

COMMON WORK RESULTS FOR HVAC

1. GENERAL

1.1 Scope:

- .1 Ventilation equipment:
- .2 Make-Up Air Unit.
- .3 Supply Fan F-1
- .4 Exhaust Fans F-2 and F-3
- .5 Ductwork, piping, fittings and supports
- .6 Natural gas piping and supports.
- .7 Valves.
- .8 Engine Exhaust System.
- .9 Insulation systems for piping, ductwork and equipment.
- .10 HVAC Controls

1.2 Intent

- .1 Provide complete, fully tested and operational HVAC system to meet the requirements described herein and in complete accordance with current edition of all applicable codes and ordinances.
- .2 Specifications and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.
- .3 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .4 Install equipment generally in locations and routes shown. Run piping and ductwork parallel to building lines so as to minimize interference with other services and free space. Remove and replace improperly installed piping, ductwork, and equipment to satisfaction of the Contract Administrator at no extra cost.
- .5 Install equipment to provide access and ease of maintenance.
- .6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Subcontractors. Uncrate equipment, move in place and install complete; start-up and test.
- .7 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by controls Subcontractor.
- .8 'Provide' shall mean 'supply and install'.

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1.3 Action and Informational Submittals

- .1 Submit Shop Drawings as per Section E3 – Submittals and Shop Drawings.
- .2 Clearly mark each Shop Drawing with the Specification Section number together with the clause number or schedule number and the item tag number (where applicable) to which it refers. Failure to include this information on shop drawings will result in the drawings being rejected.
- .3 Identify materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Contract Administrator's office. Maintenance and operating manuals are not suitable submittal material.
- .4 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special coatings, construction materials or electrical rating.
- .5 Include weights, dimensional, and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes. Provide centre of gravity diagrams. Prior to submission to the Contract Administrator, the Contractor shall review all shop drawings. By this review, the Contractor certifies that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and certifies that he has checked and coordinated each shop drawing with the requirements of the Contract. Additionally the Contractor certifies by this review the compliance of the submittal package with the requirements of items 1 through 5 above. The Contractor's review of each Shop Drawing shall be indicated by stamp, date and signature of the Contractor's designated project manager.
- .6 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Contract Administrator.
- .7 Retain one (1) copy of Shop Drawings on Site for review.
- .8 Shop drawings; submit drawings stamped, dated and signed by the Contractor to indicate acceptance, and stamped by Professional Engineer registered or licensed in the Province of Manitoba, Canada where indicated in these specifications.
- .9 Shop drawings to show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
- .10 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.

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- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.
- .11 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified Section E51 – Closeout Submittals.
 - .2 Operation and maintenance manual approved by, and final copies deposited with, Contract Administrator before final inspection.
 - .3 Operation data to include:
 - .1 Control schematics for systems including environmental controls.
 - .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .4 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .5 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

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.7 Site records:

- .1 Contract Administrator will provide 1 set of reproducible HVAC drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing HVAC systems, control systems and low voltage control wiring.
- .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
- .3 Use different colour waterproof ink for each service.
- .4 Make available for reference purposes and inspection.

.8 As-built drawings:

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

.9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 Coordination of Work

- .1 Cooperate and coordinate with other Contractors and Subcontractors on the project.
- .2 Make reference to Civil, Electrical, Plumbing, Process, Controls, Structural and Architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly work out all conflicts on Work Site before fabricating or installing any materials or equipment.
- .3 Coordinate installation with Division 26 Subcontractor.
- .4 Where dimensional details are required, work with the applicable architectural and structural drawings.
- .5 Full-size and detailed drawings shall take precedence over scale measurements from Drawings. Drawings shall take precedence over Specifications.
- .6 Any areas indicated as space for future materials or equipment shall be left clear.

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1.5 Permits

- .1 Obtain all permits and pay all fees applicable to the Work.
- .2 Contractor shall arrange for inspections of the Work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.6 Quality Assurance

- .1 Quality Assurance: in accordance with referenced standards and codes.

1.7 Metric Conversion

- .1 All units in this division are expressed in SI units.
- .2 Equivalent Nominal Diameters of Pipes - Metric and Imperial:
 - .1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.
 - .2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (in. NPS)	mm (in. NPS)	mm (in. NPS)
3 (1/8)	65 (2½)	450 (18)
6 (1/4)	75 (3)	500 (20)
10 (3/8)	100 (4)	600 (24)
15 (1/2)	125 (5)	750 (30)
20 (3/4)	150 (6)	
25 (1)	200 (8)	
30 (1¼)	250 (10)	
40 (1½)	300 (12)	
50 (2)	375 (15)	

- .3 Metric Duct Sizes:
 - .1 The Metric duct sizes are expressed as 25 mm = 1 inch.

1.8 Drawings and Specifications

- .1 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.
- .2 Should any discrepancy appear between drawings and/or specifications which leaves the Contractor in any doubt as to the true intent and meaning of the plans and specifications,

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obtain a ruling from the Engineer, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

- .3 Examine all contract documents, including all drawings and specifications, and work of other Subcontractors to ensure that work is satisfactorily carried out without changes to building.

1.9 Electrical Motors

- .1 Supply mechanical equipment complete with electrical motors.
- .2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labeled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.
- .3 All motors intended for use with a variable speed drive (VFD) shall be inverter duty rated. Variable speed drive shall be matched to motor. Coordinate with Electrical.
- .4 Two speed motors shall have separate winding for each speed.
- .5 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.
- .6 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.
- .7 Motors less than 0.37 kW shall be 120 V, 60 Hz, 1 phase. Motors 0.37 kW and larger shall be 3 phase at the indicated voltage.
- .8 All motors shall be 1800 rpm except where indicated.
- .9 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.
- .10 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.
- .11 Refer to electrical specifications Division 26, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 23.
- .12 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

1.10 Miscellaneous Metals

- .1 Provide all necessary miscellaneous metals to hang or support materials, equipment and provide access for work under this contract.
- .2 All miscellaneous metals shall be corrosion resistant primer coated.
- .3 Miscellaneous metals shall include but are not limited to:
 - .1 Hangers for equipment, piping and ductwork.

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- .2 Support for equipment.
- .3 Access platforms and catwalks.

1.11 Painting and Identification

- .1 Coordinate colour coding of piping and equipment with work of Division 09.
- .2 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour coding schedule below.
- .3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.
- .4 Identify piping with labels, colour bands, and flow arrows. Provide identification at 3 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.
- .5 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this section.
- .6 Provide 3 mm thick, 20 mm diameter white lamacoid with black engraved numbers, secured to valve stem with key chain. Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to City. Include copies in O&M Manuals.
- .7 Provide 3 mm thick, 20 mm diameter white lamacoid with black engraved lettering secured to equipment. Use a maximum of 25 letters/numbers per line. For terminal cabinets, control panels, etc. use size # 5. For equipment in Mechanical Rooms use size # 9. For equipment elsewhere size as appropriate. Conform to following table.

Size #	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

- .8 Tag automatic controls, instruments and relays and match/key to control shop drawing identification numbers. Tag all equipment and control panels.

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- .9 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this division with Lamacoid plates having 5 mm minimum letter size. Identification to state equipment controlled.
- .10 Identify the usage of duct access panels with self-adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

	<u>Colour</u>	<u>Letters</u>
Cleaning and service access	yellow	C.A.
Controls, including heat sensors	black	C.
Dampers (backdraft, balance & control)	blue	D.
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

Note: Provide black lettering for yellow or white background, white for all other colours.

.11 Mechanical Control Systems

- .1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black 'C'.
- .2 Main and secondary control panels, factory finish acceptable - control Subcontractor to install company label to identify.

.12 Ductwork

- .1 All duct work to be identified as per legend on Drawings, complete with directional arrows.

1.12 Temporary or Trial Usage

- .1 Temporary or trial usage by the Engineer or Contract Administrator of mechanical equipment supplied under contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.13 Acceptable Manufacturers/Suppliers and Agencies

- .1 The following listed manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified product. The list does not endorse the acceptability of all products available from the listed Manufacturers/Suppliers.
- .2 It remains the responsibility of the Contractor to ensure the products supplied are equal to the specified products in every respect, operate as intended, and meet the performance specifications and physical dimensions of the specified product.
- .3 The Contractor shall be fully responsible for any additional work or materials, to accommodate the use of equipment from the acceptable Manufacturers and Suppliers list.

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- .4 Submit within fourteen (14) days of contract award a copy of the list underlining the name of the manufacturer whose price was carried in the tender. If no manufacturers names are submitted, it will be assumed that the price carried in the tender was that of the specified manufacturer or where the specified product is generic, the first acceptable manufacturer listed for each item and equipment.
- .5 List of Acceptable Manufacturers/Suppliers and Agencies:
- | | |
|---|--|
| .1 Access Doors | Maxam, Acudor, Milcor, Can.Aqua, Mifab, The Williams Brothers Corporation |
| .2 Air Flow Measuring Air Monitor, Air Stations | Cambridge, Sentinel, Ebtron |
| .3 Air Terminals - Grilles Registers, Diffusers | E.H. Price, Titus, Anemostat, Nailor |
| .4 Balancing Agents | Accu-Air, Air Flo Management, Air-Tech Management Ltd, Center West Air |
| .5 Dampers – Balancing | Maxam, Ruskin |
| .6 Dampers – Control | Tamco, Ruskin |
| .7 Fans - In-Line Centrifugal | Greenheck, Jenn Air, Ammerman, ILG, Cook, Penn, Twin-City, Carnes |
| .8 Filters | FARR, Cambridge, AAF, Flanders |
| .9 Flexible Connectors - Ducting | Duro-Dyne, Thermaflex, G.I. Industries Type IHP |
| .10 Gauges - Air | Magnehelic, Dwyer |
| .11 Hanger and Supports | Anvil International, E. Myatt & Co. Inc., Empire Tool & Mfg. Co. Inc., Unistrut, Tolco, Erico Canada, Taylor |
| .12 Insulation - Piping and Duct | Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville |
| .13 Louvers | Price/Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex |
| .14 Vibration Isolation | Mason, Vibro Acoustic |

1.14 Maintenance

- .1 Furnish spare parts to the Contract Administrator as follows:
- .1 One set of spare belts for each belt-driven fan.
 - .2 One spare pressure sensor for MAU-1.

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- .3 One set of spare fuses for each fuse bank.
- .4 One spare transformer for each size of control transformer.
- .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .2 Provide one set of special tools required to service equipment as recommended by manufacturers and deliver with transmittal to the Contract Administrator.
- .3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.15 Delivery, Storage, and Handling

- .1 Materials delivered to site must be properly protected to prevent damage from handling, storage and the effects of the weather.
- .2 Provide adequate storage on site for materials received which are not yet required for installation. Storage shall be secure, weather-resistant, and available for inspection by the Contract Administrator.
- .3 Seal all open-ended pipework, ductwork, or equipment to prevent the ingress of dust and debris as installed or at the end of each work day.
- .4 At no cost to the contract, the Contractor shall repair and/or replace any installed equipment or material which is deemed to be damaged by the Contract Administrator to the Contract Administrator's satisfaction.
- .5 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.
- .6 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
- .7 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
- .8 Where two or more products of the same type are required, products shall be of the same manufacturer.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Installation

- .1 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .2 Install equipment generally in locations and routes shown. Run piping and ductwork parallel to building lines so as to minimize interference with other services and free space. Remove

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and replace improperly installed piping, ductwork, and equipment to satisfaction of the Contract Administrator at no extra cost.

