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GENERAL MECHANICAL PROVISIONS

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents 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 close to building structure, parallel to building lines to maximise head room and with minimum interference with other services and free space. Remove and replace improperly installed 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 Contractors or by the City. 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 the Contractor.

.8 Furnish a written guarantee stating that all Work executed in this Contract will be free from defective workmanship and materials for a period of one year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any Work which fails or becomes defective during the term of the guarantee/warranty, providing such Work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on Work not otherwise covered.

.9 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.10 'Provide' shall mean; 'supply and install'.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the project.

.2 Make reference to electrical, mechanical, 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 resolve all conflicts on-site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, coordinate with the applicable architectural and structural Drawings.

.4 Full size and detailed Drawings shall take precedence over scale measurements from Drawings. Drawings shall take precedence over Specifications.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Permits

.1 All Work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the Work.

.3 Contractor shall arrange for inspections of the Work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.4 Examination of Site

.1 Before submitting Bid, visit and examine the Site and note all characteristics and features affecting the Work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the Site or item existing thereon, which is visible or known to exist at the time of Bid.

1.5 Quality of Work

.1 All Work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Contract Administrator.

.2 Work which does not conform to standards accepted by the Contract Administrator and the trade may be rejected by the Contract Administrator. The Contractor shall redo rejected Work to the accepted standard at no cost to the City.

1.6 Metric Conversion

.1 All units in this Division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 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 (inch) (NPS)	mm (inch) (NPS)	mm (inch) (NPS)
3 (0.125)	50 (2)	300 (12)
6 (0.25)	65 (2.5)	375 (15)
10 (0.375)	75 (3)	450 (18)
15 (0.5)	100 (4)	500 (20)
20 (0.75)	125 (5)	600 (24)
25 (1)	150 (6)	750 (30)
30 (1.25)	200 (8)	
40 (1.5)	250 (10)	

.5 Metric Duct Sizes:

.1 The metric duct sizes are expressed as 25 mm = 1 inch.

.6 Not applicable

1.7 Alternate Materials and Equipment

.1 The price submitted for this Contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

.2 The Contractor shall be fully responsible for any additional Work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such Work.

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 Specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and Specifications, obtain a ruling from the Contract Administrator, before submitting a Bid. 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 trades to ensure that Work is satisfactorily carried out without changes to building.

1.9 Shop Drawings

.1 Refer to Section 01300.

1.10 Salvage

.1 Remove from Site all equipment, ducting or piping which is no longer required because of Work under this Contract.

.2 Turnover to and deliver to the City's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.11 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical Work. Cast holes 100 mm (4 inch) or larger in diameter. Field-cut smaller than 100 mm (4 inch).

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.12 Excavation and Backfill

.1 Refer to requirements of Division 2.

.2 Provide all excavating to facilitate installation of the mechanical Work, including shoring, pumping, 150 mm (6 inch) compacted sand bedding under and first 300 mm (12 inch) of compacted sand over piping and ducting.

1.13 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.14 Fire-Stopping

.1 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The Contractor is required to coordinate with the architectural Drawings to contractual rated wall types and installation details.

.2 Fire-stopping materials to meet ULC CAN 2S115. Acceptable Materials: by "Tremco" or "National Firestopping".

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

1.15 Connections to Existing Services

.1 Maintain liaison with the City and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory Work is completed and all required materials are on-site. Provide a minimum of 48 hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.16 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear manufacturer's name, address, catalogue and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

.4 Make known in writing to the Contract Administrator ten days prior to the Bid closing date any materials specified that are required to complete the Work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the Bid price.

1.17 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.18 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, Canadian Electrical Code Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable speed drive shall be inverter duty rated.

.3 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.

.4 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.

.5 Motors less than 0.5 hp shall be 120 V, 60 Hz, 1 phase. Motors 0.5 hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm unless otherwise indicated.

.7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.9 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.10 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.

.11 Minimum certified motor efficiency shall be as outlined the following table, or premium efficiency, whichever is higher.

	MINIMUM EFFICIENCY (%) *			
HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.6
30	90.8	91.9	91.4	90.7
40	91.4	92.5	92.3	90.6
50	91.9	92.7	92.3	91.3
60	92.4	93.2	92.9	91.6
75	92.5	93.5	93.1	92.8
100	93.0	93.7	93.5	92.7
125	93.6	93.9	93.6	93.4
150	93.8	94.3	94.2	93.4
200	94.3	94.5	94.6	93.9
250	95.0	95.0	95.0	95.0
300	95.0	95.0	95.0	95.0
400	95.0	95.0	95.0	95.0
500	95.0	95.0	95.0	95.0

(*) As defined in CSA C390 or IEEE 112B Nominal Standards

1.19 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves

.2 Volume and splitter dampers

.3 Fire dampers

.4 Cleanouts and traps

.5 Controls, coils and terminal units

.6 Expansion joints

.7 Filters

.8 Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm (8 inch x 8 inch) for cleanout, 300 mm x 300 mm (12 inch x 12 inch) for hand 600 mm x 600 mm (24 inch x 24 inch) for body access minimum.

.5 Provide ULC listed fire rated access doors installed in rated wall and ceilings.

1.20 Miscellaneous Metals

.1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for Work under this Contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but not limited to:

.1 Hangers for equipment, piping and ductwork

.2 Support for equipment

.3 Access platforms and catwalks

1.21 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.22 Painting and Identification

.1 Coordinate colour coding of piping and equipment with Work of Division 9.

.2 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour schedule at end of this Section.

.3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm (0.75 inch) 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 15 m (50 ft) 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 20 mm (0.75 inch) diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.7 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.

.8 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.9 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this Division with lamicoid plates having 6 mm (0.25 inch) 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.

	Color	Letters
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 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including control dampers and valves, and heat sensors	black
Fire, smoke, and sprinkler equipment including dampers	red
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green
Balancing Dampers	blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.23 Colour Coding Schedule

.1 Colour numbers are called for in Canadian Government Specification No. 5-GP-1a. Colours assigned from CGSB 1-GP-12c for colour code identification.

MECHANICAL PRIMARY COLOURS FOR PIPE LINES/EQUIPMENT

1.	Yellow	-	505-102
2.	Light Blue	-	502-106
3.	Green	-	503-107
4.	Orange	-	508-102
5.	Brown	-	504-103
6.	Red	-	509-102
7.	White	-	513-101
8.	Aluminum	-	515-101
9.	Purple	-	501-101
10.	Grey	-	501-107

SECONDARY COLOURS FOR BANDS

1.	Red	-	509-102
2.	Orange	-	508-102
3.	Blue	-	502-106

BANDING

1.	Red	-	to indicate extremely hazardous material
2.	Orange	-	to indicate mildly hazardous material
3.	Blue	-	to indicate non-hazardous material

.2 Identification Symbols and Colour for Piping

	Pipe Colour	Stripe Colour	Symbol
Compressed Air	White	None	kPa Air
Domestic Cold Water	Light Blue	None	Dom Cold Wat
Domestic Hot Water	Green	Orange	Dom Hot Wat
Domestic Hot Water	Green	Blue	Dom Hot Wat R
Drains	Aluminum	Red/Orange	Drain
Effluent Return	Green	Orange	Effluent R
Effluent Return	Green	Orange	Effluent S
Glycol Heating Return	Green	Orange	Glycol Heat R
Glycol Heating Supply	Green	Orange	Glycol Heat S
Vent	Aluminum	Red/Orange	Vent

.3 Identification Symbols and Colours for Equipment:

	Pipe Colour	Stripe Colour	Symbol
Fan Guards - Motor Guards	Red Machinery Enamel		
Hangers, Brackets, Hanger Rods	Black Machinery Enamel		
Heat Exchangers	Green	Orange	None
Pumps - Regular	Aluminum	None	None
Supports	Black	None	None
Tanks – Hot Water (Insulated)	Green	Orange	None
Valves Uninsulated	High Heat Aluminum		
Boiler	Green	Orange	GH

.4 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 - Contractor to install company label to identify.

.5 Ductwork

All ductwork in mechanical rooms to be identified as follows, complete with directional arrows:

Return Air	R.A.
Supply Air	S.A.
Outside Air	O.A.
Exhaust Air	E.A.
Mixed Air	M.A.
Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

1.24 Temporary Heat

.1 Do not use the permanent system for temporary heating purposes without written permission from the Contract Administrator.

.2 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection.

.3 Use of permanent systems for temporary heat shall not modify terms of warranty.

.4 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

.5 Air systems shall not be used for temporary heating.

.6 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company system.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.25 Temporary or Trial Usage

.1 Temporary or trial usage by the City 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.

.4 Avoid thermal shock to heating system by coordination with the City during planning, construction and operation of temporary heating system.

.5 Return condensate to the heating plant. Meter equipment is not required.

1.26 Substantial and Total Performance Inspection

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 The Contractor shall ensure that all mechanical systems are ready for testing a minimum of eight weeks in advance of the projected completion date to allow for completion of DCS programming by City and all commissioning activities.

.3 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Heating air conditioning, plumbing and fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a Substantial Completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Air and water systems have been balanced with draft report submitted to Contract Administrator.

.4 Valve tagging and equipment identification is complete.

.5 Warranty forms have been mailed to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.6 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.

.7 Draft O&M Manuals have been submitted.

.8 Operating and maintenance demonstrations have been provided to the City.

.9 Written inspection report by manufacturer’s representative has been submitted for noise and vibration control devices and flexible connections.

.10 As-Constructed Drawings have been submitted.

.11 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.12 All previously identified deficiencies have been corrected.

.4 The following shall be an outline checklist of the minimum requirements to be met by the Contractor prior to the Contract Administrators' Substantial Performance by the Contractor.

Inspection:

- ☐ Complete commissioning checklists
- ☐ Final plumbing inspection certificate from local plumbing inspector
- ☐ Final backflow prevention test reports for all backflow devices
- ☐ Controls commissioning, checklist and 15 day trend logs for all major equipment (AHU's, Chiller/Boiler Plants, etc.)
- ☐ Fire alarm test certificate (via Division.16)
- ☐ Fire stopping and fire damper test letter
- ☐ Vibration isolation supplier's inspection report
- ☐ Chemical treatment supplies final inspection and test certificate
- ☐ Potable water main's flushing and chlorination test certificate
- ☐ Sound level tests reports (as required)
- ☐ Major equipment – suppliers start-up test sheets and letters certifying start-up. (boilers, chillers, packaged equipment)
- ☐ Final As-Constructed Drawings ready for review
- ☐ O&M Manuals, ready for review

.5 Prior to Total Performance inspection provide declaration in writing that deficiencies noted at time of Substantial Performance inspection have been corrected and the following items completed prior to the Total Performance inspection:

.1 Submit find air and water balance reports

.2 Submit final O&M Manuals

.3 Complete final calibration

.6 The Contract Administrator shall provide one (1) visitation for the purpose of Total Performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.

.7 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.27 Acceptable Manufacturers

.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.

.4 Submit within 14 days of Contract award a copy of the list underlining the name of the manufacturer whose price was carried in the Bid. If no manufacturers' names are submitted, it will be assumed that the price carried in the Bid 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:

.1	Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab
.2	Actuators – Dampers	Belimo, Johnson, Honeywell, Siemens *(*All actuators supplied for control components must be by same Manufacturer).
.3	Air Handling Units – Electrical Room	Circulaire
.4	Make Up Air Units	Haakon, Scott Springfield, Racan, Circulaire
.5	Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco
.6	Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Nailor
.7	Air Vents	Hoffman, Maid-O-Mist, Taco
.8	Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison
.9	Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
.10	Boilers – Electric	Super Hot, CCI Thermal
.11	Coils – Heating and Cooling	Trane, Aerofin, Engineered Air, McQuay
.12	Dampers - Control, Backdraft	Ruskin, Tamco
.13	Domestic Water Heaters - Electric	Jetglas, Aerco, AO Smith, Ruud-Rheem, State

.14	Drains – Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
.15	Expansion Compensators	Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.16	Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.17	Eye Wash Fountains	Western, Haws
.18	Fan Coil Units (low profile)	McQuay, Trane, Engineered Air
.19	Fans – Centrifugal Roof Exhausters	Penn, Greenheck, Cook
.20	Fans – Direct Drive Inline Centrifugal	Penn, Greenheck, Cook
.21	Fans – Centrifugal	Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern
.22	Filters	Cambridge, AAF, Pacific, FARR
.23	Fire Dampers	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
.24	Flexible Connectors – Ducting	Thermaflex, G.I. Industries Type IHP
.25	Flexible Connectors – Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
.26	Gauges – Air	Dwyer, Magnehelic
.27	Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
.28	Grooved Mechanical Pipe Joints	Victaulic, Shurjoint, Groove-lok (only where permitted)
.29	Heat Exchangers – Plate and Frame	Armstrong, ITT, Bell & Gossett
.30	DX Condensing Units	Lennox, AAON, Carrier
.31	Hose Bibbs	Jenkins, Dahl, Crane, Toyo, Mifab
.32	Insulation – Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
.33	Louvres	Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex
.34	Piping Hangers and Saddles	Grinnell, Myatt
.35	Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons

.36	Plumbing Fixtures	Crane, American Standard, Kohler
.37	Pumps – Vertical In-Line and Base Mounted	Armstrong, Aurora, B & G, Taco, Grundfos
.38	Sinks – Mop	Fiat, Crane, American Standard
.39	Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
.40	Tank – Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc., B & G
.41	Thermometers	Trerice, Marsh, Ashcroft, Winters
.42	Valves – Butterfly	Jenkins, Keystone, DeZurik, Centreline, Dresser, Crane, Bray, Toyo, Grinnell
.43	Valves – Circuit Balancing	Armstrong, B & G, Tour & Anderson
.44	Valves – Ball (Flushing water and Heat Exchanger Effluent)	American Valve
.45	Valves – Control Valves	Belimo, Honeywell, Johnson *(Valve actuators to be supplied by same manufacture of damper actuators)*
.46	Valves – Drain, Radiator	Jenkins,Dahl, Crane, Toyo
.47	Valves, Bronze – Check, Ball	Jenkins, Toyo, Crane, Milwaukee
.48	Valves – Pressure Reducing	Armstrong, Bell & Gossett, Taco
.49	Valves – Relief	Armstrong, Bell & Gossett, Taco
.50	Valves – Silent Check	Val-matic, APCO, StreamFlo
.51	Valves – Suction Diffusers	Armstrong, B&G, Taco
.52	Valves – Thermostatic Mixing	Symmons, Powers, Leonard
.53	Vent Caps	Jenn-Air, Penn Ventilator
.54	Vent Sets	Greenheck, Trane, Sheldons, Buffalo, New York, Brundage, Loren Cook, Lau
.55	Vibration Isolation	Mason, Vibro Acoustic
.56	Water Closet Seats	Olsonite, Moldex, Beneke

1.28 Installation

.1 Make all mechanical connections to equipment supplied by others under this Contract. This shall include all water, drain, gas, exhaust, traps, ductwork and similar connections required. Provide isolation valves, unions, flanges and traps as required for a complete installation.

.2 Change to rough-in of services or final equipment connections due to a change in the make of equipment from that specified shall be made at no extra cost to the City, provided that proper Shop Drawings are available for rough-in. Prior to commencing installation of rough-in for the equipment, coordinate with the final reviewed equipment Shop Drawings and with the manufacturer.

.3 Exposed piping shall be painted as per Contract Administrator.

.4 Arrange piping connections to allow for equipment removal.

2. PRODUCTS

2.1 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 gauge) minimum thickness.

.2 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.3 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.4 Vertical flange section of roof jacks shall be screwed to face of curb.

