M621-MD to open fully to allow entry of room cooling air.
    - .3 DCS signals discharge damper M623-MD to open partially, and M624-MD to close partially.
    - .4 M623-MD will continue to open gradually as required to maintain 21C (70F)
    - .5 M624-MD will continue to close sequentially with M623-MD opening.
    - .6 If room temperature reaches 25C (77F) the DCS will send a signal to exhaust damper M622-MD to open fully and exhaust fan M620-EF to start.
    - .7 Exhaust fan M620-EF will operate at 33% of maximum speed.
    - .8 If temperature continues to increase, M620-EF will continue to increase speed to maintain room temperature of 25C (77F)

### **3.7 WET WELL**

- .1 General Description
  - .1 Physically separated from the Dry Well and SuperStructure.
  - .2 The Wet Well will be classified as Class 1, Div.1 status, and will not require any code mandated ventilation, as per 2003 NFPA 820 Table 4.2, Row 16, Line a.
  - .3 The City has requested an exhaust fan. It will be installed on the existing roof platform in the small penthouse and will have standby power. It will run continuously at 3 air changes per hour (ACH).
  - .4 Exhaust air flow, and gas detection will be monitored by the DCS.
  - .5 The 3 Wet Well levels will be monitored for flammable and explosive gases, and Hydrogen Sulphide. If 10% of the LEL/LFL is reached, the presence of H<sub>2</sub>SO<sub>4</sub> gas is detected, or if manually selected for confined space entry, the DCS will alarm and the exhaust will provide 12 ACH, equivalent to approximately 1750 litres per second (LPS) or 3600 Cubic Feet per Minute (CFM).
  - .6 Fresh air will be brought in directly from the outdoors via dedicated ducting. The air will not be heated.

.2 Sequence of Operation

- .1 The DCS provides an on/off signal for EF1
- .2 Flow Switch M6-FS provides a signal to the DCS confirming exhaust air flow.
- .3 DCS will indicate alarm if no flow is detected.
- .4 A manual selector switch (at Wet Well staircase entry) will signal the DCS to provide full exhaust airflow for personnel entry into the space.
- .5 Temperature sensor M6xy-TT monitors L300 temperature in the Wet Well
- .6 M610-EF VFD provides 1/6 of maximum speed and airflow
- .7 M910-GD, M911-GD, M920-GD, M921-GD, and M930-GD, M931-GD monitor respective levels of Wet Well for presence of flammable or Hydrogen Sulphide gas respectively.
- .8 If the 10% level is read at any detector, or if Hydrogen Sulphide gas is detected, a signal is sent to the DCS.
- .9 DCS displays alarm signal.
- .10 DCS provides a signal to M610-EF1's VFD to ramp up to maximum rpm and air flow
- .11 If temperature drops to less than 4C (39F) the DCS will show a low temperature alarm.

**3.8 INSTALLATION PRACTICES**

.1 Controls Systems Wiring

- .1 Install in accordance with Division 26 and 29.
- .2 All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor except as shown on the Electrical Trade documents. All wiring shall comply with the requirements of applicable portions of the Electrical Trade work and all local and national electric codes and the requirements of the AHJ.
- .3 All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.
- .4 The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.
- .5 Class 2 Wiring
  - .1 All Class 2 (30VAC or less) wiring shall be installed in conduit unless otherwise specified.
  - .2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5 ft. from the building structure. Wiring shall be installed parallel to the building structural lines.
- .6 Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.