- .3 Install equipment to provide access and ease of maintenance.
- .4 Connect to equipment specified in other Sections and to equipment supplied and installed by other Subcontractors. Uncrate equipment, move in place and install complete; start-up and test.
- .5 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by controls Subcontractor.

3.2 Painting Repairs and Restoration

- .1 Do painting in accordance with Section 09 91 00 – Painting – Buildings.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 Cleaning

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

3.4 Field Quality Control

- .1 Site Tests: conduct following tests in accordance with Section 23 05 93 Testing, Adjusting and Balancing for HVAC and submit report Section E3 – Submittals and Shop Drawings.
 - .1 Testing, Adjusting and Balancing of HVAC Systems.
 - .2 Pressure and leakage testing of the Control Room Superstructure.
- .2 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports in accordance with Section E3 – Submittals and Shop Drawings.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed by the Contract Administrator.

3.5 Demonstration

- .1 Engineer will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Trial usage to apply to following equipment and systems:

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- .1 Control Room Pressurization System.
- .2 Wet Well Ventilation System.
- .3 Generator fuel and ventilation systems.
- .3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .4 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .5 Instruction duration time requirements as specified in appropriate sections.
- .6 Contract Administrator will record these demonstrations on video tape for future reference.

3.6 Protection

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
- .2 Protect equipment and system components from physical damage, corrosion, and theft/vandalism.

END OF SECTION

VALVES - BRONZE

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-1983(R2006), Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International (ASTM)
 - .1 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .2 ASTM B283-08a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .3 ASTM B505/B505M-08a, Standard Specification for Copper Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
 - .1 MSS SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-80-2013, Bronze Gate, Globe, Angle and Check Valves.
 - .3 MSS SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 Action and Informational Submittals

- .1 Submittals: in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Manitoba Workplace Safety and Health requirements.
- .3 Shop Drawings:
 - .1 Submit drawings stamped dated and signed by the Contractor to indicate acceptance, and stamped by professional engineer registered or licensed in the Province of Manitoba, Canada where indicated in these specifications.
 - .2 Submit data for valves specified in this Section.

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1.3 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual as per Section 23 05 00 - Common Work Results for HVAC.

1.4 Maintenance Material Submittals

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .3 Valve handles: 2 of each size.

2. PRODUCTS

2.1 Materials

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: solder ends to ANSI/ASME B16.18.
- .3 Lockshield Keys:
 - .1 Where lockshield valves are specified, provide 3 keys of each size: malleable iron cadmium plated.
- .4 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.

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- .5 Packing: non-asbestos.
- .6 Handwheel: non-ferrous.
- .7 Handwheel Nut: bronze to ASTM B62.
- .2 NPS 2/DN 50 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: handwheel.
- .5 Globe Valves:
 - .1 Requirements common to globe valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2/DN 50 and under, composition disc, Class 125:
 - .1 Body and bonnet: screwed bonnet.
 - .2 Disc and seat: renewable rotating PTFE disc, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
 - .3 Operator: handwheel.
- .6 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2/DN 50 and under, swing type, bronze disc, Class 125:

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- .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
- .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .7 Ball Valves:
 - .1 NPS 2/DN 50 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: 4140-kPa CWP, 860 kPa steam.
 - .3 Connections: crewed ends to ANSI/ASTM B1.20.1 and with hexagonal shoulders
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: PTFE with external packing nut.
 - .8 ULC listed for natural gas service.
 - .9 Operator: removable lever handle.

3. EXECUTION

3.1 Installation

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

END OF SECTION

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B31.1-12, Power Piping.
- .2 ASTM International (ASTM)
 - .1 ASTM A125-96(R2007), Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-10, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.
 - .3 ASTM A 563-07a, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

1.2 Submittals

- .1 Submittals: in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 Shop Drawings: submit Drawings.
- .3 Submit Shop Drawings and product data for following items:
 - .1 Bases, hangers and supports.
 - .2 Connections to equipment and structure.
 - .3 Structural assemblies.
- .4 Quality assurance submittals: submit following in accordance with Section E3 - Submittals and Shop Drawings.
 - .1 Instructions: submit Manufacturer's installation instructions.

1.3 Closeout Submittals:

- .1 Provide maintenance data for incorporation into manuals specified in Section 23 05 00 - Common Work Results for HVAC.

1.4 System Description

- .1 Design Requirements:

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- .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 MSS SP-58 or ASME B31.1.
- .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 SP-58.

2. PRODUCTS

2.1 General

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI/ASME B31.1 and MSS SP-58.
- .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 electro-plating galvanizing process or hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are copper plated or epoxy coated.
- .2 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 SP-58.
- .3 Accepted Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
- .4 Hanger rods: threaded rod material to MSS SP-58:

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- .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.
- .5 Pipe attachments: material to MSS SP 58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
 - .4 Oversize pipe hangers and supports.
- .6 Adjustable clevis: material to MSS SP-58, UL Listed FM Approved, 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.
- .7 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP-58.
- .8 U-bolts: carbon steel to MSS SP-58 with two (2) nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated or epoxy coated.
- .9 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP-58.

2.3 Riser Clamps

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP-58, type 42, UL Listed FM Approved.
- .2 Copper pipe: carbon steel copper plated to MSS SP-58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

2.4 Insulation Protection Shields

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP-58, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12/DN 300 and over, carbon steel to comply with MSS SP-58.

2.5 Equipment Supports

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 50 00 - Metal Fabrications. Submit calculations with Shop Drawings.

2.6 Equipment Anchor Bolts and Templates

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

2.7 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: refer to Civil Works.

2.8 Other Equipment Supports

- .1 Fabricate equipment supports from structural grade steel.
- .2 Submit structural calculations with Shop Drawings.

3. EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

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

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- .4 Cast iron pipes: install below joint.
- .4 Clevis plates:
 - .1 Attach to concrete with four (4) minimum concrete inserts, one (1) 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, and Authority Having Jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to 15 mm: every 1.8 m.
- .4 Copper piping: up to 15 mm: 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 : mm	Maximum Spacing Steel	Maximum Spacing Copper
up to 30	2.1 m	1.8 m
40	2.7 m	2.4 m
50	3.0 m	2.7 m
65	3.6 m	3.0 m
75	3.6	3.0 m
85	3.9 m	3.3 m
100	4.2 m	3.6
125	4.8 m	
150	5.1 m	
200	5.7 m	
250	6.6 m	
300	6.9 m	

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- .7 Pipework greater than 300: to MSS SP-58.

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

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Vibration isolation materials and components, seismic control measures and their installation.

1.2 References

- .1 National Building Code of Canada (NBC) – 2010 as amended by the Manitoba Building Code Regulation 31/2011.

1.3 Action and Informational Submittals

- .1 Submittals: in accordance with Section 23 05 00 - Common Work Results for HVAC.

2. PRODUCTS

2.1 General

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

2.2 Elastomeric Pads

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

2.3 Elastomeric Mounts

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

2.4 Springs

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for 100% relative humidity installations.
- .4 Colour code springs.

2.5 Spring Mount

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

2.6 Hangers

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

2.7 Horizontal Thrust Restraint

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

3. EXECUTION

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Install vibration isolation equipment in accordance with manufacturer's instructions and adjust mountings to level equipment.
- .2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS 4/DN 100: first 3 points of support. NPS 5/DN 125 to NPS 8/DN 200: first 4 points of support. NPS 10/DN 250 and Over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .4 Where isolation is bolted to floor use vibration isolation rubber washers.
- .5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 Field Quality Control

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract.
 - .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 After delivery and storage of Products.
 - .2 After preparatory work is complete but before installation commences.
 - .3 Twice during the installation, at 25% and 60% completion stages.
 - .4 Upon completion of installation.
 - .3 Submit manufacturer's reports to the Contract Administrator within 3 days of manufacturer representative's review.

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

.4 Make adjustments and corrections in accordance with written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.2 Take vibration measurements for equipment listed below.

.1 MAU-1.

.2 Exhaust Fan F-3

.3 Provide Contract Administrator with notice 24 hours in advance of commencement of tests.

.4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.5 Submit complete report of test results including sound curves.

END OF SECTION

MECHANICAL IDENTIFICATION

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.

1.2 References

- .1 Canadian Gas Association (CGA)
 - .1 CSA B149.1-05, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-24.3-92, Identification of Piping Systems.

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. Characters are to be mechanically engraved, stamped or embossed. Hand-written nameplates will not be accepted.
- .3 Information to include, as appropriate:
 - .1 Equipment: manufacturer's name, model, size, serial number, capacity.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 System Nameplates

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

MECHANICAL IDENTIFICATION

- .1 Conform to following table:

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.
- .3 Equipment elsewhere: sizes as appropriate.

2.3 Piping Systems Governed by Codes

- .1 Identification:

- .1 Natural gas: to CSA B149.1 and the authority having jurisdiction.
- .2 Plumbing: to the requirements of the National Plumbing Code of Canada 2010 as amended by the Manitoba Plumbing Code Regulation 32/2011.

2.4 Identification of Piping Systems

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.

MECHANICAL IDENTIFICATION

- .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 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:

Contents	Background colour	Legend marking
City water	Green	CITY WATER
Engine exhaust	Yellow	ENGINE EXHAUST
Natural gas	to Codes	

2.5 Identification Ductwork Systems

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.6 Valves, Controllers

- .1 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.

MECHANICAL IDENTIFICATION

2.7 Controls Components Identification

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

3. EXECUTION

3.1 Timing

- .1 Provide identification only after painting specified Section 09 91 00 - Painting – Building has been completed.

3.2 Installation

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

3.3 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.

3.4 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.

MECHANICAL IDENTIFICATION

- .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.

3.5 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 the Contract Administrator. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

END OF SECTION

TESTING, ADJUSTING AND BALANCING FOR HVAC

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 and to do other work as specified in this section.

1.2 References

- .1 ASTM International (ASTM)
 - .1 ASTM E779-10, Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.
 - .2 ASTM E1827-11, Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door.
 - .3 ASTM E2357-11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies

1.3 Qualifications of TAB Personnel

- .1 Submit names of personnel to perform TAB to the Contract Administrator within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN1-2002.
 - .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 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.

TESTING, ADJUSTING AND BALANCING FOR HVAC

- .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 (A ABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.4 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.

1.5 Exceptions

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

1.6 Application Tolerances

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 10 %, minus 0 %.

1.7 Accuracy Tolerances

- .1 Measured values accurate to within plus or minus 5 % of actual values.