3. EXECUTION

.1 Not Applicable

END OF SECTION

.36	Plumbing Fixtures	Crane, American Standard, Kohler
.37	Pumps – Vertical In-Line and Base Mounted	Armstrong, Aurora, B & G, Taco, Grundfos
.38	Sinks – Mop	Fiat, Crane, American Standard
.39	Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
.40	Tank – Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc., B & G
.41	Thermometers	Trerice, Marsh, Ashcroft, Winters
.42	Valves – Butterfly	Jenkins, Keystone, DeZurik, Centreline, Dresser, Crane, Bray, Toyo, Grinnell
.43	Valves – Circuit Balancing	Armstrong, B & G, Tour & Anderson
.44	Valves – Ball (Flushing water and Heat Exchanger Effluent)	American Valve
.45	Valves – Control Valves	Belimo, Honeywell, Johnson *(Valve actuators to be supplied by same manufacture of damper actuators)*
.46	Valves – Drain, Radiator	Jenkins,Dahl, Crane, Toyo
.47	Valves, Bronze – Check, Ball	Jenkins, Toyo, Crane, Milwaukee
.48	Valves – Pressure Reducing	Armstrong, Bell & Gossett, Taco
.49	Valves – Relief	Armstrong, Bell & Gossett, Taco
.50	Valves – Silent Check	Val-matic, APCO, StreamFlo
.51	Valves – Suction Diffusers	Armstrong, B&G, Taco
.52	Valves – Thermostatic Mixing	Symmons, Powers, Leonard
.53	Vent Caps	Jenn-Air, Penn Ventilator
.54	Vent Sets	Greenheck, Trane, Sheldons, Buffalo, New York, Brundage, Loren Cook, Lau
.55	Vibration Isolation	Mason, Vibro Acoustic
.56	Water Closet Seats	Olsonite, Moldex, Beneke

1.28 Installation

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3. EXECUTION

.1 Not Applicable

END OF SECTION

DOCUMENTATION

1. GENERAL

1.1 Scope

.1 Operating and Maintenance Manuals

.2 Record Drawings

1.2 Quality Assurance

.1 Work specified in this section shall be performed by the Contractor.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Refer to Division 1.

.2 Index binders according to the following system:

Tab-1.0 Mechanical Systems:

Title page with clear plastic protection cover.

Tab-1.1 List of Mechanical Drawings:

Tab-1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating variances, and controller operating setpoints.

Tab-1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energise switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

Tab-1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from Shop Drawings.

Tab-1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

Tab-Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems and operational tests on oil-fired equipment.

Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

.3 The divider tabs shall be laminated Mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings & Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

2.2 Record Drawings

.1 Refer to Division 1.

3. EXECUTION

3.1 General

.1 Submit documents to the Contract Administrator for approval prior to transmitting to the City.

3.2 Record Drawings

Refer to Division 1.

END OF SECTION

COMMISSIONING

1. GENERAL

1.1 General

.1 This Section describes the commissioning of the mechanical system and outlines the duties and responsibilities of the team.

.2 The commissioning of the mechanical system shall be in accordance with the Code of Practice for Commissioning Mechanical Systems in Buildings and as described in this section.

.3 The commissioning process shall be applied to all products, equipment and systems provided under this Division.

.4 Work specified in this Section shall be performed by the Contractor and paid by the Contractor.

1.2 Scope

.1 Demonstration of equipment and systems operations.

.2 Instruction seminars for City's personnel.

1.3 Quality Assurance

.1 Work specified shall be performed by the Contractor.

2. THE COMMISSIONING PROCESS

2.1 The Commissioning Team

.1 Refer to Section 01670.

2.2 Commissioning Plan

.1 Refer to Section 01670.

2.3 Commissioning Phases

.1 **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

.1 Copies of all test and certificates have been submitted to the Contract Administrator.

.2 All safety controls installed and fully operational (dry run test).

.3 Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.

.4 Equipment lubrication and pre-start checks are complete.

.5 Air system cleaning complete.

.6 Filter systems installed and sealed in place (except for air system charcoal filters).

.7 Adjusting vibration isolation completed.

.8 Alignment of drives (direct and belt) completed.

.9 Control functional checks, including all alarms performed.

.10 Start-up verification checks by manufacturers representatives completed.

.11 All deficiencies to be recorded, reviewed by the commissioning team and, subsequently corrected before proceeding to the next phase, Phase 2.

.2 **Phase 2** - System Commissioning shall include but not necessarily be limited to:

.1 Activation of all systems.

.2 Testing and adjustment of all systems.

.3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the commissioning team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.

.4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The Work will include the following:

.1 Position all balance dampers in ductwork.

.2 Position all balance valves in piping systems (where appropriate).

.3 Make provisions for testing air pressures and flow rates.

.4 Set up air diffusers, registers and grilles.

.5 Set up all automatic temperature control devices.

.6 Set up constant volume and variable volume fans.

.7 Plug all air pressure and flow measuring holes.

.8 Adjust vibration isolators as necessary.

.9 Verification by the air balance contractor that all fire dampers have been checked.

.10 Air and water balance complete.

.5 Fine Tuning:

.1 Setting up automatic controls for accurate response and precise sequencing.

.2 Correction of problems revealed by Balancing Agency and change of fan speed and pitch as necessary.

.6 Testing:

.1 The commissioning coordinator shall perform a detailed check of the following:

.1 All items and functions to be later demonstrated to the City's representatives.

.2 Systems operation in the fire mode (pressurisation and smoke removal) in the presence of the authorities having jurisdiction. Obtain a written statement/ certificate of approval from the authorised manual jurisdiction.

.3 **Phase 3** - Verification of Commissioning.

.1 Verification of commissioning by the Contract Administrator shall not commence until the commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 Location of and opening and closing of all access panels.

.2 Operation of all automatic control dampers and automatic temperature/volume adjustment controls.

.3 Proper response of all heating, cooling and ventilation equipment to thermostats and volume adjustment controls.

.4 Operability of randomly selected fire dampers.

.5 Operation of all equipment and systems, under each mode of operation, including:

.1 Electronic control features

.2 Exhaust/make-up air systems

.3 Exhaust fans

.4 Pumps

.5 Unit heaters

.6 Fans

.7 Coils

.8 Tanks-expansion

.9 Heat recovery system

.2 At the completion of Phase 3, the Contractor shall submit the following to the Contract Administrator:

.1 A letter certifying that all Work specified under this Contract is complete, clean and operational in accordance with the Specification and Drawings.

.2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Contract Administrator.

.3 Record Drawings as specified.

.4 A letter from the testing and balancing agency certifying that all necessary data for inclusion in O&M Manuals has been received.

.5 A statement confirming completion of EMCS acceptance test, Division 17.

.3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Contract Administrator will provide a Certificate of Verification for Phase 3.

.4 Substantial Performance may, thereupon, be declared.

.4 **Phase 4** - Demonstration and Acceptance shall not commence until the commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Contract Administrator and the City upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

3.1 Plumbing

.1 Domestic hot and cold water systems - system pressure tests, flush and clean lines, system pressures at fixtures, water delivery at each fixture; identification of piping systems.

.2 Domestic hot water heater - capacity flow tests, combustion controls verification.

.3 Storm drainage - system pressure tests, pipe identification.

.4 Sanitary drainage - system pressure tests, pipe identification.

.5 Fixtures - cleaning, test hot and cold water and drain, installation.

3.2 Fire Extinguishers

.1 Confirm fire extinguisher location and charge. Verify that all tags are filled out and signed.

3.3 HVAC Systems

.1 Pumps - alignment, rotation, motor current draw, piping connections, flow and pressure test.

.2 Piping System - pressure tests, insulation, identification, water balance, hangers, expansion.

.3 Duct System - pressure tests, insulation, identification, air balance identification.

.4 Exhaust Fans - installation, rotation, motor current draw, accessories dampers, etc., air balance, identification.

.5 Gas Fired Ventilation Units - installation, gas connection, control checkout by Manufacturer's representative, duct connections, system capacity, air balance, identification certificate from inspection authority.

.6 Makeup Air Units - installation vibration isolation, duct connections, motor rotation, air balance, filters, capacity identification, controls.

.7 Control Valves - Installation, controls, capacity modulation, connection to EMCS, identification.

.8 Control Dampers - installation, operation, identification, capacity modulation, connection to EMCS.

.9 Controls - See Division 17 - commissioning of controls by the Contractor under the supervision of the commissioning coordinator.

.10 Gas Fired Unit Heaters - installation, gas connection, motor rotation, identification certificate from inspection authority.

.11 Radiation Heating - installation, expansion, compensation, cleaning, controls.

3.4 General

.1 Contractor shall arrange for presentation and demonstration of mechanical equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

3.5 Demonstrations

.1 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

.2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

.1 Air Systems

.2 Fire Protection Systems

.3 Plumbing Systems

.4 Control Systems

.5 Heat Recovery Systems

.3 Demonstrate the following pieces of equipment:

.1 Fans/Makeup Air Units

.2 Domestic Water Heaters

.3 Pumps

.4 Prepare a schedule identifying the proposed sequence of demonstration. Sequence of demonstration shall correspond to full system starting. Submit for review by Contract Administrator one month prior to demonstration.

.5 Answer all questions raised by the City at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three days.

END OF SECTION

TESTING

1. GENERAL

1.1 Scope

.1 Test domestic water piping

.2 Test sanitary sewer piping

.3 Test storm sewer piping

.4 Test refrigerant piping

.5 Test compressed air piping

.6 Test low velocity ducts

.7 Test medium and high velocity ducts

.8 Performance testing of equipment

.9 Manufacturer's start-up of equipment

1.2 Quality Assurance

.1 Test equipment and material where required by Specification or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with the current applicable portions of ASME, ASHRAE, and other recognised test codes as far as field conditions permit.

.3 Perform tests on-site to the satisfaction of the Contract Administrator.

.4 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Contract Administrator. Provide ample written notice (two working days) to the Contract Administrator before tests.

.5 Coordinate with Contract Administrator at start of project, those tests that will require witnessing by the Contract Administrator.

.6 Use factory trained representatives and submit manufacturer's check sheets for starting the following specialty equipment.

.1 Air handling units

.2 Fans

.3 Variable speed drive units

.4 Control components

.5 Emergency showers and eye wash stations

.6 Domestic water heaters

.7 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Contract Administrator any tests required to be witnessed. Provide sufficient notice to Contract Administrator prior to commencement of procedures.

.8 Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.9 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.10 Prior to starting equipment or systems, secure and review manufacturer's installation, operation and starting instructions. Read in conjunction with procedures defined herein.

.11 Use manufacturer's or supplier's starting personnel where required to ensure integrity of manufacturer's warranty.

.12 Compare installations to published manufacturer's data and record discrepancies. Items proving detrimental to equipment performance shall be corrected prior to equipment starting.

.13 Some processes involved in starting procedures defined in this Section may be duplications of authorities' verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures. (Gas inspectors, pressure vessels inspections etc.)

.14 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM and ASPE codes and standards.

.15 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the reading and tests.

.16 Assume all liabilities associated with starting, testing and balancing procedures.

1.3 Submittals

.1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in O&M Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemise each test as to time performed and personnel responsible. Include in O&M Manuals.

1.4 Liability

.1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

2. PRODUCTS

.1 Not used

3. EXECUTION

3.1 Pressure Tests

.1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests for eight-hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 Drainage Systems: test by filling with water to produce water pressure to 30 kPa minimum and 62 kPa maximum.

.4 Water Piping: test to 1.5 times maximum working pressure or 1033 kPa, whichever is greater, water pressure measured at system low point.

.5 Natural Gas: test as required by current edition of CAN/CGA 149.1, and authority having jurisdiction.

.6 Ducts: test ducts as per current edition of SMACNA Manual.

.7 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.8 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.9 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specialising in this type of Work.

.10 Should tests indicate defective Work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.2 Testing of Soldered Copper Joints

.1 Submit two (2) sample soldered copper pipe joints prepared by each tradesmen to be used on the project, to the Contract Administrator within two months of Contract award. These samples may be subjected to radiographic testing to verify quality of workmanship.

.2 Remove ten (10) samples of soldered copper pipe joints on heating system during construction as selected by the Contract Administrator and remake joints removed. Arrange and pay for radiographic testing of removed joints to verify quality of workmanship.

.3 Rejection of a sample will require re-test of adjacent joints at the Contractor's expense.

.4 Failure of more than 75 percent of the above removed samples will necessitate removal and replacement of all joints completed up to the time of test, at Contractor's expense.

3.3 General

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.

.2 Where required by the Authority having jurisdiction, gas fired appliances rated in excess of 117 kW shall be subjected to an operational test established by the Authority and shall pass this test before being approved for operation.

.3 Meet with Division 16 manufacturers, suppliers, and other specialists as required to ensure all phases of Work are properly coordinated prior to the commencement of each particular testing procedure. Establish all necessary manpower requirements.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.5 Confirm voltages and operating amperages at full load.

.6 Failure to follow instruction pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by the City at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from Site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.4 Procedures

.1 Procedures shall be identified in the following five distinct phases:

.1 Pre-Starting: visual inspection

.2 Starting: actual starting procedure

.3 Post-Starting: operational testing adjusting or balancing, and equipment run-in phase

.4 Pre-Interim Acceptance of the Work: final cleaning, re-testing, balancing and adjusting, and necessary maintenance

.5 Post-Interim Acceptance of the Work: repeat tests and fine-tuning resulting from corrective action of deficiency clean-up

.2 Check specified and Shop Drawing data against installed data.

.3 Check the installation is as defined by Contract Documents and as per manufacturer's recommendations including manufacturer's installation check sheets.

END OF SECTION

VIBRATION ISOLATION

1. GENERAL

1.1 Scope

.1 Supply all labour, materials and equipment required and necessary to isolate and restrain the equipment as indicated on the Drawings and specified herein and guarantee the function of the materials and equipment supplied.

.2 Install 300 mm long flex connection on all duct work connected to isolated equipment.

1.2 Qualifications

.1 All vibration isolators and bases shall be supplied by an acceptable supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 Provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The Drawings shall bear the stamp and signature of the responsible supplier's technical representative.

.3 The Work shall be carried out in accordance with the Specification and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of Work.

1.3 Samples

.1 Samples of materials required to complete the Work of this Section shall be submitted to the Contract Administrator for inspection and review, prior to submission of the Shop Drawings.

1.4 Inspection

.1 A qualified representative of the isolator manufacturer shall inspect the isolated equipment after installation and submit a concise report stating any deficiencies in the installation.

2. PRODUCTS

2.1 Isolators

.1 Spring isolators located out of doors or in humid areas shall have Rustoleum painted housing and neoprene coated springs, unless otherwise indicated on Drawings.

.2 Isolation mounts for equipment with operating weights substantially different from the installed weights, such as chillers or boilers, shall have adjustable limit stops.

2.2 Open Spring Isolators

.1 Springs shall be "ISO-Stiff" having equal stiffness in the horizontal and vertical planes with a working deflection between 0.3 and 0.6 of solid deflection.

.2 Spring mounts shall be complete with levelling devices, minimum 6 mm thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2 mm and shall meet the requirements for neoprene isolators.

2.3 Closed Spring Isolators

.1 Compression springs shall be used both for hangers and floor mount isolators.

.2 Springs shall be stable under operating conditions.

.3 Housings shall incorporate a minimum 6 mm thick sound pad sized for a minimum static deflection of 1.2 mm meeting the requirements for neoprene isolators.

.4 Floor mount units shall incorporate neoprene side stabilisers with a minimum 6 mm clearance.

2.4 Neoprene Isolators

.1 All neoprene isolators shall be tested to latest ASTM specifications.

.2 Where a ribbed pad is used, the height of the ribs shall not exceed 0.7 times the width of the rib. A steel layer shall be used to distribute the load in a multi-layered unit.

.3 Neoprene pads or elements shall be selected at the manufacturer's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene manufacturer's literature.

2.5 Inertia Bases

.1 Concrete inertia bases shall be a minimum of 1.5 times the weight of the isolation equipment and shall be constructed using a channel iron perimeter and adequate reinforcing. The concrete shall be rated at 20 MPa. Design shall be by the isolation suppliers.

.2 Concrete inertia bases shall meet the requirements of the isolation supplier's Shop Drawings.

.3 Structural steel bases shall be sufficiently rigid to prevent misalignment or undue stress on the machine, and to transmit design loads to the isolators.

2.6 Spring Hangers

.1 Hangers capable of a 10 degree misalignment shall be provided unless otherwise specified.