.2 Line Voltage Power Sources

- .1 120-volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical trade panelboards and circuit breakers as designated on the electrical drawings.
- .2 Circuits used for the Controls Systems shall be dedicated to these Controls Systems and shall not be used for any other services.
- .3 Controllers for powered terminal units may use 120-volt AC power from motor power circuits.
- .3 Controls Systems Raceways
  - .1 .1 All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification.
  - .2 .2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Contract Administrator.
  - .3 .3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the supporting surface.
  - .4 .4 UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.
- .4 Field Panel Installation And Location
  - .1 The Controls Systems panels, enclosures and cabinets shall be located as coordinated with the Architect at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
  - .2 All field devices shall be installed per the manufacturer recommendation and in accessible locations as coordinated with the Architect.
  - .3 Panels to be located in damp areas or areas subject to condensation shall be mounted with wall standoffs.
  - .4 Conduit configurations entering or leaving panels and devices shall be such as to preclude condensation traps.
- .5 Identification
  - .1 All control components and services shall be identified with appropriately sized lamecoid labels with a unique name/number referencing item back to the shop drawings and or maintenance manuals.
  - .2 All control wiring conduits shall be color-coded and identified so as to be distinguishable from standard electric conduiting.
  - .3 Clearly identify all controls LAN hubs and racks.
  - .4 All control wiring terminations shall be tagged and referenced.

### **3.9 VERIFICATION**

- .1 Fully test and verify all aspects of the Controls Systems Contract work on a point/system/integrated operational basis for all points, features and functions specified.
  - .1 Test each digital output for proper results from the Operator Workstation.

- .2 Test each analog output by sending commands from the Operators Workstation to stroke an actuator throughout its range.
  - .3 Test each digital input for proper verification at the Operators Workstation. Jumper digital alarm inputs as required.
  - .4 Calibrate all temperature, humidity and pressure sensors with a hand held digital meter with equal or better accuracy.
  - .5 All software programs shall be fully tested to eliminate any glitches and to ensure conformance with the specifications. A system shall be considered commissioned when all alarms and system values are appropriate for the control sequence defined. Submit history logs for approval.
- .2 Provide all necessary specialist labor, materials and tools to demonstrate to the Contract Administrator that the Controls Systems have been verified and are operating in compliance with the Controls Systems Contract.
  - .3 Promptly rectify all deficiencies and submit in writing to the Architect a signed report that this has been done.

### **3.10 MANUFACTURER'S INSTRUCTIONS**

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

### **3.11 INSTALLATION**

- .1 Install control devices.
- .2 On outside wall, mount thermostats on bracket or insulated pad 25 mm from exterior wall.
- .3 Install remote sensing device and capillary tube in metallic conduit. Conduit enclosing capillary tube must not touch heater or heating cable.

### **3.12 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 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for piping, valves and fittings for gas fired equipment.
- .2 Related Sections:
  - .1 Section 01 78 00 - Closeout Submittals.
  - .2 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
  - .3 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

**1.2 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
  - .2 ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3 ASME B16.22-01, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
  - .4 ASME B18.2.1-96, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM 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.
  - .2 CAN/CSA B149.2-00, Propane Storage and Handling Code.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 013300-Submittal Procedures.
- .2 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
  - .2 Indicate on manufacturers catalogue literature following: valves.
  - .3 Submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Instructions: submit manufacturer's installation instructions.

## **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, lubricated ball type.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 PIPING**

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

**3.3 VALVES**

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

**3.4 FIELD QUALITY CONTROL**

- .1 Site Tests/Inspection:
  - .1 Test system in accordance with CAN/CSA B149.1 CAN/CSA B149.2 and requirements of authorities having jurisdiction.
- .2 Performance Verification:
  - .1 Refer to Section 23 08 01 - Performance Verification of Mechanical Piping Systems.

**3.5 ADJUSTING**

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

**3.6 CLEANING**

- .1 Cleaning: in accordance with Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.
- .2 Perform cleaning operations and in accordance with manufacturer's recommendations.



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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
- .2 Related Sections:
  - .1 Section 02 61 33 - Hazardous Materials.
  - .2 Section 07 84 00 - Firestopping.
  - .3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
  - .2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
  - .3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .5 National Fire Protection Association (NFPA).
  - .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
  - .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
  - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.
  - .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

- .7 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

### **1.3 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 013300 Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials for the following:
  - .1 Sealants.
  - .2 Tape.
  - .3 Proprietary Joints.