1.8 Instruments

- .1 Prior to TAB, submit to the 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 the Contract Administrator.

TESTING, ADJUSTING AND BALANCING FOR HVAC

1.9 Action and Informational Submittals

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

1.10 Air Systems

- .1 Standard: TAB to most stringent of this section or TAB standards of AABC.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 including but not limited to the following systems, equipment, components, controls:
 - .1 Building Airtightness Testing of Control Room.
 - .2 MAU-1.
 - .3 F-1.
 - .4 F-2.
 - .5 F-3.
- .3 Qualifications: personnel performing TAB current member in good standing of AABC/NEBB.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by 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).

1.11 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 Airtightness Testing of Control Room:

TESTING, ADJUSTING AND BALANCING FOR HVAC

- .1 Test the integrity and airtightness of the Control Room to the requirements of the National Building Code of Canada 2010 Part 5 and ULC Standards.
- .2 Evaluate the structure during construction via tests to ASTM-E779, ASTM-E1827, and ASTM-E2357 at a minimum of 75 Pa positive pressure with respect to the outdoor ambient pressure (uncorrected for wind).
- .3 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified minimum 25 Pa positive pressure conditions at all times in the Control Room. Airflow requirement through MAU-1 to permit this pressurization shall be no more than 150 L/s with all doors in the closed condition.
 - .1 If the pressurization of the Control Room requires more than 150 L/s, coordinate with the following sections to have the leak sources located and corrected accordingly:
 - .1 Section 07 26 00 – Air/Vapour Barrier.
 - .2 Section 07 92 00 – Joint Sealants.
 - .3 Section 08 71 00 – Door Hardware.

2. PRODUCTS

2.1 Not Used

- .1 Not used.

3. EXECUTION

3.1 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.
 - .1 Building leakage testing is to be scheduled at the point where actual doors and sealants or seals are in place, but at a point where repairs and improvements can still be made to correct defective work.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

3.2 Pre-Tab Review

- .1 Review contract documents before project construction is started and confirm in writing to the 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 the Contract Administrator in writing proposed procedures which vary from standard.

TESTING, ADJUSTING AND BALANCING FOR HVAC

- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

3.3 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.

3.4 Start of TAB

- .1 Notify the Contract Administrator 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23 are complete.
 - .4 Provisions for TAB installed and operational.
- .3 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire and volume control dampers installed and open.
 - .6 Access doors, installed, closed.
 - .7 Outlets installed, volume control dampers open.

3.5 Operation of Systems During TAB

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

TESTING, ADJUSTING AND BALANCING FOR HVAC

3.6 Preliminary TAB Report

- .1 Submit for checking and approval of the 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.

3.7 Tab Report

- .1 Format in accordance with Section E51 – Closeout Submittals.
- .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 the Contract Administrator for verification and approval, in English in D-ring binders, complete with index tabs.

3.8 Verification

- .1 Reported results subject to verification by the 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 the Contract Administrator
- .4 Pay costs to repeat TAB as required to satisfaction of the Contract Administrator.

3.9 Settings

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

3.10 Post-Occupancy Tab

- .1 Measure air velocity, air flow patterns, NC levels in the Control Room. Make adjustments as directed.
- .2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after Total Performance and #2 within 1 month prior to the termination of Warranty Period.

TESTING, ADJUSTING AND BALANCING FOR HVAC

3.11 Completion of Tab

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

END OF SECTION

DUCT INSULATION

1. GENERAL

1.1 References

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - .2 ANSI/ASHRAE/IES 90.1-04, (SI); Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .3 ASTM International (ASTM)
 - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C335/C335M-10e1, Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-11 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
 - .6 ASTM C553-11, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .7 ASTM C612-10, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

DUCT INSULATION

- .8 ASTM C795-08(2013), Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
- .9 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .4 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .5 Thermal Insulation Association of Canada (TIAC)
 - .1 TIAC Mechanical Insulation Best Practices Guide
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 Action and Informational Submittals

- .1 Provide submittals in accordance with Section 23 05 00 – Common Work Results for HVAC.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.
- .3 Shop Drawings:
 - .1 Provide product data and installation recommendations from the manufacturer for each product.
- .4 Samples:
 - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .2 Mount sample on 12 mm plywood board.

DUCT INSULATION

.3 Affix typewritten label beneath sample indicating service.

.5 Manufacturers' Instructions:

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

1.3 Quality Assurance

.1 Qualifications:

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

1.4 Delivery, Storage, and Handling

.1 Deliver, store and handle in accordance with Section 23 05 00 – Common Work Results for HVAC.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

2. PRODUCTS

2.1 Fire and Smoke Rating

.1 To CAN/ULC S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 Insulation

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

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

DUCT INSULATION

2.3 Jackets

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

2.4 Accessories

- .1 Vapour retarder lap adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921 untreated.
- .5 Tape: self-adhesive, aluminum, reinforced, 50mm wide minimum.
- .6 Contact adhesive: quick-setting.
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 12 mm wide, 0.5 mm thick stainless steel.
- .10 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .11 Fasteners: 2 mm diameter pins with 35 mm square clips, length to suit thickness of insulation.

3. EXECUTION

3.1 Application

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

3.2 Pre-Installation Requirements

- .1 Pressure test ductwork systems complete, witness and certify.

DUCT INSULATION

- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 Installation

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

3.4 Ductwork Insulation Schedule

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
	TIAC Code	Vapour Retarder	Thickness (mm)
Round warm air ducts	C-1	no	25
Supply, return and exhaust ducts exposed in space being served	None		
Outside air ducts to mixing plenum	C-1	yes	25

DUCT INSULATION

Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvers	C-1	no	25

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

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

.1 Finishes: conform to following table:

	<u>TIAC Code</u>	
	Rectangular	Round
Indoor, Concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3

3.5 Cleaning

.1 Clean in accordance with Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

THERMAL INSULATION FOR PIPING

1. GENERAL

1.1 Summary

- .1 Section Includes:
 - .1 Thermal insulation for piping and piping accessories in the following applications:
 - .1 Domestic Cold Water Piping.
 - .2 Engine Exhaust Piping and Silencer(s).

1.2 References

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IES co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 ASTM International (ASTM)
 - .1 ASTM B209-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .2 ASTM C335/C335M-10e1, Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C411-05, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C449-07(2013), Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C533-13, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
 - .6 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
 - .7 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Thermal Insulation Association of Canada (TIAC)
 - .1 TIAC Mechanical Insulation Best Practices Guide.

THERMAL INSULATION FOR PIPING

- .5 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-07, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC S702-09, Standard for Thermal Insulation, Mineral Fibre, for Buildings

1.3 Definitions

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

1.4 Action and Informational Submittals

- .1 Submittals: in accordance with Section 23 05 00 – Common Work Results for HVAC.
- .2 Quality assurance submittals: submit following in accordance with Section 23 05 00 – Common Work Results for HVAC.
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 The Contractor will make available 1 copy of systems supplier's installation instructions to the Contract Administrator.

1.5 Quality Assurance

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

1.6 Delivery, Storage and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC

THERMAL INSULATION FOR PIPING

2. PRODUCTS

2.1 Fire and Smoke Rating

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

2.2 Insulation

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC S702 ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC S702 ASTM C547.
- .4 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
 - .1 Insulation: to ASTM C533.
 - .2 Maximum "k" factor: to.
 - .3 Design to permit periodic removal and re-installation.

2.3 Insulation Securement

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

2.4 Cement

- .1 Thermal insulating and finishing cement:
 - .1 Air drying on mineral wool, to ASTM C449.

THERMAL INSULATION FOR PIPING

2.5 Vapour Retarder Lap Adhesive

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

2.6 Jackets

- .1 Canvas:
 - .1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.
- .2 Aluminum:
 - .1 To ASTM B209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: stucco embossed.
 - .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
 - .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
 - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.7 Weatherproof Caulking For Jackets Installed Outdoors

- .1 Caulking to: Section 07 92 00 - Joint Sealants, suitable for elevated temperatures on engine exhaust pipe insulation.

3. EXECUTION

3.1 Pre-Installation Requirement

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

3.2 Installation

- .1 Install in accordance with TIAC Mechanical Insulation Best Practices Guide.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

THERMAL INSULATION FOR PIPING

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.3 Piping Insulation Schedules

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-3.

.1 Securements: Tape at 300mm on center.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.3 TIAC Code: A-2.

.1 Insulation securements: Stainless steel banding at 300mm on center.

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-H.

.4 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	To 1	1 ¼ to 2	2 ½ to 4	5 to 6	8 & over
Domestic CWS		A-3	25	25	25	25	25	25
Natural Gas generator exhaust system		A-2	38	65	75	100	100	100

THERMAL INSULATION FOR PIPING

- .5 Finishes:
 - .1 Exposed indoors: canvas (CWS) or aluminum (Engine Exhaust).
 - .2 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .3 Outdoors: water-proof aluminum jacket.
 - .4 Finish attachments: SS at 300 mm on centre.
 - .5 Installation: to appropriate TIAC code CRF/1 through CPF/5.

END OF SECTION

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation procedures for electric heating and cooling controls.

1.2 References

.1 Canadian Standards Association (CSA):

.1 CSA-C22.1-09, Canadian Electrical Code, Part 1.

1.3 Action and Informational Submittals

.1 Refer to Section 23 05 00 – Common Work Results for HVAC.

1.4 Delivery, Storage, and Handling

.1 Refer to Section 23 05 00 – Common Work Results for HVAC

2. PRODUCTS

2.1 Stand-Alone Floating Point Programmable Controller

.1 24 VAC input power, 5VA load, maximum 10A fuse.

.2 4 Universal inputs configurable as 200 Ω closed/50K Ω open dry contact digital inputs or analog of the following types:

.1 0 to 10VDC.

.2 0 to 1000 Ω .

.3 1000 to 1175 Ω .

.3 One additional permanently analog input as above for temperature sensor input.

.4 Two analog outputs, 0 to 10 VDC+/- 1mA current suitable for continuous short circuit.

.5 Two digital outputs with non-renewable slow-blow fuses rated for 10A.

.1 19 to 265 VAC switching voltage.

.2 4A resistive or 3A inductive at 0.6 PF.

.3 Max inrush: 10A momentary (1 second).

.6 Integral LCD display and programming/diagnostic keys.

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

- .7 Two control loops can be programmed into the same controller.
 - .1 Programming is accomplished through a push-button menu-driven system.
 - .2 Service tool connection (RJ45).
- .8 C/w 0 to 1000 Ω temperature sensor.
- .9 Integral terminal base.
- .10 Acceptable Material: Siemens Synco 200 model RL222 or approved equal in accordance with B8.

2.2 Motorized Damper Operator – Two Position, for DM-3 and DM-4A

- .1 Direct shaft-mount damper operator with reversible mounting, Super Cap internal power storage for fail-safe closing, 0.9 m cable pigtail and the following attributes:
 - .1 Voltage: 24VAC.
 - .2 Torque: 6.0 NM.
 - .3 Power: 25 VA/18W
 - .4 Positioning signal: 0 to 10VDC.
 - .5 Full 90° stroke time: 2 seconds opening with motor and 2 seconds closing with Super Cap.
 - .6 Maximum stroke range: 90°.
 - .7 Acceptable Material: Siemens GNP191.1E.