3. EXECUTION

3.1 Application

.1 Provide vibration isolator for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.2 Set steel bases for 25 mm clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm clearance. Adjust equipment level.

.3 Deflections 12 mm and over shall use steel spring isolators.

.4 Deflections 5 mm and under shall use neoprene isolators.

.5 Horizontal limit springs shall be provided on fans in excess of 1.5 kPa static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N.

.6 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm to other structures, piping equipment, etc. All isolators shall be adjusted to make equipment level.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.8 Adjustable, horizontal stabilisers on close spring isolators shall be adjusted so that the side stabilisers are clear under normal operating conditions.

.9 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector.

Pipe Size	Distance, *m*
15 - 40 mm	3.0
50 - 65 mm	4.5
75 - 100 mm	7.0
125 - 200 mm	9.0
225 - 275 mm	13.5
300 - 350 mm	15.0

The three closest hangers to the vibration source shall be selected for the lesser of a 25 mm static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25 mm static deflection or 1/2 the static deflection of the isolated equipment.

.10 Spring hangers shall be installed without binding.

.11 Adjust isolators as required and ensure springs are not compressed.

.12 Provide neoprene side snubbers or retaining springs where side torque or thrust is developed.

.13 Where movement limiting restraints are provided, they shall be set in a position with minimum 6 mm air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3 g without permanent distortion or damage.

.14 Wiring connections to isolated equipment shall be flexible.

3.2 Performance

.1 Install isolators of type and deflection as indicated on the following table, whichever provides the greater deflection.

.2 The required static deflection of isolators for equipment exceeding 0.35 kW is indicated below. Spring isolators shall be "open spring". Closed spring isolators shall only be used where specified.

Machine Speed r/min	Basement		Upper Floor	
	Under *15 kW*	Over *15 kW*	Normal	Critical
Under 400	Special*	Special*	Special*	Special*
400 - 600	25 mm	50 mm	90 mm	Special*
600 - 800	12 mm	25 mm	50 mm	90 mm
800 - 1100	5 mm.	12 mm	25 mm	50 mm
1100 - 1500	3 mm	4 mm	5 mm	12 mm

* "Special" indicates as directed by the acoustical consultant.

END OF SECTION

METERS AND GAUGES

1. GENERAL

1.1 Scope

.1 Provide meters, gauges, and taps where shown on Drawings or specified herein.

.2 Submit Shop Drawings of proposed Products to the Contract Administrator for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Contract Administrator for review.

2. PRODUCTS

2.1 Thermometers

.1 Dial thermometers: 75 mm diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer.

2.2 Thermometer Well

.1 Stainless steel suitable for stem type thermometer with gasket and cap except in potable water and open systems, in which case brass type shall be used.

2.3 Pressure Gauges

.1 100 mm diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1 percent midscale accuracy, front calibration adjustment, black figures on white background. Provide gauge cock and syphon for steam service, pulsating damper and pet cock for water service.

2.4 Pressure Gauge Taps

.1 Brass needle valve

2.5 Static Pressure Gauges

.1 Dial gauge: 100 mm dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement. Accuracy within +2 percent of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined vertical manometer: moulded plastic manometer, accuracy within +3 percent of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

3. EXECUTION

3.1 Installation

.1 Provide one pressure gauge per pump installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.2 Select gauges so that normal operating point is approximately mid-point of instrument range.

.3 On pipes 65 mm and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.2 Meters and Gauges Installation Schedule

.1 Pressure Gauges:

.1 Pumps

.2 Expansion tanks

.3 Pressure tanks

.4 Leaving side of automatic make-up valves

.5 Where shown on Drawings

.2 Pressure Gauge Taps:

.1 Both sides of two-way control valves

.2 All lines to three-way control valves

.3 Major coils, inlet and outlet

.4 Heat exchangers, inlet and outlet, tube and shell side

.5 Where shown on Drawings

.3 Thermometers:

.1 Supply and return headers of central equipment

.2 Heat exchangers, inlet and outlet tube and shell side

.3 Heating water zone supply and return mains

.4 Heating and cooling coils, inlet and outlet

.5 Where shown on Drawings

.4 Thermometer Wells Only:

.1 All lines to three-way control valves

.2 Where shown on Drawings

.5 Static Pressure Gauges:

.1 Across built-up filter banks

.2 Across unitary filter sections

.3 Across supply and return fans

.4 Where shown on Drawings

.6 Static Pressure Taps:

.1 Across all major dampers

.2 Across heating and cooling coils

.3 Across heat recovery sections

.4 Where shown on Drawings

END OF SECTION

SUPPORTS, ANCHORS AND SEALS

1. GENERAL

1.1 Scope

.1 Pipe hangers and supports

.2 Duct hangers and supports

.3 Flashing for mechanical equipment

.4 Sleeving for mechanical equipment

.5 Pipe anchors

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of current edition of ANSI B31.1, Power piping.

.2 Duct hangers shall follow the recommendations of the current edition of the SMACNA Duct Manuals.

1.3 Submittals

.1 Submit Shop Drawings of each factory manufactured component.

1.4 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment. Provide sleeves for all pipe and duct penetrations through walls, ceilings, floors and footings. Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

.6 Dielectrically isolate dissimilar metals.

.7 Obtain approval from the Contract Administrator prior to drilling for inserts and supports for piping systems.

.8 Obtain approval from the Contract Administrator prior to using percussion type fastenings.

.9 Use of piping or equipment for hanger supports is not permitted.

.10 Use of perforated band iron, wire or chain as hangers is not permitted.

.11 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Contract Administrator.

.12 Where deemed necessary by the Contract Administrator the contractor shall, at his own cost, employ a structural consultant to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanised steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Pipe Hangers and Supports

.1 Hangers, Pipe Sizes 15 mm to 40 mm: adjustable wrought steel ring.

.2 Hangers, Pipe Sizes 50 mm to 100 mm and Cold Pipe Sizes 150 mm Over: adjustable wrought steel clevis.

.3 Hangers, Hot Pipe Sizes 150 mm and Over: adjustable steel yoke and cast iron roll.

.4 Multiple or Trapeze Hangers: steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.

.5 Wall Support, Pipe Sizes to 80 mm: cast iron hook.

.6 Wall Support, Pipe Sizes 100 mm and Over: welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm and over.

.7 Vertical Support: steel riser clamp.

.8 Floor Support, Pipe Sizes to 100 mm and All Cold Pipe Sizes: cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

.9 Floor Support, Hot Pipe Sizes 125 mm and over: adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

.10 Install hangers so they cannot become disengaged by movements of supported pipe.

.11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping. Provide galvanised hangers and supports for galvanised piping.

.12 Support all piping below grade and under floor slabs in 3.2 mm continuous cadmium plated channel. Support channel with cadmium plated clevis hangers and rods. Install supports on centres as specified in 3.2. Extend cadmium plated hanger rods 450 mm above slab rebar and bend back over rebar so as to provide a minimum of 450 mm of support in slab. Do not stress rod when bending.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.4 Duct Hangers and Supports

.1 Conform to current edition of SMACNA handbooks.

2.5 Flashing

.1 Steel Flashing: 0.85 mm minimum thickness galvanised sheet steel.

.2 Lead Flashing: 25 kg/m² sheet lead for waterproofing, 5 kg/m² sheet lead for soundproofing.

.3 Safes: 25 kg/m² sheet lead or 0.5 mm neoprene.

.4 Caps: steel, 0.7 mm thickness minimum, 1.6 mm thickness at fire resistance structures.

2.6 Sleeves

.1 Pipes through Floors: form with 1.2 mm galvanised steel.

.2 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: form with schedule 40 steel pipe.

.3 Ducts: form sleeves with galvanised steel.

.4 Size large enough to allow for expansion with continuous insulation.

2.7 Pipe Seals

.1 Provide “Link-seal” pipe sealing system where passing through room foundation walls.

2.8 Finishes on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanised or factory primed with alkyd red oxide primer to CGSB 1-GP-40m.

3. EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete Work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm or ducts over 1500 mm wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports		Hanger Rod Diameter
	Steel	Copper	
15 mm	1.8 m	1.5 m	10 mm
20 mm to 40 mm	2.1 m	1.8 m	10 mm
50 mm & 65 mm	3.0 m	2.4 m	10 mm
80 mm & 100 mm	3.6 m	3.0 m	16 mm
150 mm to 300 mm	4.2 m	4.0 m	22 mm
350 mm to 450 mm	6.0 m	--	25 mm

.2 Install hangers to provide minimum 12 mm clear space between finished covering and adjacent work.

.3 Place a hanger within 300 mm of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1.5 m maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Use oversized hangers to accommodate pipe insulation thickness. For pipes up to 50 mm use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm and over, use insulation protection saddle.

3.3 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750 mm wide: 25 x 1.6 mm at 3 m spacing

.2 790 to 1200 mm wide: 40 x 1.6 mm at 3 m spacing

.3 Over 1200 mm wide: 40 x 1.6 mm at 2.4 m spacing

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to 450 mm wide: 40 x 1.6 mm or 25 x 25 x 3 mm at 2.4 m spacing

.2 480 to 1000 m wide: 40 x 40 x 3 mm at 1.2 m spacing

.3 Vertical Duct on Wall Supports Minimum Sizes at 3.65 m spacing:

.1 Up to 610 mm wide: 40 x 1.6 mm

.2 640 to 900 mm wide: 25 x 25 x 3 mm

.3 940 to 1200 mm wide: 30 x 30 x 3 mm

.4 Over 1200 mm wide: 50 x 50 x 3 mm

.4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:

.1 Up to 1520 mm wide: 40 x 40 x 3 mm

.2 Over 1520 mm wide: 50 x 50 x 3 mm

3.4 Medium and High Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 900 mm wide: 2 at 25 x 1.6 mm at 3 m spacing

.2 940 to 1520 mm wide: 2 at 25 x 1.6 mm at 2.4 m spacing and 50 x 50 x 6 mm trapeze

.3 1550 to 3050 mm wide: 2 at 38 x 2.6 mm at 2.4 m spacing and 50 x 50 x 7 mm trapeze

.4 2070 to 6700 mm wide: 3 at 10 mm diameter at 1.2 m spacing and 65 x 65 x 5 mm trapeze

.2 Round Duct Hangers Minimum Sizes at 3 m spacings:

.1 Up to 460 mm diameter: 25 x 1.6 mm

.2 480 to 900 mm diameter: 25 x 2.6 mm

.3 940 to 1270 mm diameter: 40 x 2.6 mm

.4 1300 to 2130 mm diameter: 2 at 40 x 2.6 mm from girth reinforcing angle

.3 Vertical Duct Floor Supports Minimum Sizes:

.1 Up to 1220 mm wide: 40 x 40 x 3 mm

.2 Over 1220 mm wide: 50 x 50 x 3 mm

.3 Rivet to duct and tie angles together with rod, angles or band iron

.4 Angle reinforcing may be used for support omitting trapeze

3.5 Equipment Bases and Supports

.1 Provide for floor mounted equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.6 Flashing

.1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm minimum above roof membrane with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with minimum 600 x 600 mm sheet size. For pipes through outside walls turn flange back into wall and caulk.

.3 Flash floor drains over finished areas with lead 250 mm clear on sides with minimum 920 x 920 mm sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations minimum 200 mm high. Flash and counterflash with steel; solder and make waterproof.

.5 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.6 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.7 Vertical flange section of roof jacks shall be screwed to face of curb.

.8 Provide continuous lead or neoprene safes below air supply casings, built-up mop sinks, shower stalls, shower room floors located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm into walls or to top of curbs and caulk into joints.

.9 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

3.7 Sleeves

.1 Set sleeves in position in advance of concrete Work. Provide suitable reinforcing around sleeve.

.2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and ductwork passing through floor, ceiling or wall, close off space between duct and sleeve and non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Piping passing through mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25 mm "flange" welded to the external face of the sleeve at the mid point of the thickness of the structure to provide a water stop.

.6 Install chrome plated escutcheons where piping passes through finished surfaces.

END OF SECTION

PIPE AND PIPE FITTINGS

1. GENERAL

1.1 Quality Assurance

.1 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations latest current editions.

.2 Use welders fully qualified and licensed by Provincial Authorities.

.3 Gas Piping: National Standard of Canada CAN1-B149.1, installation Code for Natural Gas Burning Appliances and Equipment.

.4 Domestic Water, Drainage and Vent Piping: current Provincial and Municipal Codes.

.5 All below grade steel piping shall be yellow jacketed with taped and sealed joints.

.6 Non specified pipe joining and pipe fitting methods such as T-drill and press fit are not permitted in any piping system covered under Division 15.

2. PRODUCTS

2.1 Pipe

	Service	Material
.1	Sanitary drainage, and vent, inside building, above ground	`DWV' copper, ASTM B306 Cast iron, CSA B70
.2	Sanitary drainage, and vent, inside building, below ground	Cast iron, CSA B70 PVC-DWV, CAN3B182
.3	Sanitary drainage and vent, outside building	Cast iron, CSA B70 PVC, SDR-35 for sizes to 300 mm**,** ASTM-D3034, complete with tracer wire. Concrete pipe for sizes over 300 mm
.4	Storm drainage, inside building, above ground	Cast iron, CSA B70 DWV Copper, ASTM B306
.5	Storm drainage, inside building, below ground	Cast iron, CSA B70 PVC-DWV, CAN3B182.1
.6	Storm drainage, outside building	Cast iron, CSA B70 PVC, SDR-35 for sizes to 300 mm, ASTM-D3034, complete with tracer wire. Concrete pipe for sizes over 300 mm

.7	Domestic water, above ground (inside building)	Type `L' hard copper for cold water and Type 'K' hard copper for hot water and recirc. water for sizes up to 100 mm, ASTM B88M Ductile Iron centrifugally cast for cold water main sizes 100 mm and larger, ANSI/AWWA C151/A21.51. No steel piping allowed for domestic hot water.
.8	Domestic Water (buried inside building)	Type `K' soft copper, ASTM B88M
.9	Domestic water service	Type `K' soft copper, ASTM B88M below ground PVC, Class 150, conforming to CSA B137.3 and AWWA C900, complete with tracer wire
.10	Hot water and glycol heating to 120°C	Steel, Sch.40, ASTM A53, Grade B heating to 120°C
.11	Natural gas, propane	Steel, Sch.40, ASTM A53 Grade B
.12	Equipment drains and overflows	Sch.40, galvanised steel, ASTM A120 Type `L' hard copper ASTM B88M
.13	Compressed air	Type `L' hard copper, ASTM B88M Steel Sch.40, galvanised, ASTM A120 (for pipes over 65 mm diameter)

2.2 Fittings and Joints

	Service	Material	Joint
.1	Sanitary drainage and vent inside building, above ground	Cast iron	Gasket clamp
		Wrought or Cast copper	50-50 Solder
.2	Sanitary drainage and vent, inside building, below ground	Cast iron (hubless fitting)	Gasket & clamp
		PVC-DWV	Solvent weld

PIPE AND PIPE FITTINGS

.3	Sanitary drainage and vent, outside building	Cast iron	Hub & spigot
		PVC- Gravity Sewer	Hub & spigot with gasket
		Concrete	Hub & spigot
.4	Storm drainage, inside building, above ground	Cast iron	Gasket & clamp
		Wrought or cast copper	50-50 solder
.5	Storm drainage, inside building, below ground	Cast iron	Gasket & clamp
		PVC-DWV	Solvent weld
.6	Storm drainage, outside building	Cast iron	Hub & spigot
		PVC-Gravity sewer	Hub & spigot with gasket
		Concrete	Hub & spigot
.7	Domestic water, above ground	Wrought copper, bronze	Lead free solder, brazed for pipes over 50 mm
		Cast bronze	Screwed
		Ductile Iron pipe	Grooved mechanical
.8	Domestic water, buried	PVC	Hub & spigot, with "O" ring
		Copper pipe	No joints permitted underground
.9	Hot water and glycol heating 120°C	Banded malleable iron, 1033 kPa, up to 50 mm	Screwed,
		Steel, same schedule as pipe, for sizes 50 mm and larger	Welded
		Wrought copper,	95-5 solder, brazed bronze, for pipes over 50 mm
		Cast brass	Screwed
		Cast bronze	Flare tube

.10	Natural gas	Banded malleable iron, 1033 kPa, for sizes 40 mm and under	Screwed
		Steel, same schedule as pipe, for sizes 50 mm and larger: and for high pressure(over 860 kPa)- all sizes; and for piping installed outdoors - all sizes	Welded
.11	Equipment drains and overflows	Galvanised banded malleable iron	Screwed
		Wrought copper, bronze	50-50 solder
		Cast brass	Screwed
.12	Compressed air	Wrought copper or cast brass	95-5 solder

.13 Use factory fabricated butt welded fittings for welded steel pipes.