### **1.4 QUALITY ASSURANCE**

- .1 Certification of Ratings:
  - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.
- .2 Indoor Air Quality (IAQ) Management Plan.
  - .1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Protect on site stored or installed absorptive material from moisture damage.
- .2 Waste Management and Disposal:
  - .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
  - .2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling.
  - .3 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste.
  - .4 Place materials defined as hazardous or toxic in designated containers.
  - .5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
  - .6 Fold up metal and plastic banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed

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

## 2.2 SEALANT

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

## 2.3 TAPE

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

## 2.4 DUCT LEAKAGE

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

## 2.5 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
  - .1 Rectangular: standard radius.
  - .2 Round: five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
  - .1 To 400 mm: with single double thickness turning vanes.
  - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
  - .1 Rectangular main and branch: with radius on branch 1.5 times width of duct 45 degrees entry on branch.
  - .2 Round main and branch: enter main duct at 45 degrees with conical connection.
  - .3 Provide volume control damper in branch duct near connection to main duct.
  - .4 Main duct branches: with splitter damper.
- .5 Transitions:

- .1 Diverging: 20 degrees maximum included angle.
- .2 Converging: 30 degrees maximum included angle.
- .6 Offsets:
  - .1 Full radiused elbows as indicated.
- .7 Obstruction deflectors: maintain full cross-sectional area.
  - .1 Maximum included angles: as for transitions.

**2.6 FIRE STOPPING**

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.
- .2 Fire stopping material and installation must not distort duct.

**2.7 GALVANIZED STEEL**

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to ASHRAE SMACNA.
- .3 Joints: to ASHRAE SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.
- .4 Stainless steel included in electronic copy.

**2.8 STAINLESS STEEL**

- .1 To ASTM A480/A480M, Type 304.
- .2 Finish: No. 4.
- .3 Thickness, fabrication and reinforcement: to ASHRAE SMACNA or as indicated.
- .4 Joints: to ASHRAE and SMACNA or continuous inert gas welded were specified.

**2.9 HANGERS AND SUPPORTS**

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
    - .1 Maximum size duct supported by strap hanger: 500.
  - .2 Hanger configuration: to ASHRAE and SMACNA.
  - .3 Hangers: galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6

Duct Size	Angle Size	Rod Size
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp steel plate washer.
  - .3 For steel beams: manufactured beam clamps:

**Part 3 Execution**

**3.1 GENERAL**

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

**3.2 HANGERS**

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

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

**3.3 WATERTIGHT DUCT**

- .1 Provide watertight duct for:
  - .1 Fresh air intake.
  - .2 As indicated.

- .2 Form bottom of horizontal duct without longitudinal seams.
  - .1 Solder weld joints of bottom and side sheets.
  - .2 Seal other joints with duct sealer.
- .3 Slope horizontal branch ductwork down towards hoods served.
  - .1 Slope header ducts down toward risers.
- .4 Fit base of riser with 150 mm deep drain sump and 32 mm drain connected, with deep seal trap and valve trap primer and discharging to open funnel drain as indicated.

### **3.4 SEALING AND TAPING**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.
- .2 Related Sections:
  - .1 Section 01 78 00 - Closeout Submittals.
  - .2 Section 02 61 33 - Hazardous Materials.

**1.2 REFERENCES**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
  - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 013300 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.
  - .2 Submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Instructions: submit manufacturer's installation instructions.

**Part 2 Products**

**2.1 GENERAL**

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



## **2.2 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame 0.66 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
  - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m<sup>2</sup>.

## **2.3 ACCESS DOORS IN DUCTS**

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

## **2.4 TURNING VANES**

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

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

- .1 Flexible Connections:
  - .1 Install in following locations:
    - .1 Inlets and outlets to supply air units and fans.
    - .2 Inlets and outlets of exhaust and return air fans.
    - .3 As indicated.
  - .2 Length of connection: 100 mm.
  - .3 Minimum distance between metal parts when system in operation: 75 mm.