2.3 Motorized Damper Operator – Two Position, Hazardous Area Rated, DM-7 and DM-8.

- .1 Direct shaft-mount damper operator with reversible mounting, spring return, suitable for Class 1 Zone 1 Hazardous Area, open and closed external end switches, switch enclosure, mounting bracket and 0.9 m cable pigtail and the following attributes:
 - .1 Voltage: 24VAC.
 - .2 Torque: 15.0 NM.
 - .3 Power: 25 VA/18W
 - .4 Positioning signal: 0 to 10VDC.
 - .5 Full 90° stroke time: 3 seconds opening with motor, 10 seconds closing on spring return..
 - .6 Maximum stroke range: 95°.

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

- .7 Acceptable Material: Siemens ExMax-15-F with ExSwitch, ExBox, and MKK-S Mounting Brackets.

2.4 Motorized Damper Operator – Modulating, for DM-4B, DM-5A-D and DM-6

- .1 Direct shaft-mount damper operator with reversible mounting, spring return, mounting bracket and 0.9 m cable pigtail and the following attributes:
 - .1 Voltage: 24VAC.
 - .2 Torque: 18.0 NM.
 - .3 Power: 7 VA/5 W
 - .4 Positioning signal: 0 to 10VDC.
 - .5 Full 90° stroke time: 90 seconds opening with motor, 15 seconds closing on spring return.
 - .6 Maximum stroke range: 90°.
 - .7 Acceptable Material: Siemens GCA161.1E.

2.5 Control Panel

- .1 NEMA 1 painted steel panel manufactured to meet the requirements of CSA-C22.1
 - .1 Hinged Door with screw locks.
 - .2 Polycarbonate window in door to allow the display of the Stand-Alone Floating Point Controller to be seen through the door.
 - .3 Mounting rails and terminal strips as required for components.

2.6 Key-Operated Switch

- .1 Manual key-operated two-position electric switch with:
 - .1 22 mm nominal diameter for installation.
 - .2 24 VAC 3A minimum contact capacity (resistive).
 - .3 Key removable in the off position only.
 - .4 50° operating angle, maintained contact type.
 - .5 Acceptable Material: Siemens Sirius 3SB3 Series, Order No. 3SB3000-4HD01 or approved equal in accordance with B8.

2.7 Relays

- .1 Electric relay, 4 pole, plug-in, general purpose, c/w socket:

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

- .1 Contacts rated to 250 VAC, 3A.
- .2 Coil side voltage to be 24 VAC.
- .3 Acceptable Material: Omron Series G2A with PyP-1 sockets or approved equal in accordance with B8.

3. EXECUTION

3.1 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.

3.2 Sequence of Operation

- .1 Supply Fan F-1 for Generator Room Ventilation
 - .1 Supply Fan F-1 will run continuously when there is normal power, and the standby generator is off. The fan provides 100% outdoor air to meet ventilation requirements for the space as required in NFPA 37.
- .2 Exhaust Fan F-2 for Generator Room Free Cooling
 - .1 Exhaust Fan F-2 will be energized when the Generator Room space temperature exceeds 30°C.
 - .2 When F-2 is energized, Damper DM-4a will be de-energized to open on spring return, and will provide outdoor air to make-up for the exhaust rate.
 - .3 When Exhaust Fan F-2 is energized, Damper DM-3 on the transfer opening from the Control Room will also be driven closed.
 - .4 The inlet of Exhaust Fan F-2 will be fitted with a backdraft damper BDD-2 to prevent reverse air flow when the fan is de-energized, and will permit excess air from the Control Room and Supply Fan F-1 to escape.
 - .5 When the Generator Room space temperature is below 25°C, Exhaust Fan F-2 will be de-energized, and Damper DM-4a will close on spring return.
- .3 Control Room Pressure Relief
 - .1 A backdraft damper BDD-1 at the wall to the adjoining Generator Room will be counterbalanced and calibrated to open and relieve excess air pressure in the Control Room to the Generator Room when the Control Room pressure exceeds + 30 Pa.
 - .2 This wall opening will also have a motorized damper DM-3 that will close the damper within 5 seconds of the standby generator starting or Fan F-2 being energized, and by spring return feature in the absence of normal power.

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

- .3 The wall opening will also incorporate a fire damper (type A).
- .4 Generator Cooling Control Operation
 - .1 When the generator is off, the outdoor air intake dampers DM-4a/b and Exhaust Air dampers DM-5a-d will be closed, and the recirculation damper DM-6 will be open.
 - .2 Upon loss of normal power or manual start-up of the generator, motorized damper DM-4a will be de-energized and will open on spring return to provide combustion air for the generator.
 - .3 Upon temperature rise in the space above 25°C, dampers DM-4b, and dampers DM-5a-d will modulate open to maintain the temperature in the space below 28°C, and damper DM-6 will modulate toward closed to reduce the generator discharge air that is recirculated.
 - .4 Upon the space temperature dropping below 25°C, dampers DM-4b, and dampers DM-5a-d will modulate closed to maintain the temperature in the space above 25°C, and damper DM-6 will modulate toward open to increase the generator discharge air that is recirculated.
 - .5 The floating point controller used to control the modulating dampers must be of the EEPROM memory type so it does not lose system setpoints and programming during a power outage.
- .5 Exhaust Fan F-3 in the Wet Well
 - .1 Exhaust Fan F-3 in the Wet Well will normally be off and discharge motorized damper DM-7 closed, and the corresponding outdoor air intake damper DM-8a/b closed.
 - .2 Prior to staff entering the Wet Well, the operator will engage the ventilation using a key switch on the exterior of the Lift Station, which will energize discharge motorized damper DM-7 and the outdoor air intake motorized damper DM-8 will be and drive both dampers to the open position.
 - .1 The end switch on damper motors of DM-7 and DM-8 will both signal when the dampers are completely open, and F-3 will then be energized on low speed.
 - .3 When the combustible/flammable gas detection (by process) indicates that levels are at 25% of the lower explosive limit, the detection system will annunciate an alarm that will engage the ventilation and will energize discharge motorized damper DM-7 and the outdoor air intake motorized damper DM-8 will be and drive both dampers to the open position.
 - .1 The end switch on damper motors of DM-7 and DM-8 will both signal when the dampers are completely open, and F-3 will then be energized on low speed.
 - .4 Once the key switch is turned off, or the combustible/flammable gas alarm is cleared, the Wet Well Exhaust Fan F-3 will be de-energized, and both DM-7 on the intake dampers and DM-8 on the discharge dampers will be de-energized and close under spring return force.

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

- .6 Unit Heater UH-1 – Control Room Heating
 - .1 Unit Heater UH-1 will be provided by electrical and will have a built-in thermostat. The unit heater will cycle its coil and fan to maintain the space temperature at 15°C.
- .7 Unit Heater UH-2 – Generator Room Heating
 - .1 Unit Heater UH-1 will be provided by electrical and will have a built-in thermostat. The unit heater will cycle its coil and fan to maintain the space temperature at 15°C.
- .8 Unit Heater UH-3 and UH-4 – Wet Well Heating
 - .1 Unit Heater UH-3 and UH-4 will be provided by electrical, will have a built-in thermostats, and be Class 1 Zone 2 Hazardous Area Rated. The unit heaters will cycle their coils and fans to maintain the space temperature at 10°C.

END OF SECTION

FACILITY GAS PIPING

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Steel pipe fittings and valve materials, components and installation for the outdoor and indoor distribution systems for natural gas.

1.2 References

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

- .1 ANSI/ASME B16.11-2011, Forged Fittings, Socket-Welding and Threaded.

.2 American Petroleum Institute (API)

- .1 API 5L: 2007, Specification for Line Pipe.
- .2 API 6D/ISO 14313:2007, Specification for Pipeline Valves.
- .3 API 1104: 2005, Welding of Pipelines and Related Facilities, 20th Edition.

.3 ASTM International (ASTM)

- .1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Stainless.
- .2 ASTM A181/A181M-12, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
- .3 ASTM A193/A193M-08b, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High-Temperature or High Pressure Service and Other Special Purpose Applications.
- .4 ASTM A194/A194M-12a, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- .5 ASTM A216/A216M-12, Standard Specification for Steel Castings, Carbon, Suitable For Fusion Welding, for High-Temperature Service.

.4 Canadian Standards Association (CSA)

- .1 CSA B149.1-05, Natural Gas and Propane Installation Code.
- .2 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .3 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.

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- .4 CSA W48-06 (R2011), Filler Metals and Allied Materials for Metal Arc Welding.
- .5 CSA W178.2-08 (2013), Certification of Welding Inspectors.
- .5 National Research Council (NRC)
 - .1 National Fire Code of Canada 2010.
- .6 Government of Manitoba
 - .1 Manitoba Fire Code Regulation 155/2011.

1.3 Submittals

- .1 Product Data:
 - .1 Submit Manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 – Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit Shop Drawings in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Quality Assurance

- .1 Qualifications:
 - .1 Welders certified in accordance with API 1104 and CSA W47.1 and CSA W47.1S1.
 - .1 Assign identification number to welders.
 - .2 Submit records of welder's certification and test results to Contract Administrator.
 - .2 Inspectors:
 - .1 Weld inspectors certified in accordance with CSA W178.2.
 - .2 Inspectors to submit records of inspections and test results to Contract Administrator.

1.5 Delivery, Storage, and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC.

2. PRODUCTS

2.1 Steel Piping

- .1 Pipe: to ASTM A53/A53M or API 5L, schedule 40. Pipe finish to be black, ends are to be threaded or plain for field threading.

FACILITY GAS PIPING

- .2 Fittings:
 - .1 Threaded type, malleable iron or steel to ASME B16.3. Class 150.
 - .2 Welding type, carbon steel, seamless or resistance weld. Wall thickness same as corresponding pipe size.
- .3 Flanges: cast carbon steel, raised face, weld neck, to ASTM-A181/A181M, Grade II Class 150, 1 MPa.
- .4 Bolting materials:
 - .1 Bolts: carbon steel to ASTM-A193/A193M.
 - .2 Nuts: carbon steel to ASTM-A194/A194M.
 - .3 Gasket: capable of chemically withstanding fluids and temperatures of 650°C.
- .5 Joints:
 - .1 Aboveground: threaded joints using compound approved by Contract Administrator for product being handled.
 - .2 Welded joints: conform to provincial, federal and municipal regulations or requirements of CSA W47.1 and CSA W47.1S1.
- .6 Corrosion and product protection:
 - .1 Protect piping against external corrosion by painting.