.14 Use long radius elbows for steel and cast iron water piping, including grooved mechanical fittings.

2.3 Unions, Flanges and Couplings

.1 Size 50 mm and under: 1033 kPa malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.

.2 Sizes 65 mm and over: 1033 kPa forged steel welding neck flanges for ferrous piping, 1033 kPa bronze slip-on flanges for copper piping. Gaskets shall be 1.5 mm thick performed synthetic rubber bonded asbestos. Gaskets for gas service shall be synthetic rubber.

.3 Flange bolting: For systems up to 120°C, use carbon steel stud bolts, semi-flushed and heavy hex nuts, ASTM A307-GrB. For systems up to 215°C, use alloy steel bolts ASTM A193-GrB7, and semi-finished heavy hex nuts ASTM A194-Gr2H.

.4 Where permitted by the Contract Administrator, use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition sealing gasket EPDM Grade `E' and steel bolts. Use galvanised couplings for galvanised pipe. Victaulic brand or Grinnel Gruv-Lok only

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the Contract Administrator, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

3.2 Connection

.1 Screw joint steel piping up to and including 40 mm. Weld piping 65 mm and larger, including branch connections. Screw or weld 50 mm piping for liquid systems, weld 50 mm piping for air and gas systems.

.2 Make screwed joints with full cut standard taper pipe threads with approved non-toxic joint compound applied to male threads only.

.3 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.4 Clamp cast iron water pipe at fittings with 20 mm rods and properly anchor and support.

.5 Use grooved mechanical couplings and mechanical fasteners, only where permitted by the Contract Administrator.

.6 Use galvanised couplings with galvanised pipe.

.7 Make connections to equipment, specialty components, and branch mains with unions or flanges.

.8 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.

.9 Use insulating plastic spacers for copper pipe installation in metal studs.

3.3 Route and Grades

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Slope water piping 0.2 percent and provide hose bibb drains at low points.

.3 Equip low points with 20 mm drain valves and hose nipples.

.4 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25 mm diameter or line size whichever is greater and 150 mm high minimum. Square tees may only be used to assist with complete venting and draining.

.5 Make reductions in water pipes with top flat eccentric reducing fittings installed to provide drainage and venting.

.6 Grade horizontal drainage and vent piping 2 percent minimum, unless noted otherwise.

.7 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns and overflows to the nearest building drain. Pipe to glycol recovery tanks for a glycol based system.

3.4 Installation

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 Install piping material specified as inside the building to 2500 mm outside of building.

.4 Yellow jacket buried steel lines, joints and fittings, prime coat and paint lines exposed to outdoors.

3.5 Welded Pipe Branch Connections

.1 Make branch connections according to the following schedule.

Legend:

T: Forged tee or reducing tee

S: Socolet

W: Weldolet

HEADER	BRANCH PIPE SIZE												
	15 mm	T											
	20 mm	T	T										
	25 mm	T	T	T									
	30 mm	T	T	T	T								
	40 mm	T	T	T	T	T							
	50 mm	S	S	S	T	T	T						
	65 mm	S	S	S	S	T	T	T					
	75 mm	S	S	S	S	S	T	T	T				
	100 mm	S	S	S	S	S	T	T	T	T			
	150 mm	S	S	S	S	S	W	T	T	T	T		
	200 mm	S	S	S	S	S	W	W	W	T	T	T	
	250 mm	S	S	S	S	S	W	W	W	W	T	T	T
	300 mm	S	S	S	S	S	W	W	W	W	W	T	T	T
		15	20	25	30	40	50	65	75	100	150	200	250	300

END OF SECTION

VALVES AND STRAINERS

1. GENERAL

1.1 Scope

.1 Ball valves

.2 Check valves

.3 Plug cocks

.4 Drain valves

1.2 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.3 Shop Drawings

.1 Submit copies of valves "ordering schedule" for review before ordering valves.

.2 Submit detailed Shop Drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. PRODUCTS

2.1 Domestic Water System

.1 Ball Valves up to 50 mm: brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa non-shock WOG rating. Threaded, Red-White Fig. 5044A. Solder joint, Red-White Fig. 5049A.

.2 Butterfly Valves: cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable EPDM seat, lever lock handle operator with multiple position lock plate for valve sizes to 100 mm, heavy duty gear handwheel operator with position indicator for valve sizes 150 mm and over. Minimum rating 1200 kPa, 121°C. Keystone F1000, F1020.

.3 Swing Check Valves up to 50 mm: bronze body, screw-in cap, replaceable disc, 860 kPa steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

.4 Swing Check Valves 65 mm and over: cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa steam. Red-White Fig. 435.

.5 Silent Check Valves for Pump Discharge:

.6 Up to 50 mm: bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa water. Val Matic VM-S1400.

.7 65 mm and over: wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

3. EXECUTION

3.1 Installation and Application

.1 Install valves with stem upright or horizontal, not inverted.

.2 Use eccentric plug valves in water systems for throttling and balancing service.

.3 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.4 Size drain lines and drain valves equal to size of apparatus drain connection.

.5 For pipe sizes 20 mm and over, minimum drain size to be 20 mm

.6 Provide hose thread connection with cap and chain for 20 mm drain valves located in ceiling and public areas.

.7 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm where not piped directly to floor drains.

.8 Provide valved drain and hose connections off the bottom of all strainers.

END OF SECTION

PIPING INSULATION

1. GENERAL

1.1 Scope

.1 Piping insulation

.2 Adhesives, tie wires, tapes

.3 Recovering

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating and recovering materials.

1.4 Job Conditions

.1 Deliver material to jobsite in original non-broken factory packaging, labelled with manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.5 Alternatives

.1 Alternative insulations are subject to review and acceptance by the Contract Administrator. Alternatives shall provide the same or better thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.3 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 Materials

.1 Cold piping: formed fine fibrous glass or formed mineral fibre pipe insulation, with factory applied vapour barrier jacket, factory moulded to conform with piping, "K" value at 24°C maximum 0.035 W/m°C. Service temperature -14°C to 100°C.

.2 Hot piping: formed fine fibrous glass or mineral fibre pipe insulation, with factory applied general purpose jacket, factory moulded to conform to piping, "K" value maximum 0.035 W/m°C at 24°C. Service temperature up to 150°C.

.3 Refrigerant piping: foamed plastic of closed cell structure or closed cell elastomer, "K" value maximum 0.04 W/m°C at 24°C. Maximum water vapour transmission rating of 0.1 perms.

.4 Roof Drains and Vents: flexible fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m°C at 24°C with factory applied reinforced aluminum foil vapour barrier. Service temperature -14°C to 50°C.

.5 Recovery Jackets:

.1 0.4 mm aluminium sheet for piping where specified.

.2 Solvent welded PVC with UV inhibitor.

3. EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.2 Insulate piping, fittings and valves. Do not insulate unions, flanges, Victaulic couplings, strainers, flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Finish insulation neatly on hangers, supports and other protrusions.

.4 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.5 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces is not considered exposed. Make smooth uneven insulated surfaces before recovering.

.6 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.7 Cold piping: seal lap joints with 100 percent coverage of vapour barrier adhesive. Seal butt joints with 50 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.

.8 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100 mm centres.

.9 Hot piping: for fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells.

.10 Vents: adhere flexible insulation with adhesive applied to all laps. Provide annealed tie wire at 400 mm centres for securing insulation. Butt insulation and seal joints and breaks with 50 mm of foil adhered over joint.

3.3 Insulation Installation Thickness Schedule

Piping or Equipment	**Pipe Sizes mm**	**Insulation Thickness mm**	**Recovery Jacket**
Domestic Cold Water Piping	15 to 20 25 and over	15 25	PVC
Domestic Hot Water Supply and Recirculation Piping	15 to 50 Over 50	25 40	PVC
Vents (Interior) within 3 m of building penetration, as measured along pipe	All sizes	25	Aluminum
Exterior Process Vents	All sizes	25	Aluminum
Condensate Drains from Heat Reclaim	All sizes	25	Aluminum

Note: Pipe insulation for piping installed in 38 mm x 92 mm wall cavity can be reduced 15 mm, for pipe sizes 40 mm to 65 mm. Install insulation to thickness specified piping outside the wall cavity.

END OF SECTION

DUCT INSULATION

1. GENERAL

1.1 Scope

.1 Duct thermal insulation

.2 Adhesives, tie wires, tapes

.3 Recovery

.4 All outdoor mounted ductwork

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet fire and smoke hazard ratings as stated in this Section and defined in applicable current building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating materials and recovering.

1.4 Job Conditions

.1 Deliver material to jobsite in original non-broken factory packaging, labelled with manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement, poor workmanship or material defects.

1.5 Alternatives

.1 Alternative insulations are subject to approval. Alternatives shall provide the same or better thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Insulation Material, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: composite fire and smoke hazard ratings shall not exceed 25 from flame spread and 50 for smoke developed.

.2 Insulating materials and accessories shall withstand service temperatures without smouldering, glowing, smoking or flaming.

.3 Recovery Jackets:

.1 0.5 mm aluminum sheet for interior ductwork where specified

.2 0.9 mm aluminum sheet for exterior ductwork and where subject to damage

.4 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

2.2 Materials

.1 Exposed Rectangular Ducts: rigid fibrous glass or mineral fibreboard insulation, "K" value maximum 0.035 W/m°C at 24°C. Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C to 65°C. Cold ducts service temperature -40°C to 65°C.

.2 Round Ducts and Concealed Rectangular Ducts: flexible fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m°C at 24°C. Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C to 65°C. Cold duct service temperature -40° to 65°C .

3. EXECUTION

3.1 Preparation

.1 Do not install covering before ductwork and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions where possible.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation materials, properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Locate insulation or cover seams in least visible locations. Locate seams on ductwork in ceiling spaces on the underside of the duct.

.4 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.

.5 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.6 Exposed Rectangular Ducts: secure rigid insulation with galvanised anchors or welded pins on 400 mm centres. Secure in place with retaining pins. Seal all insulation joints and breaks with joint tape. Seal adhesive; cover joints with 100 mm strips of open mesh cloth imbedded between two coats of lap seal adhesive. Use vapour barrier tape for insulation joints or breaks on cold ducts.

.7 Round Ducts and Concealed Rectangular Ducts: adhere flexible insulation to ductwork with adhesive applied in 150 mm wide strips on 400 mm centres. Provide annealed tie wire tied at 400 mm centres for securing duct insulation. Butt insulation and seal joints and breaks with lap seal adhesive; cover joints with joint tape. Use vapour barrier tape for cold ducts.

.8 Where duct velocities exceed 15 m/s, cover internal duct insulation with 0.8 mm perforated galvanised steel with 24 percent free area.

.9 Fasten aluminium recovery jacket in place with aluminum banding on 200 mm centres or screws or rivets on 150 mm centres.

3.3 Insulation Installation Thickness Schedule

Ducts and Equipment	Insulation Thickness (mm)	Recovery Jacket
Relief Duct	50	Aluminum
Exhaust Ducts within 3000 mm of Exterior Walls or Openings	25	Aluminum
Outside Air Intake Ducts	50	Aluminum
Ducts Exposed to Outdoors	50	Aluminum
Ventilation Equipment Casings	25	Aluminum
Ventilation Equipment	50	Aluminum

END OF SECTION

EQUIPMENT INSULATION

1. GENERAL

1.1 Scope

.1 Hot and Cold Equipment Insulation

.2 Tanks, Pipeline Devices, Pumps Insulation

.3 Recovering

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating and recovering materials.

1.4 Job Conditions

.1 Deliver material to jobsite in original non-broken factory packaging, labelled with manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

2. PRODUCTS

2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.3 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 Materials

.1 Hot Equipment: rigid fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m°C (0.25 BTUh-in/(sqft°F)) at 24° (75°F). Service temperature -14°C (7°F) to 200°C (392°F).

.2 Cold Equipment: rigid fibrous glass or mineral fibre insulation with factory applied reinforced aluminum foil vapour barrier, "K" value maximum 0.035 W/m°C (0.25 BTUh-in/(sqft°F)) at 24°C (75°F). Service temperature -10°C (14°F) to 100°C (212°F).

.3 Provide Velcro or zippered removable insulation coverings over equipment access ports, controls devices and connection fittings. Do not insulate over nameplates or other data plates. Finish all exposed edges to the exterior insulation finish specified

.4 Recovery Jackets:

.1 *ULC labelled thermo-canvas flamespread less than 25 smoke developed less than 50.

.2 0.4 mm (30 gauge) *smooth *embossed aluminum sheet for piping.

.3 0.9 mm (20 gauge) *smooth *embossed aluminum sheet for equipment.

3. EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces is not considered exposed. Make smooth uneven insulated surfaces before recovering.

.2 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm centres or screws on 150 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.3 Equipment: apply insulation with edges tightly butted, joints staggered and secured in place by metal bands. Where necessary, weld on suitable anchors. Provide sufficient clearance around openings for normal operation of equipment. Finish surface of cold equipment insulation with vapour barrier jacket sealed with vapour barrier adhesive. Make uneven surfaces smooth with insulating cement.

.4 Install 25 mm thick aluminum foil-back fibreglass or mineral wool insulation onto the back of all radiant panels and hold in place with wire retainers sprung in at 900 mm on centre.

3.3 Insulation Thickness

.1 The insulation on all hot and cold equipment shall be the same thickness as the connected piping, and not less than 50 mm thick.

END OF SECTION

PRE-FABRICATED FIBREGLASS REINFORCED PLASTIC PUMPING STATIONS

1. GENERAL

1.1 Scope

.1 This Specification is intended for the design, fabrication, pre-assembly and supply of a pre-fabricated fibreglass reinforced plastic (FRP) sewage pump station or water lift station for burial in the vertical position.

.2 The station shall consist of an all FRP tank, including top and bottom, all internal piping, including valves, electric submersible pumps, electrical controls and other components and accessories necessary for reliable operation.

.3 All materials in the station shall be of a non-corrosive nature as much as possible in order to minimize long term corrosion

.4 The station is to be pre-assembled with all equipment installed except for the pumps and electrical hook-ups, allowing economical shipment to site and reducing installation time and start-up costs.

2. PRODUCTS

2.1 Main Chamber Pumping Station Tank

.1 The main chamber shall be a vertical cylinder made integrally with a reinforced bottom capable of withstanding a full hydrostatic head from the exterior of the tank while the station is completely empty.

.2 The station bottom shall include 6 inch at minimum, knuckle radius smooth molded corners to minimize build up of solids. Bottom shall be cored for stiffness with solid sections where pump anchor bolts are located. These bolts are to be permanently laminated into this solid section and sealed.

.3 The shell section will be made of FRP using the filament winding process. This process provides maximum strength to weight ratio. Materials for construction are detailed in section 2.7.1. This chamber shall also be constructed to handle the external ground loads for the specific application and also withstand both corrosive environments of the liquids inside and outside the wet well. Filament wound external reinforcing ribs shall be provided for additional strength against buckling and also provide a method of securing the support lugs. Quantity and size of these ribs shall be calculated for each application. Main chamber is to have adequate hydraulic storage capacity for each application and is designed for mounting and removal of the submersible pumps specified.

.4 The interior finish is to be a smooth, bright white mold finish for ease of cleaning.