- .4 Install in accordance with recommendations of SMACNA.
- .5 When fan is running:
  - .1 Ducting on sides of flexible connection to be in alignment.
  - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
  - .1 Size:
    - .1 600 x 600 mm for person size entry.
    - .2 300 x 300 mm for viewing.
    - .3 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Elsewhere as indicated.
- .3 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.
      - .2 In mixed air applications in locations as approved by Contract Administrator.
      - .3 At inlet and outlet of coils.
      - .4 Downstream of junctions of two converging air streams of different temperatures.
      - .5 And as indicated.
- .4 Turning vanes:
  - .1 Install in accordance with recommendations of SMACNA and as indicated.

### **3.3 CLEANING**

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

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
    - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with Manufacturer's Instructions.

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 SPLITTER DAMPERS**

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Single thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.

- .6 Folded leading edge.

### **2.3 SINGLE BLADE DAMPERS**

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm as indicated.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside nylon end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

### **2.4 MULTI-BLADED DAMPERS**

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

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Contract Administrator.

**3.3 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 SUMMARY**

- .1 Section Includes:
  - .1 Operating dampers for mechanical forced air ventilation and air conditioning systems.

**1.2 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 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).
  - .2 Indicate the following:
    - .1 Performance data.

**1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2 Products**

**2.1 MULTI-LEAF DAMPERS**

- .1 Opposed and or parallel blade type as indicated.
- .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.
- .3 Pressure fit self-lubricated bronze bearings.
- .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

- .5 Operator: to Section 23 09 33 Electric and Electronic Control system for HVAC.
- .6 Performance:
  - .1 Leakage: in closed position less than 2% of rated air flow at 250 Pa differential across damper.
  - .2 Pressure drop: at full open position less than 25 Pa differential across damper at 10 m/s.
- .7 Insulated aluminum dampers:
  - .1 Frames: insulated with extruded polystyrene foam with RSI 0.88.
  - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

## **2.2 BACK DRAFT DAMPERS**

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

## **2.3 RELIEF DAMPERS**

- .1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at 25 Pa static pressure.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

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

### **3.3 CLEANING**

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



**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

.1 Section Includes:

- .1 Fire and smoke dampers, and fire stop flaps.

**1.2 REFERENCES**

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

**1.3 SUBMITTALS**

- .1 Product Data:
- .2 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 013300 - Submittal Procedures.
  - .1
  - .2 Indicate the following:
    - .1 Fire dampers.
    - .2 Smoke dampers.
    - .3 Fire stop flaps.
    - .4 Operators.
    - .5 Fusible links.
    - .6 Design details of break-away joints.
- .3 Quality assurance submittals: submit following
  - .1 Instructions: submit manufacturer's installation instructions.
- .4 Closeout Submittals:
  - .1 Provide maintenance data for incorporation into manual.

**1.4 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide following:
    - .1 3 fusible links of each type.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

**Part 2 Products**

**2.1 FIRE DAMPERS**

- .1 Fire dampers: arrangement Type A listed and bear label of ULC, meet requirements of authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
  - .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.
- .3 Top hinged: offset ,square; multi-blade hinged sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.
- .5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.
- .7 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .8 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.
- .9 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

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

- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories .
- .5 Co-ordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

### **3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Roof and wall exhausters.

**1.2 REFERENCES**

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

**1.3 SYSTEM DESCRIPTION**

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

**1.4 SUBMITTALS**

- .1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 – Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
  - .2 Include :
    - .1 Fan performance curves showing specified point of operation.
    - .2 Sound rating data.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

## **1.6 MAINTENANCE**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with City of Winnipeg CW 1110 – General Instructions.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
  - .1 Bearings and seals.
  - .2 Addresses of suppliers.
  - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **Part 2 Products**

### **2.1 VANE-AXIAL EXHAUSTER**

- .1 Vane-Axial V belt driven.
  - .1 Housings: 304 stainless steel complete with resilient mounted motor and fan.
  - .2 Impeller: spark proof.
  - .3 Adjustable motor sheave.
  - .4 12 mm mesh 2.0 mm diameter aluminum birdscreen.
  - .5 Vertical mounting lugs.