2.2 Flexible Connectors:

- .1 Listed/approved and labelled for Natural Gas service.
- .2 To match pipe size
- .3 Corrugated stainless steel hose
- .4 Stainless steel exterior braiding
- .5 NPT ends
- .6 Minimum working pressure: 345 kPa at 50°C

2.3 Regulators

- .1 Service Regulator: As provided by utility supplier.
- .2 PRV-1 at the Standby Generator:
 - .1 Cast gray iron body with 50mm threaded inlet and outlet, internal relief valve, and calibrated spring driven by internal outlet pressure sensing.

FACILITY GAS PIPING

- .2 Maximum 1.2 kPa inlet pressure or 0.6 specific gravity natural gas.
- .3 Setpoints and orifice sizes vary depending on manufacturer/model of standby generator, refer to schedule on drawing.
- .4 Acceptable Material: Fisher Model CS800 regulator or approved equal in accordance
.....with B8.

2.4 Valves

- .1 50mm and smaller: ULC Listed ball valves, refer to Section 23 05 23.01 Valves - Bronze.
- .2 Stem seals and valve seats: materials resistant to conveyed gas or fluid.

3. EXECUTION

3.1 Handling

- .1 Protect and shield pre-coated equipment and piping.

3.2 Coatings

- .1 Clean surfaces to base metal. Store clean pipe for short time period in sheltered dry location.
- .2 Shop application: prefabricated piping sections are limited to 15 m maximum length.
- .3 Reprime mill primed pipe before coating.

3.3 Anchors and Guides

- .1 Install anchors and guides as indicated and at following points:
 - .1 At changes of pipe sizes.
 - .2 At branch line take offs.
 - .3 At changes of piping directions.
 - .4 At terminal points.
 - .5 Elsewhere as indicated.

3.4 Provision for Expansion

- .1 Install loops offsets as indicated.

3.5 Supports

- .1 Above-ground piping: prevent excessive vibration and stress on adjacent equipment.

FACILITY GAS PIPING

3.6 Protection

- .1 Protect piping system from damage by vehicular traffic using guard devices, marked with fluorescent markers painted with warning colours.

3.7 Sleeves

- .1 Install where pipes pass through walls or floors. Firestop around pipes.

3.8 Location of Pipework

- .1 General: locate not to constitute hazard to personnel, buildings or equipment.
- .2 Above-ground outdoor piping:
 - .1 Do not locate on exterior walls constructed of combustible material.
 - .2 Do not locate above windows, or door openings.
 - .3 Locate above roofs only if roof is accessible for pipe maintenance.
- .3 Underground pipework: coordinate with utility to locate at least 300 mm away from foundations of building structure, and rise above grade for regulator and meter station before piping enters building.

3.9 Indoor Installation

- .1 Install to CSA B149.1 and the additional requirements of the authority having jurisdiction.
- .2 Take most direct route possible or practicable.
- .3 Support overhead or locate in trenches which contain no other services.
- .4 Install overhead piping close to ceiling or beams or along walls, where possible. Support from building structure at least 2100 mm from floor.
- .5 Hanger spacing:
 - .1 Up to 30mm, 3700 mm.
 - .2 40mm and over, 4600 mm.
 - .3 Design to prevent lateral movement.
- .6 Exposed risers: protect against mechanical damage by installing:
 - .1 Adjacent to walls or pilasters.
 - .2 Between flanges of steel columns.
 - .3 Guards.

FACILITY GAS PIPING

- .7 Install loops or swing connections to compensate for pipe movement.
- .8 Do not jeopardize fireproofing of structural elements or fire separations.

3.10 Valves

- .1 Install valves to control flow and to isolate equipment at following locations:
 - .1 Branch lines at points of connection to main line;
 - .2 At equipment requiring periodic servicing such as pressure regulators and appliances.

3.11 Welding

- .1 Do work in accordance with API 1104.
- .2 Make joints in accordance with Manufacturer's recommendations.
- .3 Use bevelling machine to produce bevel cuts.
- .4 Electrodes: to CSA W48.
- .5 Welds: full penetration. Provide split backing ring for field joints above 50mm or as indicated. Use welding sockets for joints 50mm or smaller, conforming to ANSI/ASME B16.11.
- .6 Make branch connections with welding tees or forged branch outlet fittings.
- .7 Leave welds uncovered until inspected and approved by Contract Administrator.
- .8 Replace welds which fail to meet API 1104 requirements.

3.12 Pre-Assembly of Piping Systems

- .1 Obtain Contract Administrator 's approval for pre-assembly of sections of pipe systems. Seal pipes against infiltration of dirt and moisture.

3.13 Field Quality Control

- .1 Testing:
 - .1 Test system in accordance with CSA B149.1 and requirements of authorities having jurisdiction.
 - .2 Pressure test with air, nitrogen or liquid approved by Contract Administrator to at least 1.5 times maximum operating pressure. Submit certificate of tests and test results to Contract Administrator.
 - .3 Should there be loss of pressure, soap test each weld or use tracer gas with compressed air as directed by Contract Administrator.

END OF SECTION

METAL DUCTS - LOW PRESSURE TO 500 PA

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

1.2 References

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 ASTM International, (ASTM).

.1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Stainless.

.2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for..

.3 ASTM A653/A653M-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM B209-10, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 National Fire Protection Association (NFPA).

.1 NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.

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

.1 SMACNA, HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, 2005.

.2 SMACNA, HVAC Air Duct Leakage Test Manual, 1985, 1st Edition, 1985.

1.3 Action and Informational Submittals

.1 Submit shop drawings and product data in accordance with Section 23 05 00 - Common Work Results for HVAC..

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 23 05 00 - Common Work Results for HVAC. for the following:

.1 Sealants.

.2 Tape.

.3 Proprietary Joints.

METAL DUCTS - LOW PRESSURE TO 500 PA

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.

1.5 Delivery, Storage, and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC.

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 airtight with sealant, tape or combination thereof. Longitudinal seams unsealed.
- .4 Unsealed seams and joints.

2.2 Sealant

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 35 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.

METAL DUCTS - LOW PRESSURE TO 500 PA

2.5 Fittings

- .1 Fabrication: to SMACNA Standards and ASHRAE Guidelines.
- .2 Radiused elbows.
 - .1 Rectangular: Centreline radius: 1.0 times width of duct.
 - .2 Round: smooth radius or five piece. Centreline radius: 1.0 times diameter.
- .3 Mitred elbows, rectangular:
 - .1 To 400 mm: with single thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: with radius on branch 1.0 times width of duct.
 - .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 Short 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 23 33 16 – Dampers – Fire and Smoke.
- .2 Fire stopping material and installation must not distort duct or have direct fasteners to wall or floor.

2.7 Galvanized Steel Sheet

- .1 Lock forming quality: to ASTM-A653/A653M, Z90 zinc coating.

METAL DUCTS - LOW PRESSURE TO 500 PA

- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

2.8 Aluminum

- .1 To ASTM-B209M. Aluminum type: 3003-H-14.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

2.9 Galvanized Steel Pipe

- .1 To ASTM A53/A53M, Grade B, ERW, hot-dipped galvanized.
- .2 Thickness: Schedule 10.
- .3 Fabrication: shop and field welded as shown.
- .4 Embedment: as indicated.
- .5 Joints: continuous weld.

2.10 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 SMACNA.
 - .3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA and the following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.

METAL DUCTS - LOW PRESSURE TO 500 PA

.2 For wood joist: manufactured joist clamp][steel plate washer].

.3 For steel beams: manufactured beam clamps:

3. EXECUTION

3.1 General

.1 Do work in accordance with ASHRAE and SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct.

.3 Install breakaway joints in ductwork on sides of fire separation in conformance with the listing of the fire damper.

.4 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

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 SMACNA as follows:

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

3.3 Watertight Duct

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Plenums.

.3 As indicated.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

METAL DUCTS - LOW PRESSURE TO 500 PA

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.

3.5 Leakage Tests

- .1 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .2 Do leakage tests in sections.
- .3 Make trial leakage tests as instructed to demonstrate workmanship.
- .4 Do not install additional ductwork until trial test has been passed.
- .5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .6 Complete test before performance insulation or concealment Work.

3.6 Duct Materials

- .1 Make ductwork out of the materials as specified below in specific areas, or out of galvanized steel sheet elsewhere:
 - .1 Ductwork in the Wet Well on the intake and exhaust system shall be of aluminum materials.
 - .2 Ductwork (pipe) in the Discharge Chamber shall be of galvanized steel pipe up to and including the discharge above grade. Refer to the details on the drawings.

END OF SECTION

AIR DUCT ACCESSORIES

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

1.2 References

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

- .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 3rd Edition, 2005.

1.3 Action and Informational Submittals

.1 Submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.

.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 information for adhesive and solvents during application and curing.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturer's Field Reports: manufacturer's field reports specified.

AIR DUCT ACCESSORIES

1.4 Delivery, Storage and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC

2. PRODUCTS

2.1 General

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

2.2 Flexible Connections

- .1 Frame: galvanized sheet metal frame 1.6 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/m².

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: closed cell neoprene foam rubber.
- .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.
 - .5 Hold open devices.

2.4 Turning Vanes

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

2.5 Instrument Test

- .1 1.6 mm thick steel zinc plated after manufacture.

AIR DUCT ACCESSORIES

- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.6 Spin-In Collars

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

3. EXECUTION

3.1 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: 100mm.
 - .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:
 - .1 900 x 900 mm for person size entry.
 - .2 600 x 600 mm for servicing entry.
 - .3 300 x 300 mm for viewing and hand/arm entry.
 - .4 As indicated.
 - .2 Locations:

AIR DUCT ACCESSORIES

- .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
- .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.
 - .4 And as indicated.
 - .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 And as indicated.
- .4 Turning vanes:
- .1 Install in accordance with recommendations of SMACNA and as indicated.

END OF SECTION

DAMPERS - OPERATING

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-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.3 Action and Informational Submittals

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 - Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.2 Indicate the following:

- .1 Performance data.
 - .1 Pressure drop.
 - .2 Shaft torque requirements.
- .2 Schedule of sizes by tag number.
 - .1 Type of mounting/fastening.

1.4 Quality Assurance

.1 Certificates:

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

1.5 Delivery, Storage, and Handling

- .1 Refer to Section 23 05 00 - Common Work Results for HVAC.

2. PRODUCTS

2.1 Multi-Leaf Dampers

- .1 Opposed or parallel blade type as indicated.