2.2 Service Platform

.1 An intermediate platform capable of withstanding a concentrated load of 200 kg plus the dead weight of one of the pumps will form a service area with sufficient servicing space in the upper section of the main chamber. This platform is to be made of non-corrosive materials such as FRP, marine grade aluminum or stainless steel. All bolting hardware shall be 304 SS minimum. Hinged access hatches shall be sized for the removal of the pumps furnished and capable of handling the weight of one. The valves are to be located above the platform to facilitate operation and maintenance. Any bolting through the tank wall is to be sealed and laminated over on the exterior to prevent internal or external seepage.

2.3 Entrance Covers

.1 The hinged and lockable entrance covers are to be made of either FRP or checker plate aluminum. Each access cover will be suitable to support the weight of two men (200 kg). The hinges are to be fabricated out of stainless steel. The cover stays and lock boxes are to be made of stainless steel or marine grade aluminum.

.2 Doors are to be designed to lay flat on their backs when open or maintained in the vertical position by cover stays or pneumatic cylinders.

2.4 Access Ladder

.1 An access ladder shall provide a safe access to the station bottom and or the optional intermediate platform. Materials for this ladder can be aluminum, stainless steel or FRP, depending on the corrosive properties of the liquids and its gases. Ladder construction and its supports are to be capable of holding two people at one time or 200 kg. Its design shall meet all safety requirements of the Workmen's Compensation Board and safety codes of the local area.

2.5 Influent and Discharge Connections

.1 All nozzle connections to the tank wall shall be fabricated from FRP and laminated to the tank wall with inside and outside lay-ups using laminating resins equivalent to the resin used in the shell construction. Two connection types are acceptable, one being a full face flange the other a machined spigot. The full face FRP flange shall be of a 50 psi design for the inlet and 200 psi design for the discharge, as per standards described in section 2.6. The machined spigot shall be 0.5 inch thick minimum. A 6 inch long portion of the machined end is required for proper fit -up to field connections. Machined spigots, flanges, and their attachment layups are to be made using alternate layers of chopped strand mats and woven roving with an overall glass content between 30 percent to 40 percent.

2.6 Design Standards

.1 The following standards are used for the FRP fabrication where applicable

.1 Amec 4S-10.01 Manufacture and Installation for FRP structures

.2 Amec 4S-10.02 FRP pressure pipe, fittings and flanges

.3 Canadian Government Standard 41-GP-22 (safety factor of 4 only)

.2 A safety factor of four on the minimum ultimate tensile strength of the laminate shall be used in designing the wall, bottom and roof thickness of the station, taking into account all normally imposed loads arising from floatation, soil pressures, normal backfill, handling loads, operating loads and static loads imposed by equipment used in hoisting the pumps in and out of station

2.7 Construction

.1 Materials

.1 The white interior finish shall a premium isopthalic NPG gelcoat.

.2 Resin for the corrosion liner and structural layers shall be a premium grade isopthalic polyester at minimum. Vinyl esters resins shall be used on the corrosion liner for leachate or more severe corrosive environments.

.3 Glass fibre reinforcing materials other than the surfacing veil is to be commercial Grade "E" type glass

.2 Laminate Construction

.1 All FRP laminates shall have a corrosion liner on surfaces that are exposed to the corrosive environment and a structural laminate. The tank shell and its external reinforcing ribs shall use the filament winding process for the structure. The structural laminate shall be by the hand lay-up method for all sections or parts other than the tank shell.

.3 Corrosion Liner

.1 The surface of the liner exposed to the corrosive medium shall be resin rich reinforced with a "C" grade surfacing veil. The veil shall be saturated with white pigmented resin or an ISO-NPG white gelcoat. This layer is to be .01 inch minimum thickness.

.2 The liner behind the surface shall have a minimum thickness of .10 inch and shall be reinforced with not less than 20 percent and not more than 30 percent by weight of non continuous chopped strand mat. The inside surface is to be a smooth molded surface with a bright white finish. Corrosion liner shall be free of air and voids for optimum corrosion resistance.

.4 Structural Laminates

.1 Once the liner is completed and cured, the remainder of the wall thickness of FRP laminates shall be built up to provide sufficient strength to meet the mechanical requirements. The tank shell shall be filament wound in a helical pattern, while the top and base are to be fabricated using the hand lay-up method

.1 Hand Layup Construction

.1 In hand lay-up laminates, alternate layers of chopped stand mat and woven roving, saturated in catalyzed resin, shall be added until the required of layers have been applied or the required wall thickness has been obtained. The exterior of the laminate shall consist of a chopped strand mat. Glass content shall be between 30 percent and 50 percent by weight. Laminate should be properly wetted out and rolled out, free of air voids as per design Specifications.

.2 Filament Winding Construction

.1 Filament wound structural laminates provide superior strength to weight ratio by a higher glass content than hand lay-up or chop-hoop winding methods.

.1 Filament wound laminates shall be constructed by saturating continuous strand glass roving in a controlled pattern over the corrosion liner on a suitable mold.

.2 The rovings shall be applied at an angle to the axis of the mold. This winding angle shall be selected by the fabricator to obtain the desired hoop and longitudinal properties required for each application. It shall be uniform throughout the entire length and thickness of the product. Each cover or bi-directional layer, is to consist of two (2) complete layers of continuous rovings. As many of these covers will be applied as is required to provide adequate thickness for the mechanical loads of each application. The winding pattern shall be regular and shall produce a dense laminate without unreinforced resin pockets or air bridging between the rovings. Glass content shall be between 60 percent to 70 percent by weight.

.5 Surface Finish

.1 Inside

.1 All inside surfaces should be smooth and free of cracks and crazing. The inside surface will be pigmented or gelcoated to a bright white finish. All surfaces other than those made in contact with the mold surface shall be coated with air-inhibited resin or gelcoat, this includes any cut edges of laminates.

.2 Outside

.1 All external surfaces are to be resin coated with an air inhibited resin coat, including any drilled holes, ground areas or cut edges.

.2 The portion of the station to be above ground level shall be painted with forest green colour gelcoat with UV inhibitors and air inhibitor additives. Above ground portions may also be painted with a polyurethane base type paints. Different colours are acceptable as requested by end user.

2.8 Lifting Lugs

.1 A minimum of two (2) lifting lugs are required on stations 6 feet in diameter or under and a minimum of four (4) on larger ones, each capable of handling the entire weight of the station. These lugs will also be capable of handling a lift from the horizontal position to the vertical position.

.2 Material can be mild steel epoxy coated, galvanized or stainless steel. It is critical that the shape of the lugs is such that they cannot pull out of the fibreglass overlay. The overlay can be hand lay-up or filament wound in conjunction with the top external reinforcing rib. This eliminates the need for bolting through the station shell. In larger station, 10 feet to 12 feet in diameter larger custom designed lugs will be required.

2.9 Anchoring Lugs

.1 A sufficient amount of lugs shall be provided to secure the pre-fabricated station to the concrete base. Materials and design shall be similar to those of the lifting lugs, with the exception that a bolt through lug is not allowed near the station bottom. Lugs are to be designed in such a manner to fit over 7/8 inch diameter "J" type anchors imbedded in the concrete slab. The bottom external reinforcing rib shall be placed as near to the bottom as possible in order to encapsulate this rib in the second concrete pour. Concrete shall be poured to 6 inch above the bottom rib. This second pour provides additional ballast and anchoring. It is critical that the second pour of concrete be sufficiently anchored to the main concrete base. The combination of the hold down lugs, encapsulation of the bottom rib in concrete and the loading of the backfill material over the concrete base will provide adequate ballast against buoyancy in a full hydrostatic head scenario.

3. PIPING AND DUCTS

3.1 Piping

.1 The discharge piping shall run from each pump discharge connection and terminate in a common discharge inside the station. This includes an inside header onto which the vertical risers and valves connect to.

.2 All piping, with the exception of the guide rails, (see section 5.3) is made of non corrosive FRP rated for 200 psi. This piping shall also be painted with a bright white gelcoat. All flanges shall be full and flat face type and have ANSI B16.1, class 125 drilling

4. VALVES

4.1 Check Valves

.1 The check valves shall be non-clog ball type design. The ball shall be hollow steel covered with nitrile rubber resistant to grease, animal and vegetable fats, diluted concentrations of acids and alkaline (pH 4 to 10), tearing and abrasion. The ball should be guided to and from the seat by guide vanes cast in the housing. The ball shall clear the water by providing "full flow" equal to nominal size. There shall be only one moving part (the ball) and no outside levers, weights, springs, dash pots or other accessories are required.

.2 The body shall be of grey cast iron, class 35. Exterior shall be painted with a black coal tar epoxy.

.3 Flange drilling shall be according to ANSI- B16.1, Class 125.

4.2 Plug Valves

.1 The valves shall be of the round port eccentric plug type, with bodies made of ASTM -A126 Class B Cast Iron, lever operated. The plug shall have a resilient nitrile rubber coating, wear and corrosion resistant.

.2 Flange drilling shall be according to ANSI B 16.1, Class 125

5. PUMPS AND EQUIPMENT

5.1 Pumps

.1 The pumps shall be Flygt model CP Series, totally submersible pumps, all as described in the applicable Flygt Sewage Pump Specifications.

5.2 Discharge Connections

.1 A Flygt patented automatic discharge connection shall be provided for each pump to connect the pump to the discharge piping. The discharge connection shall be made of cast iron per ASTM A-40 Class 30B and shall be bolted to the bottom of the pump chamber, sealed from internal or external seepage.

.2 Its discharge flange shall be drilled as per ANSI B16.1, Class 125

5.3 Guide Bars

.1 Two vertical bars shall be provided for each pump for the purpose of assuring correct alignment of the pump with the Flygt automatic discharge connection.

.2 For each pump the guide bars shall consist of galvanized, Schedule 40 pipe, securely fixed at the lower end to the discharge connection by means of special bosses provided. The guide bars shall extend from the discharge connection upward, to ground level, or to the intermediate floor, and shall be securely fixed at this point by means of a bracket, (upper guide bar holder). The upper guide bar holder shall be provided with special rubber inserts.

.3 When intermediate guide bar holders are required, they shall be supported at the intermediate platform or by the discharge piping.

5.4 Level Regulation

.1 Flygt liquid level regulators ENH-10 shall be provided to control the operation of the pumps in accordance with variations of the liquid level in the pump chamber. Each regulator shall consist of a mercury switch enclosed in a watertight PVC casing and a 3 conductor cable.

.2 The regulators shall be suspended from the top of the pump chamber via a galvanized steel level regulator hanger, at pre-determined elevations.

5.5 Forced Ventilation

.1 A ventilation fan shall draw air from outside of the station and discharge it within. The fan shall have adequate capacity to change the air in the station a minimum of once every ten minutes. The fan motor shall be thermally protected. Manually operated, it shall be controlled by a switch in the control panel, where a pilot light will indicate its operation.

5.6 Station Light

.1 When required, a vapour-tight light with a heavy duty 100 Watt light bulb shall be provided. The light shall be operated by a switch in the control panel.

6. ELECTRIC WIRING AND CONTROL

6.1 General:

.1 The control panel shall be complete with all the components listed under this section and all necessary hardware and software to provide a trouble-free pumping station in accordance with the CSA norms. The control panel shall be specifically designed and manufactured for use with Flygt pumps and shall include the programmable logic control LOGIMAC 280 of ITT Flygt for the control and the surveillance of the pumping station.

.2 All parts shall be of the best industrial quality. The control panel shall be supplied by the pump manufacturer and installed as indicated on the Drawing.

6.2 Standards and requirements

.1 The control panel shall be in accordance with all the CSA standards and requirements. Grounding shall also meet all the requirements of the electrical code.

.2 Supply a fully assembled control panel for the duplex operation of two submersible pumps. The control panel is supplied with two (2) full voltage, direct-on-line starter as well as necessary components to operate the pumps.

.3 The heavy industrial quality enclosure is in accordance with EEMAC 3 to provide reliable outdoor operation. The panel is fitted with a heavy steel inner door, which is hinge-mounted and an exterior door with a 135° angle opening to allow easy access to the components. The panel shall be in steel painted with a grey coating ASA61 and a minimum thickness of gage #16 (1.6 mm), all assembled and factory tested.

6.3 Identification:

.1 Any component of the control panel shall be identified with a label bearing the same code or name described on the drawing. All wiring shall be numbered and identified at both ends to facilitate service and troubleshooting.

.2 The control shall be equipped with a terminal board relaying alarms, power supply, pump wiring, and probe signal, digital inputs. The terminal board shall be located at the bottom of the panel.

6.4 Cabling

.1 The control panel shall be wired according to the National Electricity Code. The level regulator shall also be supplied with necessary cable to provide direct connection to the panel without splicing. Control cable shall be rated #14 AWG with exemption for 24 VDC PLC inputs and outputs which can be # 18 AWG or bigger. Power cable shall be separated from signal cable. All cabling shall be routed in conduit.

7. COMPONENTS

.1 All components are of the best industrial quality, designed for extended, reliable and maintenance-free operation under extremely cold and warm weather conditions. Electro-mechanical components are limited to a strict minimum.

7.1 Programmable Logic Controller

.1 The control panel is equipped with the programmable logic controller LOGIMAC 280 of ITT Flygt or approved equivalent. The LOGIMAC 280 shall have necessary protection and be sturdy to remain operational in a hostile environment. Its power supply shall be protected against the network fluctuations and its inputs-outputs

.2 I/O shall also be protected against noise and interference to allow steady operation and maintain reliability of the pump station.

.3 The LOGIMAC 280 programming shall be the pump manufacturer responsibility and be made in “LADDER” Logic. The LOGIMAC 280 receives discrete and analog inputs, and controls discrete outputs in a manner dictated by the user specified logic called Relay Ladder Logic. The LOGIMAC 280 can also perform data handling operations and communicate with external devices. The programming software shall also be commercially available. The pump manufacturer shall supply a copy of the LOGIMAC 280 program, with the control.

.4 The programmable logic control LOGIMAC 280, from ITT Flygt, shall feature:

.1 Modular

.2 16 Kwords programming memory

.3 9999 words storage memory

.4 16 digital inputs and 16 digital outputs

.5 Built-in real time clock

.6 4 analog inputs (4-20 mA)

.7 User's program on flash memory (no volatile)

.8 Battery back-up RAM memory

.9 Boolean function execution rate of .6 microseconds per instructions

.10 LED indication

.11 Programming software readily and commercially available

.12 Protected power supply against network surge

.13 Power supply at 120 VAC

.14 Plug-in cards

.5 All products shall be designed, manufactured, and tested in accordance with recognized UL, CSA, IEC and JIS industrial standards. The system shall be operational during and after testing.

VIBRATION	The method of testing is to be based upon the IEC 68-2-6 and JIS C 0911 standard specifications for vibration.
SHOCK	The method of testing is to be based upon the IEC 68-2-27 and JIS C 0912 standard specifications for shock.
NOISE	The method of testing is to be based upon the following: - Showering Arc per NEMA ICS 2-230 - Ring Wave per ANSI C37.90A - Fast Transient per IEC 801.4.

.6 Complete product documentation describing installation and simple field maintenance shall be provided.

.7 The manufacturer or its authorized representative shall provide complete technical support for all of the products. This shall include headquarters or local training, regional application centers, and local or headquarters technical assistance.

.8 The system shall consist of rugged components designed specifically for industrial environments. A complete system shall consist of one or more racks containing I/O modules, interconnected by signal cables.

.9 The LOGIMAC 280 CPU shall be modular. The CPU shall be fully enclosed within a durable plastic shroud.

.10 All signal cables furnished by the manufacturer shall be constructed so as to withstand, without damage, all normal use and handling.

.11 The I/O system shall be modular. Each module shall be fully enclosed within a durable plastic shroud. When mounted on the system base, each I/O module shall not occupy more than one available slot.

.12 I/O modules shall be installed in any available slot in the CPU or expansion baseplate, and shall require no tools for insertion and extraction. I/O modules shall connect electrically to the baseplate via a pin and socket connector.

.13 Wherever possible, all assemblies and sub-assemblies performing similar functions shall be interchangeable

.14 The system design shall accommodate the replacement of assemblies without having to disconnect field wiring. Wherever possible, removable connectors shall be used to connect field wiring to the individual circuit board assemblies.

.15 All components within the controller family shall be manufactured with a high degree of durability.