### **2.2 WALL EXHAUSTERS**

- .1 Propeller fan units, V belt driven.
  - .1 Galvanized steel housings, complete with resilient mounted motor and fan.
  - .2 12 mm mesh 2.0 mm diameter aluminum birdscreen.
  - .3 Cadmium plated securing bolts and screws.

- .2 Housings:
  - .1 Provide with rubber or neoprene grommets for wiring passages, integral attachment collar, or angle ring mounted to mating flanged wall sleeve with full gasketting.
  - .2 Discharge pattern: away from building.

**Part 3 Execution**

**3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

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

**3.3 ANCHOR BOLTS AND TEMPLATES**

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

**3.4 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                SUMMARY**

.1            Section Includes:

- .1            Supply, return and exhaust grilles and diffusers and linear grilles, for commercial and residential use.

**1.2                SYSTEM DESCRIPTION**

.1            Performance Requirements:

- .1            Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

**1.3                SUBMITTALS**

.1            Product Data:

- .1            Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 013300 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2            Indicate following:
  - .1            Capacity.
  - .2            Throw and terminal velocity.
  - .3            Pressure drop.
  - .4            Neck velocity.

**1.4                DELIVERY, STORAGE, AND HANDLING**

.1            Packing, shipping, handling and unloading:

- .1            Deliver, store and handle materials in accordance with manufacturer's written instructions.

**1.5                MAINTENANCE**

.1            Extra Materials:

- .1            Include:
  - .1            Keys for volume control adjustment.
  - .2            Keys for air flow pattern adjustment.

**Part 2            Products**

**2.1                GENERAL**

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



- .2 Frames:
  - .1 Full perimeter gaskets.
- .3 Concealed manual volume control damper operators.
- .4 Colour: standard.

## **2.2 MANUFACTURED UNITS**

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

## **2.3 SUPPLY GRILLES AND REGISTERS**

- .1 As specified on drawings.

## **2.4 RETURN AND EXHAUST GRILLES AND REGISTERS**

- .1 As specified on 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 manufacturers instructions.
- .2 Install with flat head oval head cadmium plated screws in countersunk holes where fastenings are visible.

### **3.3 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 SUMMARY**

.1 Section Includes:

- .1 Mechanical louvers; intakes; vents; and reinforcement and bracing for air vents, intakes and gooseneck hoods.

**1.2 REFERENCES**

.1 American National Standards Institute (ANSI)/ National Fire Protection Association (NFPA)

- .1 ANSI/NFPA 96-04, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 American Society for Testing and Materials International (ASTM)

- .1 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

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

- .1 Material Safety Data Sheets (MSDS).

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

.5 Society of Automotive Engineers (SAE)

**1.3 SYSTEM DESCRIPTION**

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

**1.4 SUBMITTALS**

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 013300 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Indicate following:
  - .1 Pressure drop.
  - .2 Face area.
  - .3 Free area.

**1.5 DELIVERY, STORAGE, AND HANDLING**

.1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

## **Part 2 Products**

### **2.1 FIXED LOUVRES - ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy 6063-T5.
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.
- .4 Frame, head, sill and jamb: 100 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at 1500 mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: 12 mm exhaust 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.
- .8 Finish: factory applied enamel, Colour: to Contract Administrator's approval.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