DAMPERS - OPERATING

- .2 2.0 mm thick extruded 6063-T5 aluminum alloy, interlocking airfoil blades with two-sided profile, center pivot, complete with extruded rubber blade tip and side frame seals, extruded 6063-T5 aluminum frame.
- .3 Pressure fit self-lubricated Celcon bearings on shafts rotating within polycarbonate outer bearings pressed into the frame to prevent metal-to-metal or metal-to-plastic movement.
- .4 Linkage: aluminum tie rods, brass pivots and zinc-plated steel fasteners within the damper frame, factory set for proper damper blade timing.
- .5 101.6 mm thick Frame to be complete with minimum 25mm wide flanges for flange-mounting to ductwork.
- .6 Hexagonal 11.1mm aluminum drive rod with u-bolt fastener and hexagonal retaining nuts of zinc-plated steel extends out through the side of the damper frame for external mounting of actuator beyond duct wall and insulation.
- .7 Operator: to Section 23 09 33 – Electric and Electronic Control System for HVAC.
- .8 Performance:
 - .1 Leakage: in closed position less than 15.2 liters/second at 250 Pa differential across damper.
 - .2 Pressure drop: at full open position less than 25 Pa differential across damper at 3.5 m/s.
- .9 Insulated aluminum dampers DM-4A/B, DM-5A-D, DM-7 and DM-8:
 - .1 Frames: insulated with duct insulation as specified in Section 23 07 13 – Duct Insulation. Leave sufficient room for linkage operation.
 - .2 Blades: thermally broken aluminum extrusions with internal hollows insulated with polyurethane foam, RSI 0.88.
 - .3 Blade tip and frame side seals are constructed of silicone rubber for -40°C to 100°C operation.
 - .4 Acceptable Material: Tamco Series 9000SC or approved equal in accordance with B8.
- .10 Uninsulated dampers DM-3 and DM-6:
 - .1 Hollow one-piece aluminum blade extrusions
 - .2 Blade tip and frame side seals are made of EPDM rubber for -40°C to 100°C operation.
 - .3 Acceptable Material: Tamco Series 1000 or approved equal in accordance with B8.

2.2 Back Draft Dampers

- .1 Automatic gravity operated, multi-leaf, extruded aluminum construction.

DAMPERS - OPERATING

- .2 1.5 mm thick extruded 6063-T5 aluminum alloy frame, and blades extruded silicone rubber blade seals and frame side seals.
- .3 Pressure fit self-lubricated Celcon bearings on shafts rotating within polycarbonate outer bearings pressed into the frame to prevent metal-to-metal or metal-to-plastic movement.
- .4 Linkage: aluminum tie rods, brass pivots and zinc-plated steel fasteners within the damper frame, factory set for proper damper blade timing.
- .5 63.5 mm thick frame to be complete with minimum 16mm wide flanges for in-duct mounting.
- .6 Performance:
 - .1 Leakage: in closed position less than 22 liters/second at 250 Pa differential across damper.
 - .2 Pressure drop: at full open position less than 75 Pa differential across damper at 4 m/s.
- .7 Counterweighted BDD-1:
 - .1 6061-T6 Aluminum alloy adjustable counterbalance weights are mounted on a torque arm extending off the inlet side of each blade
 - .2 Minimum differential pressure of 3 Pa in temperature range of -40° C to 100° C operation.
 - .3 Acceptable Material: Tamco Series 7000 CW or approved equal in accordance with B8.
- .8 Non-Counterweighted BDD-2
 - .1 Acceptable Material: Tamco Series 7000 or approved equal in accordance with B8.

3. EXECUTION

3.1 Installation

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Provide aluminum mullion framing where multiple dampers meet within ductwork.
- .4 Seal single or multiple damper modules to duct flanges or structural mullions with silicon sealant.
- .5 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .6 Ensure dampers are observable and accessible.

END OF SECTION

DAMPERS - FIRE AND SMOKE

1. GENERAL

1.1 Summary

.1 Section Includes:

.1 Fire dampers.

1.2 Related Requirements

1.3 References

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

.1 ANSI/NFPA 90A-2012, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC S112-M1990, Standard Methods of Fire Test of Fire Damper Assemblies.

.2 ULC S505-1974, Fusible Links for Fire Protection Services.

1.4 Action and Informational Submittals

.1 Product Data:

.2 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 – Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

.2 Design details of break-away joints.

1.5 Quality Assurance

.1 Certificates:

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

1.6 Maintenance

.1 Extra Materials:

.1 Provide following:

.1 6 fusible links of each type.

DAMPERS - FIRE AND SMOKE

1.7 Delivery, Storage, and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC.

2. PRODUCTS

2.1 Fire Dampers

- .1 Fire dampers: arrangement Type A listed and bear label of ULC, UL, or Warnock Hersey (WH)/Intertek, and meet requirements of ANSI/NFPA 90A and the authority having jurisdiction. Fire damper assemblies fire tested in accordance with CAN/ULC 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.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: interlocking type, sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type 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 fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.
- .7 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.
- .8 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .9 Unless otherwise indicated, the installation details given in SMACNA and in manufacturer's instructions on fire dampers' ULC listing shall be followed.

3. EXECUTION

3.1 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.

DAMPERS - FIRE AND SMOKE

- .4 Install access door adjacent to each damper. Refer to Section 23 33 00 - Air Duct Accessories.
- .5 Co-ordinate with installer of concrete masonry units for proper opening size.
- .6 Ensure access doors/panels, f usable links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.

END OF SECTION

HVAC FANS

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Fans, motors, accessories and hardware for commercial use.

1.2 Related Requirements

1.3 References

.1 American National Standards Institute (ANSI)/Air Movement and Control Association International, Inc. (AMCA)

- .1 ANSI/AMCA 99-2003, Standards Handbook.
- .2 ANSI/AMCA 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .3 ANSI/AMCA 300-1996, Reverberant Room Method for Sound Testing of Fans.
- .4 ANSI/AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

1.4 System Description

.1 Performance Requirements:

- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.
- .2 Capacity: flow rate, static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA 99.
- .4 Sound ratings: comply with ANSI/AMCA 301, tested to ANSI/AMCA 300. Supply unit with AMCA certified sound rating seal.
- .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

1.5 Action and Informational Submittals

.1 Product Data:

HVAC FANS

- .2 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 – Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .2 Shop Drawings:
 - .1 Submit shop drawings and product data in accordance with Section 23 05 00 – Common Work Results for HVAC.
- .3 Provide:
 - .1 Fan performance curves showing point of operation, W and efficiency.
 - .2 Sound rating data at point of operation.
- .4 Indicate:
 - .1 Motors, bearings, accessories.

1.6 Delivery, Storage, and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC

2. PRODUCTS

2.1 Fans General

- .1 Motors:
 - .1 In accordance with CSA C22.1, Division 26 and as specified herein.
 - .2 Sizes as indicated in schedules on the drawings.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, inlet and outlet cones, discharge and inlet screens, backdraft dampers, and as listed in the schedules on the drawings and as indicated herein.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .5 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.2 Centrifugal Fans

- .1 Fan wheels:
 - .1 Dual inlet welded steel, dynamically balanced, direct driven.

HVAC FANS

- .2 Maximum operating speed of centrifugal fans not more than 50 % of first critical speed.
- .3 Forward curved fan wheel.
- .2 Bearings: integral to motor, permanently sealed and lubricated.
- .3 Disconnect: integral plug-in disconnect.
- .4 Overloads ; Built-in
- .5 Scroll integrally fabricated with the cabinet.

2.3 Cabinet Fans – F-1

- .1 Fan characteristics and construction: as centrifugal fans.
- .2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, and insulated casing.
- .3 Fabricate casing of zinc coated or phosphate treated steel of 1.0 mm thickness or thicker, reinforced and braced for rigidity. Provide removable panels for access to interior. Paint uncoated, steel parts with corrosion resistant paint. Finish inside and out, over prime coat, with rust resistant enamel. Internally line cabinet with 25 mm thick rigid acoustic insulation, pinned and cemented, 56 kg/m³ density.
- .4 Integral backdraft damper on discharge, and TDA Inlet Duct Sleeve.

2.4 Axial Flow Fans (Tube-Axial) – F-3

- .1 Casings: welded steel with welded motor support, bolted access plates, streamlined inlet cone, streamlined discharge cone sections and heresite phenolic coating of all steel surfaces.
- .2 Blade material: Cast T319 aluminum with 7 blades and integral hub.
- .3 Supports:
 - .1 Wall Mounted unit: support brackets welded to side of casing. Extended grease lubrication lines to outside of casing.
- .4 Bearings:
 - .1 Fan shaft: heavy duty grease lubricated ball or roller with extension tubes to outside of casing. Minimum average bearing life ABMA L 50 in excess of 200,000 hours at maximum RPM.
 - .2 Motor: Greaseable ball bearing with grounding strap.
- .5 Belt drive:
 - .1 Fixed blades driven by externally mounted motor through V-belt drive. Provide internal belt fairing, fixed sheave, external OSHA belt guard and adjustable motor mounts.

HVAC FANS

- .2 Adjustable drive pulley mounted on the output shaft of the electric motor to allow balancing and adjusting of the fan speed.

3. EXECUTION

3.1 Fan Installation

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

END OF SECTION

PACKAGED ROOF AND WALL EXHAUSTERS

1. GENERAL

1.1 Summary

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

1.2 References

- .1 American National Standards Institute (ANSI)/Air Movement and Control Association International, Inc. (AMCA)
 - .1 ANSI/AMCA 99-10, Standards Handbook.
 - .2 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
 - .3 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
 - .4 AMCA 301-90, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

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, static pressure Pa, r/min, kW, model and size and sound ratings as indicated on schedule.
- .2 Statically and dynamically balanced. Constructed to ANSI/AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to ANSI/AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, unit to bear AMCA certified rating seal.
- .5 Bearings: sealed lifetime heavy duty ball bearings with oil-retaining, dust excluding seals and a certified minimum ABMA L50 rated life of 200,000 hours.

1.4 Action and Informational Submittals

- .1 Submittals: in accordance with Section 23 05 00 - Common Work Results for HVAC.

1.5 Delivery, Storage, and Handling

- .1 Refer to Section 23 05 00 – Common Work Results for HVAC

PACKAGED ROOF AND WALL EXHAUSTERS

2. PRODUCTS

2.1 Wall Exhausters

- .1 Centrifugal backward inclined fan units, V-belt driven.
 - .1 Spun aluminum housings, complete with resilient mounted motor and fan.
 - .2 12 mm mesh 2.0 mm diameter aluminum birdscreen.
 - .3 Automatic gas kitted aluminum backdraft dampers, refer to Section 23 33 15 – Dampers - Operating.
 - .4 Disconnect switch within fan housing.
 - .5 Cadmium plated securing bolts and screws.
- .2 Aluminum spark-resistant and non-overloading wheel for fume service with motor out of air stream.
- .3 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 gasketing.
 - .2 Discharge pattern: away from building.
- .4 Single speed motor: Single winding, continuous duty permanently lubricated ball bearing design with speed of approximately 1750 r/min. Motor to be mounted out of the main airstream, and provided with a cooling tube to the exterior of the fan.
 - .1 Refer to Division 26 for voltage, phase and frequency requirements.

3. EXECUTION

3.1 Installation

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

END OF SECTION

ENGINE EXHAUST SYSTEMS

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B16.3-2006, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .2 ANSI/ASME B16.5-2003, Pipe Flanges and Flanged Fittings: NPS ½ through NPS24 Metric/Inch Standard.
 - .3 ANSI/ASME B16.20-2007, Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed.
- .2 ASTM International (ASTM)
 - .1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
 - .2 ASTM A105/A105M-12, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .3 ASTM A193/A193M-08b, Standard Specification for Alloy Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A758/A758M-10, Standard Specification for Wrought Carbon Steel Butt Welding Piping Fittings with Improved Notch Toughness.
- .3 National Fire Protection Association (NFPA)
 - .1 NFPA 37-2006, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines..
 - .2 NFPA 211-2006, Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.