.16 All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings each of which indicates the manufacturer's catalog number, product manufacturing date code, UL and CSA certifications.

.17 All components of the LOGIMAC 280, except CRT terminals and programming workstations, shall meet the following environmental specifications:

.1 Storage conditions: Temperature -40 to 85°C

.2 Operating conditions: Temperature 0 to 60°C

.3 Humidity: 5 to 95 percent relative humidity, non-condensing

.18 The LOGIMAC 280 shall have a 120 VAC power supply with built-in 24 VDC power supply for input/output connection.

.19 The power supply shall be modular in design, separate from the CPU and baseplate for easy replacement in the unlikely event of failure. The power supply shall provide +5 VDC to the bus.

.20 The power supply shall not use a slot available for an I/O card.

.21 The central processing unit (CPU) of the LOGIMAC 280 shall be modular. It shall possess the capability to solve application logic, store the application program, and store numerical values related to the application processes and logic, and interface to the I/O systems.

.22 The modular type CPU shall contain a dedicated VLSI Instruction Sequencer

.23 Coprocessor (ISCP - Boolean Coprocessor) for performing Boolean operations, and interfaces to a serial port and the system bus.

.24 The modular and embedded CPU's shall contain an alarm processor that is special PLC feature designed to receive and process faults. The diagnostics shall provide information on the configuration and CPU, memory, communications and I/O status.

.25 The alarm processor function shall log I/O and system faults in two fault tables that shall be accessible for display on the IBM compatible programming software screen or uploaded to a host computer or other coprocessor.

.26 The alarm processor shall maintain the state system diagnostic bits to be read by a host or incorporated as contacts into the ladder program for customized diagnostic routines.

.27 The CPU shall be programmed by an external peripheral IBM compatible via a serial port. The software shall execute on DOS operating system and shall provide on-screen help information throughout its execution paths.

.28 The programming interface shall be capable of being remotely or locally connected to the CPU while the CPU is running. The Hand-Held Programmer shall be able to access the application program, the system configuration, the registers and the diagnosis system.

.29 The programming devices shall have access to the application program, the CPU and I/O system configurations, all registers, CPU and I/O status, system diagnostic relays, and I/O over-ride capabilities.

.30 It shall have the capability of programming the relay ladder program, store the program to the PLC, monitor program and reference address status while the PLC is in Run or Stop mode.

.31 All application memory shall be available to the user program. Executive level operations performed by the CPU shall not consume application memory.

.32 The register values and the application program shall be stored in battery backed, CMOS static RAM memory.

.33 The LOGIMAC 280 shall have a long-life Lithium battery used to maintain the contents of the CMOS RAM memory in the CPU. There shall be an easily accessible battery compartment in the power supply with dual battery connectors. The battery shall be replaceable with power applied to the PLC and without removing the CPU.

.34 The battery shall allow resident user program to be maintained in the CPU without power applied. Additionally, a low battery condition shall be alarmed with a system diagnostic bit.

.35 The CPU shall calculate the application program checksum at the end of every sweep. A fixed number of program memory checksum shall be calculated each sweep. If the calculated checksum does not equal the reference checksum, a fault shall be recorded, and the CPU mode will change to STOP.

.36 The CPU shall be capable of solving an application program whose source format shall be relay ladder diagram. The language shall support relay, timers and counters, arithmetic, relational, bit operation, data move, conversion, and control functions.

.37 The arithmetic function block shall used simple data types, under a 16 or 32 bits integer configuration. The arithmetic operations shall support two data types, Signed Integer (INT), and Double Precision Integer (DINT).

.38 The battery shall maintain the application program for six months without power supply.

.39 The LOGIMAC 280 CPU shall have a real-time clock battery protected, accessible by both the application program and the fault processor.

.40 The LOGIMAC 280 CPU shall support high level diagnostic functions together with the distributed intelligent I/O system.

.41 The LOGIMAC 280 shall record the system and I/O malfunctions with the date and the time of occurrences.

.42 The LOGIMAC 280 shall record the faults in registers assigned respectively for the CPU and the I/O. These registers shall be accessible via the programming interface or a PC.

.43 I/O reference addressing for each I/O module shall be assigned through the use of the IBM compatible configuration and programming software or the hand held programmer. There shall be no jumpers or DIP switch settings required addressing modules

.44 The circuit status of each I/O point shall be indicated by LED mounted at the top of the module. Also each I/O status shall be available through the programming interface

.45 The LOGIMAC 280 shall support an operator interface, based on high level performing characters. This intelligent module shall communicate with the central processing unit via a cable connected to a serial port.

7.2 Main Disconnect

.1 The control panel is equipped with a main disconnect switch mechanically interlocked with the inner door to electrically isolate the components of the control panel when the inner door is opened.

.2 For ratings up to 100A, the main disconnect switch is of the fusible type with fuses rated at 100,000A short circuit capacity. For capacities above 100A, the main disconnect switch is a thermal-magnetic circuit breaker having a fast response, high interrupting capacity and sealed contact chambers with clear covers for inspection.

7.3 Pump Protection

.1 Each pump circuit is fitted with a three-pole thermal-magnetic circuit breaker or current limiting motor protector with instantaneous magnetic trip and overload relay. The response time under short circuit conditions is less than one-quarter of a cycle; the action opens all poles thus avoiding single-phase operation of three phase pumps.

.2 Isolated rotary handles for each motor protector are mounted on the inner door.

.3 The circuit breaker and overload relay exhibit stable operation under changing temperature conditions from 25°C below zero up to 40° above zero. The circuit breaker has a high interrupting capacity independent of the thermal setting.

7.4 Pump selector switch

.1 The control panel is fitted with a MANUAL/OFF/AUTO switch for each pump to allow manual pump operation.

7.5 Pump contactor

.1 Each pump circuit is fitted with a three-pole fast-acting magnetic contactor, designed for a minimum of 20 years of service under normal operating conditions. Under overload conditions, the circuit is designed to clear the fault by opening the motor protector or circuit breaker and then the contactor.

7.6 Control relay

.1 The necessary electromechanical relays for control and alarm function shall be protected against malfunctioning. They shall be rated for a service factor up to 600 VAC and 300 VDC.

7.7 Heating element

.1 The control panel is equipped with a heating element with a thermostat, of not less than 100 Watt. A protective shield around the heating element shall be supplied to prevent accidental injuries.

7.8 Control circuit protection

.1 The pump control circuit shall be protected by circuit breakers and fuses on the primary shall protect auxiliary circuits.

7.9 Annunciator panel

.1 The control panel shall include the annunciator panel. The annunciator panel shall indicate the following alarms and status:

.1 High level

.2 Low level

.3 Power failure

.4 Power supply

.5 Leakage P1

.6 Leakage P2

.7 High temperature P1

.8 High temperature P2

.9 Overload P1

.10 Overload P2

.11 Run P1

.12 Run P2

.2 The annunciator panels shall have one reset button and a lamp test button.

8. CONTROL PANEL FUNCTIONS

.1 The control panel shall be equipped with a programmable logic control LOGIMAC 280 specifically chosen and programmed to provide a safe and reliable operation of the pumping station. The LOGIMAC 280 shall provide, but is not limited to the following functions:

.1 Controls the starting, stopping and, if necessary, alternation of up to two pumps. The number of pumps to control and the number of pumps allowed to parallel operation shall be user configurable.

.2 An adjustable software time delay from 0 to 60 seconds, before the starting of a pump is available to prevent the high inrush current, which would result if both pumps were started at the same time.

.3 Registers the running time and the number of starts of each pump.

.4 The LOGIMAC 280 constantly monitors the pumps to verify that there is no leakage or excessive temperature in the motor windings. The signal for motor over temperature or leakage is coming from the supervision relay (mini CAS II as per ITT Flygt). If a pump overheats, the LOGIMAC 280 stops it before overheating. The LOGIMAC 280 provides the same protection for leakage. For either one of these abnormal situations, the LOGIMAC 280 stops the faulty pump and activates an alarm.

.5 The following alarms shall be latched by the LOGIMAC 280 until manually resetted. The LOGIMAC 280 shall activate the following alarms without any delay:

.1 For each pump:

.1 Motor overload

.2 High temperature stator

.3 Leakage

.2 Low level

.3 High level

.4 Power failure

.6 The LOGIMAC 280 shall have an analogue input to accommodate the 4-20 mA signal from the sump level detector. From this signal the LOGIMAC 280, shall control the starting and stopping of the pumps.

.7 The LOGIMAC 280 is fitted with a real time clock. A battery back up is provided to maintain correct alarm registration

.8 The LOGIMAC 280 is protected against signal interference that could occur in the pumping stations. In order to reduce the sensibility to interference, all inputs and outputs are galvanically isolated from ground.

.9 The LOGIMAC 280 is equipped with LED type lights indicating the operational functions and the alarm status.

.10 The LOGIMAC 280 shall have an interface operator allowing:

.1 Easy access to set points and operating parameters, password protected.

.2 Normal text displayed

.3 Key-in station data (read-only)

.4 Alarm display

.11 In the automatic mode, the LOGIMAC 280 and the control panel operate the pumps according to the following level signals:

.1 Low level float: low level alarm and stopping of the pump(s)

.2 4-20 mA signal: start/stop/alternate the pump(s)

.3 High level float: high level alarm and starting of all pumps available in parallel operation.

.4 The level floats shall be mercury and lead free, compatible with the latest environmental laws and approved by CSA Floats shall be model ENM-10 as fabricated by ITT Flygt.

.5 The float shall be mounted on a galvanised steel guide rail and each float shall be supplied with an adjustable vertical support. If the 4-20 mA signal is faulty the low level float shall stop the pumps and the high level float shall start a pump.

.6 The pumps shall alternate after each pumping cycle if ALTERNATE mode is chosen.

9. ACCESSORIES

.1 The panel shall be equipped with a monitoring relay for leakage detection and stator high temperature model MiniCas II as fabricated by ITT Flygt. In case of a malfunction, the monitoring relay should stop the pump. On high temperature detection a pump shall not be made available until a manual reset has been performed.

.2 The floats shall be equipped with intrinsically safe, CSA approved relays to render the float installation conform for operation in Class I, Division 2, Group C and D hazardous environments.

.3 The LOGIMAC 280 panel shall be equipped with a UPS (Uninterrupted Power Supply) for three hour back up.

.4 The control panel will be supplied with the following equipment mounted on the inner door:

.1 An ammeter per pump with phase selector

.2 A voltmeter with phase selector

.5 The control panel shall be supplied with a protective relay against phase failure and phase reversal.

.6 An alarm circuit with circuit breaker protection shall be provided with the panel. This circuit will energise an alarm light mounted on top of the panel for outdoor installation.

.7 A 120 V outlet shall be provided for connection of convenience equipment with a maximum load of 100W. The maximum rating shall be clearly identified in the panel with a label. A control transformer, dry type single phase with 120 volts secondary shall be added if the supply ifs different than 120 VAC. The transformer rating shall be calculated according to the control load.

.8 An alarm silencing push button shall be present to stop the alarm from unnecessary operation once the station operator has taken notice of the fault.

.9 The control panel shall be in accordance to the Specifications and the wiring diagram provided under the electrical section.

10. START-UP

.1 The contractor shall insure proper start-up of the pump station and provide total reliability of the control panel. The contractor shall include in his price a day for the control start-up to perform:

.1 Simulate and verify each control loop

.2 Calibrate the instrumentation and sensors

.3 Adjust each alarm contact or level

.4 Verify the cabling and wiring

.5 Verify the component identification

.6 Coordinate start-up

.7 Render operational the control panel according to the Specifications and Drawings.

11. DOCUMENTATION

.1 The contractor shall submit for approval the following

.1 Complete As-Built Drawing

.2 Complete instruction manuals

.3 Control sequences and detailed programming ("Listing of the program")

.4 A bill of material

12. DRAWINGS, INSPECTION AND SHIPMENT

12.1 Drawings

.1 Within three weeks of receipt of the order the supplier will furnish three (3) complete sets of Drawings for approval. The Drawings will provide detail of the major construction elements and a list of all equipment furnished.

12.2 Inspection

.1 Prior to installation in the station the pumps have been thoroughly tested and operated for at least half an hour (see pump specifications). The level regulators have also been checked for correct operation. A Factory Inspection Certificate can be furnished indicating that all equipment has been submitted to detailed inspections and was found to be satisfactory. The certificate shall be signed by a responsible official of the supplier.

.1 The supplier grants the right of inspection of the pumping station to any authorized representative of the purchaser before shipment from factory. If inspection is requested Flygt will give 48 hours notice in advance of the time when the equipment will be ready for inspection at the factory.

.2 Any equipment in the pumping station that may have been provided by another supplier shall have been tested by the original supplier

12.3 Shipment

.1 The station will be shipped assembled to the greatest extent possible to reduce installation and start-up costs. Shipped separately from the tank will be the pumps, the controls including the regulators, and a container of miscellaneous connecting hardware, etc.

13. MAINTENANCE AND OPERATIONS MANUALS

.1 Two (2) copies of the maintenance and operations manual shall be provided with the pumping station. These manuals shall contain the following information:

.1 A copy of the general assembly drawing(s) of the station confirming locations, sizes, elevations and equipment to be supplied

.2 An outline drawing of the CP series pumps and discharge connections

.3 A performance curve for the pumps

.4 Information of the level regulation system and components

.5 A schematic diagram of the control system

.6 Start-up, operating and safety instructions for the system

.7 Operating and maintenance information for optional equipment

14. INSTALLATION SUPERVISION

.1 A trained representative of the supplier can be made available to:

.1 Supervise the connection of electrical power to station,

.2 Supervise the installation of the pumps,

.3 Install and adjust the level regulators,

.4 Test the controls, and

.5 Start, test and adjust the equipment for complete and satisfactory operation after installation.

15. WORK AND MATERIAL NOT COVERED

.1 Unless specifically stated otherwise in the purchase order the following Work and materials shall be supplied by others:

.1 Off-loading the station at the jobsite

.2 Excavation and backfill

.3 Foundation, including design and anchor bolts

.4 Setting in place of the pumping station, using a spreader bar

.5 Backfilling with concrete up to 250 mm above the lowest reinforcing ring

.6 Connection and sealing of inflow pipe and external discharge piping

.7 Installing the pumps in the station

.8 Installation of connecting vent ducts, if air vents terminate underground

.9 Provision and installation of wiring and conduit from the control panel to the couplings onto the station wall

.10 Electrical power supply to pumping station including main disconnect (and meter if required

.11 Site surface restoration

END OF SECTION

PLUMBING GENERAL

1. GENERAL

1.1 Scope

.1 Cleanouts

.2 Floor drains

.3 Sumps

.4 Domestic water heaters

.5 Sanitary sewer service connections

.6 Water service connections

.7 Backflow preventers

.8 Vacuum breakers

.9 Backwater valves

1.2 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide water and drainage connections to equipment furnished in other Sections of this Specification and as supplied by the City.

.3 Provide and include charges for connections to Municipal and Utility Company Service.

1.3 Submittals

.1 Submit Shop Drawings for review by the Contract Administrator, in accordance with Division 1. Provide Shop Drawings for the following items:

.1 Floor drains

.2 Domestic water heaters

.3 Backflow preventers

.4 Vacuum breakers

2. PRODUCTS

2.1 Clean-Outs and Clean-Out Access Covers

.1 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.

.2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

2.2 Floor Drains

.1 FD-1: floor drain with heavy duty round strainer and clamping collar. Floor drain shall have lacquered cast iron body with bottom outlet, combination invertible membrane clamp, trap primer connection, sediment bucket and adjustable collar heavy-duty five-inch polished nickel bronze strainer. Extension adaptors provided as required. Washroom floor drains shall have a removable perforated sediment bucket. Standard of acceptance: 'Zurn' model ZX-415-A5-AR-P-Y.

.2 Floor drains in equipment rooms shall have polished bronze funnel type strainer and extension for floating floor where applicable.

2.3 Backflow Preventer Assemblies

.1 Provide backflow preventer assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall meet current AWWA requirements and CSA B64 standards.