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

### **3.3 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)
  - .1 ANSI/NFPA 96- 1994 , Ventilation Control and Fire Protection of Commercial Cooking Operations .
- .2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 52.1- 1992 , Gravimetric And Dust Spot for Testing Air-cleaning Devices Used in General Ventilation for Removing Particulate Matter.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-115.10- M90 , Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
  - .2 CAN/CGSB-115.11- M85 , Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
  - .3 CAN/CGSB-115.12- M85 , Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985).
  - .4 CAN/CGSB-115.13- 85 , Filter Media, Automatic Roll (Reaffirmed April 1985).
  - .5 CAN/CGSB-115.14- M91 , High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems.
  - .6 CAN/CGSB-115.15- M91 , High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems.
  - .7 CAN/CGSB-115.16- M82 , Activated Carbon for Odor Removal from Ventilating Systems.
  - .8 CAN/CGSB-115.18- M85 , Filter, Air, Extended Area Panel Type, Medium Efficiency.
  - .9 CAN/CGSB-115.20- 95 , Polarized Media Air Filter.
- .4 Underwriters= Laboratories of Canada
  - .1 ULC -S111- M80 , "Fire Tests for Air Filter Units".
  - .2 ULC-S649-1993, Grease Filters for Commercial and Institutional Kitchen Exhaust Systems.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawing and product data in accordance with Section 013300- Submittal Procedures.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual.

**1.4 MAINTENANCE MATERIALS**

- .1 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.

**1.5 EXTRA MATERIALS**

- .1 Spare filters: in addition to filters to be installed immediately prior to acceptance by Contract Administrator, supply 1 complete set of filters for each filter unit or filter bank.

**Part 2 Products**

**2.1 GENERAL**

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

**2.2 ACCESSORIES**

- .1 Holding frames: permanent channel section construction of galvanized steel 1.6 mm thick, except where specified otherwise.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side.

**2.3 FIBROUS GLASS PANEL FILTERS**

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diam hinged wire mesh screen.
- .3 Performance: minimum average synthetic dust weight arrestance 70 % to ASHRAE 52.1 .
- .4 Fire rated: to ULC -S111.

**2.4 CARTRIDGE TYPE FILTERS, 80-85 % EFFICIENCY**

- .1 Media: deep pleated, disposable, high efficiency, to CAN/CGSB-115.14.
- .2 Holding frame: galvanized steel with bracing.

- .3 Media support: welded wire grid.
- .4 Performance: average atmospheric dust spot efficiency 80-85 % to ASHRAE 52.1 .
- .5 Fire rated: to ULC -S111.

**2.5 FILTER GAUGES - DIAL TYPE**

- .1 Diaphragm actuated, direct reading.
- .2 Range: 0 to 2 times initial pressure 0 to 250 Pa .

**2.6 FILTER GAUGES - MANOMETER TYPE**

- .1 Inclined acrylic tube.
- .2 Complete with levelling screws.
- .3 Range: 0 to 2 times initial pressure 0 to 250 Pa .

**Part 3 Execution**

**3.1 INSTALLATION GENERAL**

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

**3.2 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.

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for self-contained multizone and single zone, gas, electric, HVAC units.
- .2 Related Sections:
  - .1 Section 02 61 33 - Hazardous Materials: Submission Requirements for WHMIS MSDS.
  - .2 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)
  - .1 ANSI/ARI 210/240-03, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
  - .2 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 B52-99, Mechanical Refrigeration Code.
  - .2 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.

**1.3 SUBMITTALS**

- .1 Submittals in accordance with Section 013300 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet for packaged rooftop HVAC units.
- .3 Submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials
- .4 Shop Drawings:
  - .1 Submit shop drawings to indicate project layout and dimensions; indicate:



- .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
  - .2 Piping, valves, 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 Pump and 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.
- .5 Instructions: submit manufacturer's installation instructions.
  - .6 Closeout submittals: submit maintenance and engineering data for incorporation into manual.
    - .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.

#### **1.4 WARRANTY**

- .1 For Work of this Section 23 74 00 Packaged Outdoor HVAC Equipment, 12 months warranty period prescribed is extended to 24 months.

### **Part 2 Products**

#### **2.1 GENERAL**

- .1 Self-contained single zone unit with gas burner and bear label of CSA, CGA, FM, UL and ULC.
- .2 Units to consist of cabinet and frame, supply fan, heat exchanger, burner with integral induced draft fan, heater control, air filter, motorized outside air damper, return damper.
- .3 Conform to ANSI/ARI 210/240, rating for unit larger than 40 kW nominal.