1.2 Action and Informational Submittals

- .1 Provide submittals in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for inlets, hoses, ducts, and fans, and include product characteristics, performance criteria, physical size,

1.3 Closeout Submittals

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 23 05 00 - Common Work Results for HVAC.

ENGINE EXHAUST SYSTEMS

1.4 Extra Materials

- .1 Provide maintenance materials in accordance with Section 23 05 00 - Common Work Results for HVAC.

1.5 Quality Assurance

- .1 Certifications:
 - .1 Provide catalogued or published ratings obtained from tests carried out by manufacturer or ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.6 Delivery, Storage, and Handling

- .1 Deliver, store and handle in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with the requirements of available local recyclers and the Contract Administrator.

2. PRODUCTS

2.1 Flexible Piping Connectors

- .1 Corrugated metal flexible connector(s) will be supplied with the generator package as specified by Division 26.
- .2 Provide bolts, gaskets, and guard as specified to install the flexible connectors under this section.

2.2 Silencers

- .1 Silencer(s) will be supplied with the generator package as specified by Division 26.
- .2 Provide bolts, gaskets, piping, valves, supports and insulation as specified to install the silencer(s) under this section.

2.3 Pipe and Fittings

- .1 Pipe shall conform to ASTM A53/A53M Grade B, ERW with plain ends for welding, schedule 40 wall thickness.
- .2 Fittings .
 - .1 Sizes 65 and larger: Fittings shall have butt-welding ends and be wrought of steel to schedule 40 ID according to ASTM A758/A758M.

ENGINE EXHAUST SYSTEMS

.2 Sizes 50 and smaller: Malleable iron Class 300 threaded pipe fittings according to ANSI/ASME B16.3.

.3 Flanges are to be made in accordance with ASTM A105/A105M and ANSI/ASME B16.5, Class 150 raised face.

2.4 Gaskets

.1 Spiral-wound AISI Type 347 stainless steel winding, centering and inner ring, with ceramic filler to ANSI/ASME B16.20. Temperature rating to 925°C, for Class 150 flat and raised face flanges. Acceptable Material: Garlock Style RWI.

2.5 Fasteners

.1 AISI Type 347 Class I cap screws and nuts, minimum 413 MPa yield to ASTM A193/A193M.

3. EXECUTION

3.1 Installation

.1 Install in accordance with NFPA 37 and NFPA 211.

.2 Provide substantial supports and brace supports for seismic forces.

.3 Slope piping up towards the discharge outside so that condensate drains back to the low point drain in the silencer.

.1 Use eccentric reducers for size changes to promote drainage,

.4 Install piping from the low point drain to approximately 150mm above the floor of the generator room.

.5 Install drain valve in piping from low point in drain between 1000 and 1500 mm above the floor.

.6 Make joints watertight and airtight when subjected to 15 kPa pressure.

.7 Install silencer supports to manufacturer's recommendations.

3.2 Testing

.1 Test assembled and sealed piping and silencer from silencer inlet to plugged discharges under 15 kPa positive pressure for 30 minutes using dry nitrogen gas.

.1 No leakage is permissible.

.2 Test apparatus to be isolated once test pressure is achieved, no topping up will be accepted.

END OF SECTION

DIFFUSERS, REGISTERS AND GRILLES

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Supply, return and exhaust grilles and registers, 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 Action and Informational Submittals

.1 Product Data:

- .2 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 – Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.3 Indicate following:

- .1 Capacity.
- .2 Throw and terminal velocity.
- .3 Noise criteria.
- .4 Pressure drop.
- .5 Neck velocity.

.2 Instructions: submit manufacturer's installation instructions.

1.4 Delivery, Storage, and Handling

- .1 Deliver, store and handle in accordance with Section 23 05 00 - Common Work Results for HVAC.

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

1.5 Maintenance

.1 Extra Materials:

DIFFUSERS, REGISTERS AND GRILLES

- .1 Provide maintenance materials in accordance with Section 23 05 00 - Common Work Results for HVAC.
- .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

2. PRODUCTS

2.1 General

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as specified.
- .2 Frames:
 - .1 Full perimeter gaskets.
- .3 Concealed manual volume control damper operators.
- .4 Colour: Aluminum.

2.2 Manufactured Units

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

2.3 Supply Grilles and Registers

- .1 General: with opposed blade dampers.
- .2 Type SA: steel 32 mm border, double deflection with airfoil shape, horizontal face and vertical rear bars. Finish: painted.

3. EXECUTION

3.1 Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Install with oval head cadmium plated screws in countersunk holes where fastenings are visible.

END OF SECTION

LOUVERS, INTAKES AND VENTS

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 Air Movement and Control Association International, Inc. (AMCA)

- .1 AMCA M3/N, Damper/Louver Application Manual.
- .2 Standard 500-L-12, Laboratory Methods of Testing Louvers for Rating.

.2 ASTM International (ASTM)

- .1 ASTM E90-09, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

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

- .1 SMACNA HVAC Duct Construction Standards – Metal and Flexible 3rd Edition, 2005

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 Action and Informational Submittals

.1 Product Data:

- .2 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 – Common Work Results for HVAC. Include product characteristics, performance criteria, and limitations.

.3 Indicate following:

- .1 Pressure drop.
- .2 Face area.
- .3 Free area.
- .4 Accessories.

LOUVERS, INTAKES AND VENTS

.4 Instructions: submit manufacturer's installation instructions.

.5 Test Reports:

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

1.5 Delivery, Storage, and Handling

.1 Deliver, store and handle in accordance with Section 23 05 00 - Common Work Results for HVAC.

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

2. PRODUCTS

2.1 Gooseneck Hoods

.1 Thickness: to ASHRAE and SMACNA HVAC Duct Construction Standards.

.2 Fabrication: to ASHRAE and SMACNA HVAC Duct Construction Standards.

.3 Joints: continuously welded.

.4 Supports: self-supporting.

.5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm x 12 mm mesh on exhaust.

2.2 Fixed Louvers - Aluminum

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T6.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick.

.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 x 12 mm mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvers in formed U-frame.

.8 Finish: factory anodized. Colour: to the Contract Administrator's approval.

LOUVERS, INTAKES AND VENTS

.9 For sizes and performance data, refer to the drawings.

3. EXECUTION

3.1 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.

END OF SECTION

HVAC AIR FILTRATION

1. GENERAL

1.1 Summary

.1 Section Includes:

- .1 Filters and filter gauges for various types of mechanical air handling equipment.

1.2 References

.1 American Society of Heating, Refrigerating 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 (ANSI Approved).

.2 Underwriters Laboratories of Canada

- .1 ULC -S111-95, Standard Method of Fire Tests for Air Filter Units.

1.3 Action and Informational Submittals

.1 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 23 05 00 – Common Work Results for HVAC.

- .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).

.2 Shop Drawings:

- .1 Submit shop drawings in accordance with Section 23 05 00 – Common Work Results for HVAC.

- .1 Shop Drawings: submit drawings stamped, dated and signed by the Contractor to indicate acceptance, and stamped by a Professional Engineer registered or licensed in Manitoba, Canada where indicated in these specifications.

- .2 Indicate following: Air flow resistance at the clean condition, recommended maximum dust loading, and maximum pressure differential the filter is designed for.

.3 Closeout Submittals

- .1 Provide maintenance data for incorporation into manuals specified in Section E51 - Closeout Submittals.

1.4 Delivery, Storage, and Handling

.1 Packing, shipping, handling and unloading:

HVAC AIR FILTRATION

- .1 Deliver, store and handle in accordance with Section 23 05 00 – Common Work Results for HVAC.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.5 Maintenance

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 23 05 00 - Common Work Results for HVAC.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.
 - .3 Spare filters: in addition to filters installed immediately prior to acceptance by Contract Administrator, supply one (1) complete set of filters for each filter unit or filter bank in accordance with Section 23 05 00 - Common Work Results for HVAC.

2. PRODUCTS

2.1 General

- .1 Media: suitable for air at 100% RH and air temperatures between minus 35 and 50 degrees 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 "T" section or channel section construction of galvanized steel or extruded aluminum, 1.6 mm thick, except where specified.
- .2 Seals: to ensure leakproof operation.
- .3 Blank-off plates: as required, to fit all openings and of same material as holding frames.
- .4 Access and servicing: through doors/panels on each side.

2.3 Pleated Fibrous Panel Filters

- .1 Disposable pleated fibrous synthetic media: with adhesive.
- .2 Holding frame: 28 pt. minimum thick beverage carrier board.
- .3 Performance: Minimum Efficiency Reporting Value (MERV) value for prefilter: MERV 8 filtration media to ASHRAE 52.2.

HVAC AIR FILTRATION

- .4 Fire rated: to ULC S111.
- .5 Nominal thickness: 50 mm.
- .6 Acceptable Material: American Air Filter (AAF) PerfectPleat HC 8 or approved equal in accordance with B8.

2.4 Cartridge Type Filters, 80-85 % Efficiency

- .1 Media: deep pleated, disposable, high efficiency,
- .2 Holding frame: thermoplastic frame, header and cell sides.
- .3 Media support: ABS plastic.
- .4 Final filter: Minimum Efficiency Reporting Value (MERV) of 13 in accordance with ASHRAE 52.2
- .5 Fire rated: to ULC S111.
- .6 Acceptable Material: American Air Filter (AAF) VariCel VXL or approved equal in accordance with B8.

2.5 Filter Gauges - Dial Type

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

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 Replacement Media

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

3.3 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

AIR HANDLING UNITS - PACKAGED

1. GENERAL

1.1 References

- .1 American National Standards Institute (ANSI)/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 430-99(R2002), Central Station Air Handling Units.
- .2 American National Standards Institute (ANSI)/American Society of Heating, Refrigerating & Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IES 90.1-2007, (I-P) Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .2 ANSI/ASHRAE 52.2-2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

1.2 Action and Informational Submittals

- .1 Provide submittals in accordance Section 23 05 00 – Common Work Results for HVAC.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation, filters, adhesives, and paints, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide drawings stamped, dated and signed by the Contractor to indicate acceptance, and stamped by a professional engineer registered or licensed in Manitoba, Canada where indicated in these specifications.
 - .2 Indicate following: fan curves showing point/range of operation, motor drive, bearings, filters, mixing box, dampers, heating coils, include performance data.

1.3 Closeout Submittals

- .1 Provide maintenance data for incorporation into manual s pecified in Section 23 05 00 - Common Work Results for HVAC.

1.4 Maintenance Material Submittals

- .1 Provide maintenance materials in accordance w ith Section 23 05 00 - Common Work Results for HVAC.
- .2 Provide one (1) spare set of filters.