.2 Provide complete reduced pressure principle type assembly, consisting of pressure differential relief valve, located between two positive seating replaceable check valves with stainless steel or bronze seats Watts No. 909. Provide strainer between gate valve and first check valve on units 50 mm and smaller.

2.4 Vacuum Breaker Assemblies

.1 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable. Watts No. 8A. For freezing conditions, Watts No. NF8.

2.5 Backwater Valve Assemblies

.1 Provide complete assembly, epoxy coated, cast-iron body, bronze flapper check valve, bolted access cover with neoprene gasket heavy gauge steel epoxy coated access housing and neoprene gasketted heavy-duty nickel-bronze cover.

3. EXECUTION

3.1 Installation

.1 Bury outside water and drainage pipe minimum 2400 mm, unless noted otherwise.

.2 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leakproof joint.

.3 Install backflow prevention devices on plumbing lines, to code requirements, where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibs and flush valves.

.4 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.

.5 Where floor drains are located over occupied areas, provide waterproof installation.

.6 Drainage lines shall grade 1.0 mm per 100 mm for pipes over 75 mm diameter and 2 mm per 100 mm for pipes 75 mm diameter and smaller.

.7 Locate plumbing vents minimum 5000 mm from air intakes.

.8 Provide a heat trap loop in domestic hot water supply piping at domestic hot water storage tank.

3.2 Services

.1 Provide new sanitary sewer connections to Site Services. Before commencing Work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with sufficient slope for drainage and adequate cover to avoid freezing.

.2 Provide new water service. Provide necessary thrust blocks on underground water piping as required and detailed. Provide steel pipe sleeve in wall for service main and adequately support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Securely anchor service main inside to concrete wall. Size for minimum of 50 mm of loose fill insulation.

END OF SECTION

PLUMBING FIXTURES AND TRIM

1. GENERAL

1.1 Scope

.1 Plumbing fixtures and trim

.2 Thermostatic mixing valves

1.2 General Requirements

.1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be product of one manufacturer. Fittings of same type shall be of product of one manufacturer.

.4 Protect fixtures against use and damage during construction.

1.3 Job Conditions

.1 Confirm location and size of fixtures and openings before rough-in and installation.

1.4 Submittals

.1 Submit Shop Drawings for review.

2. PRODUCTS

2.1 Stainless Steel Sink (SK-1)

.1 Bowl: 1143 mm W x 533 mm D x 889 mm H, 14 gauge, grade 18-8, type 304 stainless steel, polished satin finish, radius coved bowl corners, anti-splash rim, 76 mm x 76 mm threaded waste outlet. Standard of acceptance: Aristaline SSS1827SDSR

.2 Trim: Sink supply faucet, backsplash mounted, two-handle, swivel tubular spout, wing handles, chrome plated cast brass body, male thread for aerator, 197 mm to 210 mm adjustable faucet inlet, 51 mm inlet flanges, 0.5 inch NPT female inlets, ceramic cartridges. Standard of acceptance: Sloan SL-0231

2.2 Hose Reel (HR-1)

.1 Refer to the Plumbing Fixtures Schedule in Section 15999.

2.3 Hose Bibb (HB-1)

.1 Refer to the Plumbing Fixtures Schedule in Section 15999.

2.4 All Weather Emergency Shower and Eyewash (EES-1 / EES-2)

.1 Model 8710 Polar Booth series includes an insulated all-weather booth with an integral hot water supply and tempered blending system. Haws offers 119 gallon storage capacities. All tempered water systems incorporate fail-safe features, including anti-scald protection and full flow cold water bypass. It is ideal as a complete stand-alone system, or as a feeder to other remote polar booth substations. Multiple shower systems may be connected with heat-traced lines or pump driven recirculation lines.

.2 Specifications:

.1 Enclosure Booth: exterior and interior FRP skins with 1.5 inch flame retardant insulation to give an appropriate value of R11. Protected with UV inhibitors, the exterior resin skin is bright yellow with Safety Green graphics. Large graphics identify the booth as an emergency shower/eyewash station and assist in guiding the user to the double swing doors. Interior space is heated and illuminated to provide for safe user comfort. Shower area is a spacious 5 feet x 4 feet, the tempering area is 5 feet x 5 feet, and a large access panel is provided to facilitate equipment access and maintenance.

.2 Grate: Floor grate is fibreglass.

.3 Doors: Dual spring-loaded, self-closing with clear 8 inch x 12 inch Lexan windows.

.3 Multiple Drench Systems:

.1 Shower: Model 8129FC 10 inch ABS plastic showerhead with integral 20 gpm flow control in Safety Green

.2 Eye/Face Wash: 5 gpm Feather-Flo® ABS plastic heads

.3 Drench Hose: 4 gpm hose with flag and ball valve

.4 Freeze/Scald Valves: Models SP157A and SP158A

.5 Alarm System: standard alarm system is flow switch activated, and provides local audible and visible alarms with dry hemetic relay contacts for remote alarm hook up. System includes silencing circuit with auto reset. Area light flashes and alarm sounds upon activation.

.6 Flow Switch: 5 amp, DPDT, alarm activation at 2.2 gpm

.7 Blending System: Model TWBS.SH

.8 Water Heater: 4.0 Kw, 240 VAC copper immersion heater or steam heat exchanger. Dual element thermostat with manual reset hi-limit protection

.9 Space Heater: Natural convection 2.5 Kw, for hazardous classification; forced air 3 Kw for NEMA 4

.10 Lights: 100 Watt, interior clear and exterior green (normally on).

.11 Combination shower and eyewash is certified by CSA to meet the ANSI Z358.1 Standard for Emergency Eyewash and Shower Equipment.

.4 Plumbing

.1 Schedule 40 galvanized piping with brass and stainless steel valves

.2 Supply: 1.25 inch IPS

.3 Waste: 3 inch Caulk

.5 Tempering System

.1 Tank Systems

.1 Option No. 21: 119 gallon tank: stores enough hot water to provide a single 20 gpm shower for 15 minutes. Recovery time of up to seven hours.

.2 Tank is insulated and jacketed.

.6 Electrical System Options

.1 Standard system requires 208-240/120 VAC, single phase, 3 wire and ground, 40 amp electrical supply. Electrical systems can be provided to meet various environmental requirements. Select the electrical option that meets the environmental conditions where the Polar unit is to be installed.

.2 Option 31: NEMA 4 water/dust tight when tank tempering system is selected.

.7 Specify Polar model as follows: model number, tempering system option, electrical system option. Example: 8710.22.32 is a 8710 equipped with a 119 ASME gallon tank and a NEMA 7, Class 1, Division 2, Groups B, C, and D electrical system.

.8 Shower Head: Model 8127FC corrosion-resistant 10 inch stainless steel showerhead with integral 20 gpm flow control.

.9 Refer to the Emergency Eyewash/Polar Unit Schedule in Section 15999.

2.5 Combination Emergency Shower & Eyewash (EES-3)

.1 Refer to the Emergency Eyewash/Polar Unit Schedule in Section 15999.

3. EXECUTION

3.1 Installation

.1 Install each fixture with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

END OF SECTION

FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers

.2 Fire extinguisher cabinets and mounting hardware

1.2 General Requirements

.1 Provide portable hand extinguishers where indicated on Drawings and specified herein.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be approved by local Fire Commissioner.

.2 Equipment and installation shall meet the requirements of NFPA 10 Portable Fire Extinguishers.

1.4 Submittals

.1 Submit Shop Drawings for review. Submit with Shop Drawings Material Safety Data Sheets (MSDS) for each chemical used in the Fire Extinguishers.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers

.1 Multi-Purpose Dry Chemical (FE-1): pressurized with hose and shut-off nozzle or integral shut-off nozzle and mounting brackets with 4.5 kg capacity rating 4A:60BC.

.2 Multi-Purpose Dry Chemical (FE-2): pressurized with hose and shut-off nozzle or integral shut-off nozzle and metal cabinet with 9.0 kg capacity rating 10A:80BC.

2.2 Fire Extinguisher Cabinets

.1 Fire Extinguishers Cabinet (for FE-2 only): surface type 16 gauge steel construction with 12 gauge fully opening door in adjustable frame, 5 mm (0.2 inch) glass full panel, approved latching device, and prime coat.

3. EXECUTION

3.1 Installation

.1 Install extinguishers so that the bottom of extinguisher is no more than 1200 mm above floor.

FIRE EXTINGUISHERS

END OF SECTION

AIR COOLED CONDENSING UNITS

1. GENERAL

1.1 Scope

.1 Air cooled refrigerant condensing unit package

.2 Refrigerant piping and accessories

.3 Controls

.4 Charge of refrigerant and oil

.5 Start-up and commissioning

1.2 Quality Assurance

.1 Conform to current requirements of CSA, UL, Provincial and Municipal Codes.

.2 Materials in contact with refrigerant shall be corrosion resistant.

.3 Units shall be product of manufacturer regularly engaged in production of refrigeration units and who issues complete catalogue data on such products.

1.3 Submittals

.1 Submit with Shop Drawings, schematic layouts showing condensing units, cooling coils, refrigerant piping and accessories required for complete system, including equipment weights and detailed performance data, with full wiring diagram for power and controls.

.2 Submit complete pipe sizing data.

1.4 Start-up and Testing

.1 Supply initial charge of refrigerant and oil for each refrigeration system. Losses of oil or refrigerant prior to acceptance of equipment or due to defects covered under guarantee shall be replaced. Supply to the City, one (1) complete charge of lubricating oil in addition to that placed in the system.

.2 Charge the system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

.3 Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

.4 Provide cooling season start-up, winter season shut-down for first year of operation.

.5 Inspect and test for refrigerant leaks every six months during first year of operation.

AIR COOLED CONDENSING UNITS

2. PRODUCTS

2.1 Type

.1 Units shall be self-contained, packaged, factory assembled and prewired suitable for outdoor use consisting of casing, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, screens.

2.2 Cabinet

.1 Construct of heavy gauge galvanised steel with baked enamel finish, easily removed access doors or panels with quick fasteners.

2.3 Compressor

.1 Provide serviceable, hermetic, 1750 rev/min, resiliently mounted compressor with positive lubrication, crankcase heater, cylinder unloaders for capacity modulation, motor overload protection, service valves and filter drier.

.2 Provide timer circuits to prevent rapid loading and unloading for system stabilisation.

2.4 Condenser

.1 Coil: seamless copper tubing with aluminum fins.

.2 Fans: vertical discharge, direct drive axial fans, resiliently mounted with guard and motor.

.3 Motors: permanently lubricated ball bearing motors with built-in current and overload protection.

2.5 Controls

.1 Provide high and low pressure cut-outs for compressor, oil pressure control, non-recycling pump-down and reset relay.

.2 Provide controls to permit operation down to -35°C (31°F) ambient temperature at minimum compressor load.

3. EXECUTION

3.1 Performance

.1 Refer to equipment schedules.

END OF SECTION

OUTDOOR PREMANUFACTURED AIR HANDLING UNITS

1. GENERAL

1.1 Scope

.1 Outdoor mounted custom pre-manufactured air handler.

1.2 Quality Assurance

.1 It is the intent of this Specification that the manufacturer provide air handling units designed and manufactured specifically to the requirements of this project. Overall dimensions and configuration are to be as shown on the plans and as described in the Specifications. Take responsibility for the engineering and operational integrity of the air handling units.

.2 Unit construction shall be per the construction details included at the end of this Section, and as described herein.

.3 Provide unit produced by a recognised manufacturer who maintains a local service agency and parts stock.

.4 Air flow rates, external static pressures, water flow rates, coil face velocities, filter face velocities, water and air side pressure drops shall be the same or better than specified for alternate selections.

.5 Fans shall be AMCA certified.

.6 Coils shall be ARI certified.

.7 Provide all motors with thermal overload protection. All motors shall be high efficiency type, suitable for inverter duty (variable frequency drives).

.8 Start-up of unit shall be executed by manufacturer's personnel. A complete manufacturer's check list of field start-up tests must be submitted with operations and maintenance instructions and shall be signed by start-up technician and mechanical trade, field supervisor as certified satisfactory for operation.

.9 All components, paints and lining shall have a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50.

1.3 Factory Inspection by Engineer

.1 All air handling units shall be inspected at the manufacturer's plant by the Contract Administrator, prior to shipment to the Site. The manufacturer shall include all costs of these plant visits including the cost of the Contract Administor’s time and travel expenses. A minimum five working days notice will be required prior to each plant visit.

1.4 Submittals

.1 Submit Shop Drawing which shall include the following minimum information. Shop Drawings submitted without this information shall be automatically rejected.

.1 Construction details: submit unit construction Drawings for the following components:

.1 Side panels, including connection details

.2 Top panel, including connection details

.3 Floor, including connection details

.4 Doors, hinges, latch, viewing port

.5 Fan, motor and drive, mounting and isolation

.6 Coil section

.7 Pipe and conduit penetration through casing or floor

.8 Drain pan

.9 Damper, linkage and drive construction and mounting

.2 Materials of Construction: indicate material and gauge of all construction components.

.3 Mass Distribution Drawings: show point loads and recommended method of unit installation.

.4 Fan Performance Data: submit fan performance curves as well as performance tables.

.5 Air Blenders: make, model, selection criteria and pressure drop curves.

.6 Coils: selection criteria indicating air side and fluid side capacities, in and out conditions, velocities, pressure drops and fouling factors. Submit a Drawing showing headers, circuiting arrangement, connection sizes, and materials of construction.

.7 Air Filters: media, efficiency rating, velocity, pressure drop charts and capacities. Indicate mounting method and arrangement.

.8 Vibration isolator Shop Drawings.

.9 Table indicating pressure drops through all components of the unit.

.10 Refrigeration Compressors: make, model mounting detail, selection tables, selection criteria and the point of compressor selection on the tables or graphs. Identify all correction factors applied.

.11 Condenser fans Shop Drawings

.12 Damper Shop Drawings

.13 Detailed composite wiring diagrams showing factory installed wiring, including wiring of the control components.

.14 Sound Levels: submit sound power levels generated by the air handling unit at the inlet and outlet of the unit and outside the fan section. List for individual octave bands in dB referenced to A rating.

2. PRODUCTS

2.1 Components

.1 Air handling units shall consist of, but not be limited to, the following components:

.1 Supply fan

.2 Return fan

.3 Preheat coil

.4 Reheat coil

.5 Cooling coil

.6 Summer prefilter

.7 Winter prefilter frame

.8 Final filter

.9 Motorized exhaust air section

.10 Motorized outdoor air section complete with separate minimum outdoor air section

.11 Motorized return air section

.12 Air blender

.13 Access sections

.14 Refrigeration compressors

.15 Condenser coils and fans

2.2 Cabinet

.1 Exterior Panels:

.1 Minimum 16 gauge satin coat galvanised steel with air dried enamel finish.

.2 Walls and Ceilings:

.1 Interlocking construction with at least two breaks at each interlocking joint. Wall and ceiling joints to be broken outward. All panel joints to be caulked, and roof to be pitched slightly to prevent water pooling. Casing depth to match the specified insulation thickness. Inside surfaces shall be clean and flush, free of exposed flanges. Provide min. 25 mm x 25 mm drip channels over all access doors.

.3 Base:

.1 Construct from structural steel channel iron around perimeter with intermediate channel and angle iron supports. Provide a 14 gauge thick checker steel plate in all sections of the unit. Provide floor bracing channels at maximum 300 mm on centre.

.4 Insulation and Liner:

.1 Insulate all exterior walls and roof with 100 mm thick rigid fibrous glass acoustic insulation, 48 kg/m³ (3 lb/cuft) density. Line interior of all panels with 22 gauge perforated *stainless steel liner, *galvanised steel liner.

.2 Insulate underside of unit floor with 100 mm thick rigid fibrous glass insulation 48 kg/m³ (3 lb/cuft) density. Hold in place insulation with welded pins 400 mm on centre. Line insulation with 22 gauge perforated liner, if roof curb used as return air plenum.