#### **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 at top of unit.
- .3 Outer casing: weathertight 1.0 mm thick galvanized steel with baked enamel finish, complete with flashing.
- .4 Access: gasketed hinged doors with quick locking door handle type fasteners.
- .5 Insulation: neoprene coated glass fiber on surfaces where conditioned air is handled, 50 mm thick, 32 kg/m<sup>3</sup> density.

### **2.3 FANS**

- .1 Centrifugal, forward curved impellers, statically and dynamically balanced. Multi V-belt drive with adjustable variable pitch motor pulley, spring isolated hinge mounted motor fan and motor integrally mounted on isolation base, separated from unit casing with flexible connections and spring isolators. Vibration isolators: 95 % efficiency.

### **2.4 AIR FILTERS**

- .1 50 mm thick, 85% efficiency, metal framed, replaceable media throwaway, standard to unit manufacturer.
- .2 To meet NFPA 90A, air filter requirements type Class 2.

### **2.5 HEAT EXCHANGERS AND BURNERS**

- .1 Gas fired, multiple flue passes, with primary heating surface of stainless steel ; secondary heating surface, stainless steel tubes.
  - .1 Gas burner: factory mounted, wired and fire tested complete with operating and safety controls.
  - .2 Forced continuous port steel multi-slotted non-clogging cast iron inshot type.
  - .3 Spark ignited pilot with pilot flame safety shut-off.

### **2.6 CONTROLS**

- .1 Combustion safety controls.

### **2.7 REMOTE PANEL**

- .1 Provide remote readout panel for each unit containing:
  - .1 Signal lights indicating system status, heating system failure and dirty filters.
  - .2 Check switches proving signal light operation.
  - .3 System on-off switch.
  - .4 Fan on-off switch.
- .2 Provide gauges in remote panel indicating outside air, mixed air, return air and discharge air temperatures for each deck before heat exchangers.

**2.8 CAPACITY**

- .1 As indicated in schedule.

**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.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.

**3.3 FIELD QUALITY CONTROL**

- .1 General:
  - .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
  - .2 Verify accessibility, serviceability of components including motorized dampers, filters, fans, motors, operators, sensors, electrical disconnects.
- .3 Performance Verification:
  - .1 General:
    - .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems, supplemented as specified herein.
  - .2 Air Handling Units:
    - .1 Check for smooth, vibration less correct rotation of supply fan impeller.
    - .2 Measure supply fan capacity.
    - .3 Adjust impeller speed as necessary and repeat measurement of fan capacity.
    - .4 Measure pressure drop each component of air handling unit.
    - .5 Set outside air dampers for the % of outside air required by design and repeat measurements of fan capacity.
    - .6 OAD: verify for proper stroking.
    - .7 Measure DBT, of SA.
    - .8 Measure flow rates (minimum and maximum) of SA.
    - .9 Simulate maximum heating load and:
      - .1 Verify temperature rise across heat exchanger.
      - .2 Perform flue gas analysis. Adjust for peak efficiency.
      - .3 Verify combustion air flow to heat exchanger.

- .4 Simulate minimum heating load and repeat measurements.
- .10 Verify operating control strategies, including:
  - .1 Heat exchanger operating and high limit.
  - .2 Early morning warm-up cycle.
  - .3 Alarms.
  - .4 Voltage drop across thermostat wiring.
  - .5 Operation of remote panel including pilot lights, failure modes.
- .11 Adjust impeller speed as necessary and repeat measurement of return fan capacity.
- .12 Check capacity of heating unit.
- .13 Refer to other sections of these specifications for PV procedures for other components.
- .3 Start-Up:
  - .1 General: in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
  - .4 Verify accessibility, serviceability of components including motorized dampers, filters, fans, motors, operators, sensors, electrical disconnects.
  - .5 Verify accessibility, clean ability, drainage of drain pans for coils, humidifiers.

### **3.4 CLEANING**

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

**END OF SECTION**