AIR HANDLING UNITS - PACKAGED

- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .4 Spare filters: in addition to filters installed immediately prior to acceptance by the Contract Administrator, supply one (1) complete set of filters for each filter unit or filter bank.

1.5 Delivery, Storage and Handling

- .1 Deliver, store and handle in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. PRODUCTS

2.1 General – MAU-1

- .1 Factory assembled components to form indoor unit supplying air at designed conditions, to maintain constant pressure as indicated.
- .2 Certify ratings: to ANSI/ARI 430 with ARI seal.
- .3 Horizontal type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, dampers, bypass section, heating coils, mixing box and integral controls/electrical cabinet.
 - .1 Discharge plenum on top of unit with integral aluminum diffusers on three sides sized for 1.3 m/s discharge velocity
- .4 Configuration as shown on drawings.

2.2 Casings

- .1 G-90 galvanized steel double wall construction with reinforcement and bracing for rigidity.
 - .1 Outer casing wall and roof: 1.3 mm thickness.
 - .2 Inner casing liner: 0.85mm thickness.
 - .3 Inner floor: 1.3 mm thickness.
 - .4 Outer floor: 0.85mm thickness.
 - .2 Hinged inspection doors: provide access for maintenance of internal parts.
 - .3 Integral 100 mm welded black iron channel base, painted.
 - .4 Paint steel parts, where not galvanized, with corrosion resistant paint.
 - .5 Finish unit, inside and out, with rust resistant enamel.
- .2 Line casing with solid galvanized steel liner.

AIR HANDLING UNITS - PACKAGED

2.3 Cabinet Insulation

- .1 Do not use expanded polystyrene and polyurethane insulation materials in this unit.
- .2 Insulate between outer and inner surface of panels with 50mm high density mineral wool insulation of 56 kg/m³ density.
 - .1 No fibrous insulation to be exposed to the airstream.

2.4 Fan

- .1 Cabinet hung, direct drive plenum fan with heavy duty 200,000 hours service self aligning bearings.
 - .1 Provide AMCA-rated for sound and performance tested centrifugal fans with backward inclined SWSI wheel, selected to operate in stable part of performance curve at all times.
 - .2 Motor: TEFC to ASHRAE 90.1, 2.24 kW, 1725 r/min maximum.
- .2 Maximum sound power levels, as indicated.
- .3 Internally mounted motor and fan.

2.5 Vibration Isolation

- .1 Vibration isolators on fan frame within fan section: neoprene rubber pads in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

2.6 Variable Volume Devices

- .1 Variable speed drives: 6 to 60 Hz range,

2.7 Filter Box

- .1 Material to match casing. For flat panel prefilter and cartridge type final filter arrangement:
 - .1 Provide access to filter through hinged door with suitable hardware.
- .2 Provide blank-off plates and gaskets to prevent air bypass.
- .3 Filters: in accordance with Section 23 44 00 - HVAC Air Filtration.
 - .1 Minimum Efficiency Reporting Value (MERV) value for prefilter: MERV 8 filtration media to ASHRAE 52.2.
 - .2 Final filter: Minimum Efficiency Reporting Value (MERV) of 13 in accordance with ASHRAE 52.2.

AIR HANDLING UNITS - PACKAGED

2.8 Mixing Box

- .1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degrees C of design across face of outlet.

2.9 Dampers:

- .1 Dampers for mixing boxes: in accordance with Section 23 33 15 - Dampers - Operating.
- .2 Hollow airfoil aluminum extrusions for blades with low leakage silicon rubber blade tip seals and side seal vanes.
 - .1 Acceptable material: Tamco Series 1000.

2.10 Coils

- .1 Capacity: as indicated in schedules on drawings.
- .2 Voltage: 575V 3 phase.
- .3 Construction:
 - .1 Casings: 1.5 mm thick galvanized sheet steel.
 - .1 Supports of galvanized steel double angle frames.
 - .2 Blank-off plates. Insulated sandwich construction.
 - .3 Elements: 80% nickel, 20% chrome open wire resistance type..
 - .4 Control: Full modulation SCR.
 - .5 Accessories:
 - .1 Discharge air temperature sensor.
 - .2 Airflow sensor.
 - .3 High limit sensor.
 - .4 Phase ad burn-out protection.
 - .5 Digital input for coil shut-down on generator operation for coil EC-2.

2.11 Power and Controls.

- .1 Single point of power supply.
 - .1 Incoming power: 575 Volt 3 phase, 60 Hz.
 - .2 Non-fused NEMA 3R main electrical disconnect switch.

AIR HANDLING UNITS - PACKAGED

- .3 VFD with integrated starter and overloads.
- .4 Internal transformation for control voltages as required.
- .2 Control panel complete with:
 - .1 Summer/Off/Winter Switch.
 - .2 Unit in operation status light.
 - .3 Main heating coil EC-1 in function light.
 - .4 Bypass coil EC-2 in function light.
 - .5 Clogged filter alarm light.
 - .6 Discharge temperature selector.
 - .7 Bypass heater EC-2 temperature selector.
 - .8 Internal terminal strips for the following output and input signals:
 - .1 Unit shut-down alarm dry contact output terminals.
 - .2 Loss of normal power input terminals.
 - .3 Low Limit alarm dry contact output terminals.
 - .4 Clogged filter alarm dry contact output terminals.
 - .5 Airflow proving dry contact output terminals.
 - .6 Low space pressure alarm PSL-100 output terminals.
 - .9 Room thermostat for unit control in summer mode.
 - .10 Pressure sensor with 0 – 10VDC signal feedback to drive the VFD to maintain 25 Pa positive space pressure referenced to outdoor air pressure.
 - .11 Adjustable inlet temperature thermostat for heat cut-off in mild weather, and to enable EC-2 in cold weather.
 - .12 Adjustable inlet temperature thermostat to switch unit between summer and winter modes based on outdoor air temperature entering the unit.
 - .13 Discharge temperature thermostat with 300 second timed delay to annunciate the low-limit alarm when air below 4°C is leaving the unit.
 - .14 All wiring to be tagged, main electrical components to be labeled and all terminal strips are to be numbered.

AIR HANDLING UNITS - PACKAGED

2.12 Acceptable Material:

- .1 Bousquet custom air handling unit MAU-1 as per schedule on drawings, or approved equal in accordance with B8.

3. EXECUTION

3.1 Installation

- .1 Provide appropriate protection during handling and installation.
- .2 Install units in accordance with manufacturer's instructions and as indicated.
- .3 Ensure adequate clearance for servicing and maintenance.
- .4 Provide signage on the control panel door of the unit to indicate **Danger – This Equipment Has More Than One Power Supply**.

3.2 Fans

- .1 Remove any shipping blocking and ensure that the fan wheel rotates smoothly and without binding.

3.3 Sequence of Operation

- .1 The controls of this unit are included in the scope of supply from the factory, prewired, tested and with site support for start-up and verification.
 - .1 The fan of MAU- 1 shall run continuously, and its speed be controlled by a variable frequency drive to maintain a positive pressure of +25 – 28 Pa in the Control Room referenced to the outdoors. When the fan of MAU-1 is energized, the inlet damper DM-1 from outdoors shall be driven fully open. Upon the pressure in the Control Room exceeding +28 Pa when referenced to the outdoors, the fan control shall ramp down the VFD speed until the pressure is below +28 Pa within 5 seconds. When the pressure in the Control Room is less than +25 Pa, when referenced to the outdoors, the fan control shall ramp up the VFD speed until the pressure is above +25 Pa within 5 seconds.
 - .2 When the Control Room space pressure drops below +25 Pa, the pressure sensor PS-100 will trigger an alarm contact PSL-100 to change state and will be monitored by the Process Control Panel. The Programmable Logic Controller (PLC) in the Process Control Panel will use the security monitoring features to determine if the pressure drop is due to doors being open, and if this is true, the PLC will just display the alarm locally. If no doors are open, then an alarm condition will also be annunciated to the monitoring control room at the McPhillips Pumping Station.
 - .3 When the pressure drop through the filter bank exceeds a programmed setting (250 Pa, field adjustable) then an alarm contact will become energized for a future alarm output to the Process PLC, and illuminating an LED alarm light on the unit control panel.
 - .4 If the discharge air temperature sensor detects a leaving air temperature below +4°C, an alarm contact will become energized for a future alarm output to the Process PLC, and illuminating an LED alarm light on the unit control panel.

AIR HANDLING UNITS - PACKAGED

- .5 In WINTER mode: The outdoor air temperature sensor in the intake duct will sense when the outdoor air temperature is less than 15°C, and will permit damper DM-2 to modulate to recirculate discharge air and maintain a minimum +4°C mixed air temperature as sensed by an averaging element at the inlet to the filters. Should the door(s) to the Control Room be opened, the pressure sensor PS-1 will sense the rapid space pressure loss, the supply fan will ramp up and damper DM-2 will close within 5 seconds to bring in 100% outdoor air. EC-1 in the main air stream of MAU-1 will modulate its output using an SCR controller to maintain a constant 15°C supply air temperature. The electric heating coil EC-1 will be protected by a flow sensor and hi-limit thermostat to avoid damage to the coil from fluctuating air flow and temperature.
- .1 Should the mixed air temperature sensed by the averaging element at the inlet to the filters fall below 4°C, and the damper DM-2 be fully open, EC-2 in the bypass airstream will be energized and will modulate the output to maintain +4°C mixed air temperature as sensed by an averaging element at the inlet to the filters until such time as the bypass damper DM-2 is no longer fully open.
- .2 The electric heating coil EC-2 will be protected by a flow sensor and hi-limit thermostat to avoid damage to the coil from fluctuating air flow and temperature.
- .3 When normal power is available, the “loss of normal power input terminals” will receive a 120 VAC signal from the MCC provided by Division 26 that permits EC-2 to operate when required. When normal power is not available, the “loss of normal power input terminals” will not receive a signal from the MCC indicating that normal power is not available and the generator will soon start. When normal power is not available, the MAU-1 internal controls will de-energize the bypass heating coil EC-2 before the diesel generator is connected to the load, and will close the bypass damper DM-2 within 5 seconds.
- .6 In SUMMER mode: The outdoor air temperature sensor in the intake duct will sense when the outdoor air temperature is more than 15°C, and will signal damper DM-2 to modulate to closed to bring in 100% outdoor air. Should the door(s) to the Control Room be opened, the pressure sensor PS-1 will sense the rapid space pressure loss, the supply fan will ramp up to 1835l/s airflow (by field measurement and calibration of VFD drive) and will remain there until the space pressure rises above +25 Pa relative to the outdoors. EC-1 in the main air stream and EC-2 in the bypass of MAU-1 will remain off.
- .1 During SUMMER mode operation, the supply fan speed can be increased independently from the space pressure controls in response to a modulating signal corresponding to the space temperature as measured by a space temperature sensor. The supply air delivery can be increased above the discharge air required to meet the pressurization control, but the discharge air volume required to meet the space pressurization will form the minimum fan speed control. The space temperature setpoint that will initiate the discharge air increase is 30°C.

END OF SECTION