2.3 Access Doors

.1 Provide hinged man sized access doors. Door construction to be the same as casing each complete with 250 mm diameter round wired glass viewing window. Provide minimum two (2) latches per door openable from both sides. Doors to be sealed with neoprene gasketting (foam gasketting not acceptable). Door hinge to be continuous stainless steel piano hinge. Door sizes to be 750 mm x 1800 mm or as limited by height of unit. Provide access doors for the following sections.

.1 Fan section

.2 Humidifier section

.3 Reheat coil section

.4 Cooling coil section

.5 Final filter section

.6 Prefilter section

.7 Mixing section

.8 Access sections

2.4 Finish

.1 Entire exterior is to be painted with two (2) coats primer paint followed by minimum two (2) coats of exterior application of air dried enamel. Colour selection by the Architect.

2.5 Marine Lights

.1 Provide marine type lights in all sections having an access door on all units. Lights shall be factory installed and wired to a single lighted switch located outside the supply fan access door.

.2 Wire power connection for all lights to one point for connection by Division 16.

.3 Light to be fed from a separate source so that the lights are operative even when the unit is off.

2.6 Drain Pans

.1 On units without stacked coils, provide a single fabricated 16 gauge galvanised steel drain pan under cooling coils. Prime coat pan inside and out with zinc chromate, iron oxide, phenolic resin paint and two coats of bitumastic paint.

On units with stacked coils, provide a separate drain pan under each coil. On all units, provide a secondary drain pan extending under the entire access section downstream of the cooling coil and the humidifier section. Provide a drain pan to drain the fresh air intake or mixing plenum. Pipe all drains to the exterior side of unit.

2.7 Roof Curbs

.1 Construct from 12 gauge galvanised steel with 50 mm x 100 mm nailing strip around the entire perimeter.

.2 Insulate interior of the curb with 50 mm thick, 24 kg/m^3 (1.5 lb/cuft) neoprene coated fibreglass insulation.

.3 Provide a 25 mm x 19 mm closed cell neoprene sealing gasket to seal the perimeter joint between roof curb and air processing unit.

.4 Roof curb shall be seismic rated with attachment points to both the unit and the structure: coordinate the roof attachment with the Structural Engineer.

2.8 Fan

.1 Acceptable fan manufacturers: Trane, Chicago, Northern, Loren Cook, Twin City, Barry Blower.

.2 Fans to be single width forward curved centrifugal type. Fan to be both statically and dynamically balanced.

.3 Mount fans on steel shaft, on self-aligning ball bearings. Extend lubrication fittings to exterior of fan casing.

.4 Provide variable sheaves for motors 11 kW (15 hp) and under and fixed sheaves for motors 15 kW (20 hp) and over.

.5 Provide variable speed drives.

.6 Entire fan assembly including fan scroll, wheel and motor to be integrally mounted on an inertia base and to be separated from unit casing with flexible connections and spring isolators. Concrete may be poured into steel base on site but fan and base must be factory mounted.

.7 The entire fan assembly shall be seismically restrained using approved methods.

2.9 Filters

.1 Refer to Section 15865 for detailed filter specifications.

.2 Filters containing asbestos, and urea formaldehyde are not acceptable.

.3 Summer Prefilter: 50 mm, pleated filter, average efficiency 25 to 30 percent on ASHRAE Test Standard 52-76. Non-woven cotton and synthetic fabric media. FARR 30/30.

.4 Winter Prefilter: frame only

.5 Final Filter: 300 mm, deep pleated filter, average efficiency 80 to 85 percent on ASHRAE Test Standard 52-76. High density microfine glass fibres, laminated to non-woven synthetic backing. FARR RIGA-FLO 100.

.6 Mounting racks to be galvanised, to suit specified filter type.

.7 Limit filter velocity based on face area to less than 2.5 m/s (500 fpm).

.8 Provide one (1) Dwyer 2000 magnehelic filter gauge for each bank of filters, including for each position of prefilter. Flush mount gauge on the exterior of the unit. Gauge shall be suitable for outdoor operation.

2.10 Coil Section

.1 Enclose coils in coil section with headers and U-bends fully contained within the casing. Meet requirements of Section 15750.

.2 Extend coil supply and return header connections, through base of the unit and drain and vent fittings through casing. Coil connections shall be of same material as the coil headers.

.3 Coil racks to be angle iron, providing completely independent support for each coil. Each coil is to be separately removable without disturbing the other coils. Provide removable coil access panels in the unit casing.

.4 Limit cooling coil face velocity to 2.5 m/s (500 fpm).

.5 Limit heating coil face velocity to 2.5 m/s (500 fpm).

2.11 Mixing Section

.1 Configured to ensure complete mix of air. Arrange dampers to direct the air flow from set of blades into the other.

.2 Manifold fresh air to top of mixing box with return air underneath.

.3 Provide a separate minimum fresh air damper section in the centre of the overall fresh air section.

.4 Provide damper sections which extend across unit width plane with maximum width not exceeding 1200 mm.

2.12 Air Blender

.1 Provide static air blenders downstream of mixing section to eliminate air stratification. The air blenders shall be manufactured by RM. Generic air blenders are not acceptable.

2.13 Louvres

.1 Provide louvres on the outside air intake and relief air openings of the unit

.2 Fixed louvre blades at 45° angle, 100 mm on centre, 100 mm wide, extruded aluminum construction

.3 Galvanised 13 mm x 13 mm mesh bird screen

.4 Natural mill finish

2.14 Dampers

.1 Low leakage type dampers with hollow blades filled with extruded polyurethane insulation.

.2 Blades shall be minimum 12 gauge extruded aluminum. Blades shall be of air foil design, 150 mm side. Maximum blade length 1200 mm.

.3 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

.4 Frames shall be minimum 12 gauge extruded aluminum channel with grooved inserts for vinyl seal.

.5 Install blade linkage hardware in frame out of air stream. Use cadmium plated steel hardware.

.6 Arrange linkage and provide an adequate number of damper operators to ensure that the interconnected damper sections operate in unison without binding.

.7 The outdoor dampers shall be integral part of the Air Handling Units and shall be supplied and installed by the Air Handling Unit manufacturer at the factory.

.8 Damper operators shall be supplied by controls contractor and installed by the Air Handling Unit manufacturer at the factory, in accordance with instructions from controls contractor.

2.15 Refrigeration/Electrical

.1 Conform to CSA B52-M1977 and UL 465-1978 requirements.

.2 Condensing section:

.1 Hermetic compressors, vibration isolated with flexible suction and discharge connections, oil sight glass.

.2 Fans: Propeller type with single piece spun Venturi outlets and zinc plated guards.

.3 Condenser: Staggered copper tube aluminum fin coil assembly.

.4 Factory piped and charged refrigerant piping with sight glass, filter and valves.

.3 Evaporator coil:

.1 Rated to ARI Standard 210-75.

.2 Staggered seamless copper tubes expanded into aluminum fins complete with drain pan and coil slide-out rails.

.3 Alternate row circuiting for multi-compressor system, with each compressor on a totally independent refrigeration circuit complete with independent expansion valve.

.4 Electrical/controls:

.1 Electrical system shall have operating controls, oil and refrigerant pressure protection and motor overload protection. Wiring shall be weather proofed: Mount all controls, transformers, disconnects, starters, etc. in a weather proof rain tight cabinet.

.2 Provide motor starters for all compressors and fans.

.3 Provide terminal strip suitable for wiring to the dry control contactors of the Building Automatic System.

.4 Provide ambient control to prevent condenser operation below 13°C (55°F).

.5 Provide anti-cycle timers between each stage of cooling.

.6 Provide a temperature controller to control mix air temperature at 13°C (55°F) by modulating mix dampers.

.7 Control unit supply temperature from space thermostat by sequentially modulating the preheat coil valve, reheat coil valve and cycling the various stages of refrigerant cooling. Provide a discharge air limit controller that will ensure that the supply air temperature is maintained between the present minimum and maximum limits.

3. EXECUTION

3.1 Assembly

.1 Units are to be one-piece construction. Mount units on galvanised roof mounting curb with wood nailing strip. Roof curb to be fully insulated prior to lowering unit on curb.

.2 Pipe units to permit coil removal.

.3 Any piping or conduit passing through the unit casings must be sealed with rubber grommets and retaining plates to prevent air or water leakage.

.4 Insulate all piping as per Section 15200.

3.2 Air Handling Unit Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

FANS

1. GENERAL

1.1 Scope

.1 Centrifugal fans

1.2 Quality Assurance

.1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 Fans shall bear CSA label.

.3 Motors to be high efficiency as specified in Section 15010.

1.3 Submittals

.1 Submit with Shop Drawings acoustical data and fan curves showing fan performance with fan and system operating point plotted on curves, including equipment weights and centre of gravity diagrams for suspended fans.

1.4 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters are in place, bearings are lubricated and fan has been run under close supervision of unit manufacturer.

1.5 Alternates

.1 Equivalent fan selections shall not increase motor kilowatts, increase rpm, increase noise level, increase tip speed by more than 10 percent, or increase inlet air velocity by more than 20 percent, from that of the specified fan.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide balanced variable sheaves for motors 11.2 kW (15 hp) and under and fixed sheave for 15 kW (20 hp) and over.

.3 Fans are to be capable of accommodating static pressure variations of ±10 percent with no objectionable operating characteristics.

.4 Fan suppliers to provide replacement sheaves for balancing purposes.

.5 Provide cross linkage and inlet vanes on double inlet fan.

.6 Size motors for parallel operating fans for non-overloading operation with only one fan operating.

.7 Provide belt guards with tachometer holes.

.8 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.

.9 Two speed motors shall have separate winding for each speed. Variable speed applications shall be inverter duty complete with variable speed drive matched to fan motor.

2.2 Centrifugal Fans

.1 Fabricate with multi-blade wheels in heavy gauge steel housing reinforced for service encountered.

.2 Provide V-belt drives with fan and motor mounted on reinforced, rigid steel base with adjustable motor mount.

.3 Provide heavy duty, self-aligning, anti-friction bearings. Extend lubrication fittings to outside of fan casing.

.4 Provide where indicated variable inlet vanes complete with linkage and pneumatic operators.

.5 Provide access door and drain connection to scroll.

.6 Unless noted otherwise, centrifugal fans over 425 mm diameter shall have die formed air foil blades welded to side and back plate.

.7 Provide fan cabinets lined with minimum 25 mm acoustic insulation, unless noted otherwise elsewhere in the specifications.

3. EXECUTION

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screen.

.2 Provide belt guards on belt driven fans complete with tachometer access.

.3 Supply and install sheaves as necessary for final air balancing.

.4 Provide 100 mm high housekeeping base for floor mounted units.

3.2 Priming

.1 Prime coat fan wheels and housing at factory inside and outside. Prime coating on aluminum part is not required.

.2 Provide two additional coats of paint on fans handling air downstream of humidifiers.

3.3 Performance

.1 Fan performance based on 225 m above sea level conditions.

.2 Refer to Equipment Schedule.

END OF SECTION

DUCTWORK

1. GENERAL

1.1 Scope

.1 Ductwork and plenums

.2 Fasteners

.3 Sealants

.4 Duct cleaning

1.2 Definitions

.1 Low Pressure: Static pressure in duct less than 500 Pa (2 inch wg) and velocities less than 10 m/s (2000 fpm).

.2 Medium Pressure: Static pressure in duct less than 1500 Pa (6 inch wg) and velocities greater than 10 m/s (2000 fpm).

.3 High Pressure: Static pressure over 1500 Pa (6 inch wg) and less than 2500 Pa (10 inch wg) and velocities greater than 10 m/s (2000 fpm).

.4 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.3 Quality Assurance

.1 Ductwork shall meet the requirements of NFPA No. 90A - Air Conditioning and Ventilating Systems.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

.3 Flexible air duct shall conform to NFPA 90A and UL181 standard for factory made air duct materials and air duct connectors.

1.4 Submittals

.1 Submit Shop Drawings and Samples of duct fittings for review, including particulars such as gauge sizes, welds and configurations prior to start of Work.

1.5 Alternatives

.1 Obtain written permission from the Contract Administrator prior to making variations in duct configuration or sizes. Size alternatives using ASHRAE table for circular equivalents of rectangular ducts.

2. PRODUCTS

2.1 Materials

.1 Ducts: galvanised steel lock forming quality, having galvanised coating of 380 g/m^2 (1.25 oz/ft^2) for both sides.

.2 Fasteners: use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.3 Sealant: water resistant, fire resistive, compatible with mating materials.

.4 Use stainless steel ducts for handling moisture laden air, gauges as per SMACNA for pressure rating, where indicated on the Drawings.

3. EXECUTION

3.1 Installation

.1 Fabricate ductwork from field measurements and not from Drawings and Shop Drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm cross brace for rigidity. Open corners are not acceptable.

.3 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.4 Construct tees, bends and elbows with radius of not less than 1.5 times width of cut on centre line. Where not possible and where rectangular elbows are specified, provide double wall air foil type turning vanes.

.5 Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 4° convergence downstream.

.6 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Seal seams on fresh air and exhaust ducts watertight with mastic or low velocity duct sealant.

.7 Weld all stainless steel ductwork and ensure a smooth finish on all interiors.

.8 Provide drains in fresh air sections with deep seal traps.

.9 Set plenum doors 150 mm above floor. Arrange door swings so that fan static holds door in closed position.

3.2 Plenum Gauges

.1 Fabricate fan plenums and plenums downstream of fan in accordance with SMACNA manual.

.2 Fabricate plenums between fan and upstream apparatus of 1.6 mm (16 gauge) thick material.

.3 Fabricate plenums between filters and upstream apparatus of 1.3 mm (18 gauge) thick material.

3.3 Duct Sealing

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, should be sealed using:

.1 Low Pressure Ductwork:

.1 Slip joints: apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5 mm use heavy mastic type sealant.

.2 Flanged joints: soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.

.3 Other joints: heavy mastic type sealant.

.2 Medium and High Pressure Ductwork

.1 Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Duct tapes as sealing method are not permitted.

.3 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.4 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the Contract Administrator.

.5 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

3.4 Installation

.1 Locate ducts with sufficient space around equipment to allow normal operation and maintenance activities.

.2 Coordinate the location of duct access doors. Refer to Section 15835, Duct Accessories.

.3 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.4 Interrupt duct linings at fire, balancing backdraft and smoke dampers so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both sides of damper device.

.5 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.

.6 Protect carbon steel ductwork exposed to weather by painting or coating with suitable weather resistant material.

.7 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 15835 - Duct Accessories.

.8 Prove that ductwork is substantially air tight before covering or concealing.

.9 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters or bypass during cleaning.

.10 Clean systems with power vacuum machines.

END OF SECTION

DUCT ACCESSORIES

1. GENERAL

1.1 Scope

.1 Access doors

.2 Motorized dampers

.3 Fire dampers

.4 Balancing dampers

.5 Flexible connections

1.2 Quality Assurance

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S 112 “Fire Dampers”.

.2 Fusible links on fire dampers shall be constructed to ULC Standard S 505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and the City's Representative.

.4 Access doors shall be ULC labelled.

.5 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

.6 Prove all dampers to inspector at job completion.

1.3 Submittals

.1 Submit Shop Drawings of factory fabricated assemblies.

.2 Submit Shop Drawings and product data in accordance with Section 01300 - Submittals and Section 15010 - Mechanical General Requirements.

.3 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.4 Provide all technical information relevant to the product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

2. PRODUCTS

2.1 Duct Access Doors

.1 Fabricate rigid and close-fitting doors of 304L stainless steel with sealing gaskets and suitable quick fastening locking devices. Duct access panels with screws are not acceptable. Install minimum 25 mm (1 inch) thick insulation with suitable sheet metal cover frame for insulated ductwork.

.2 Fabricated with two butt hinges and two sash locks for sizes up to 450 mm (18 inch), two hinges and two compression latches with outside and inside handles for sizes up to 600 mm x 1200 mm (24 inch x 48 inch) and an additional hinge for larger sizes.

2.2 Motorized Dampers

.1 Rectangular

.1 Motorized dampers which are not supplied with MUA units or AHU's shall be 'Greenheck' severe environment dampers, corrosive resistant and constructed of 316 SS.

.2 Dampers shall be AMCA certified

.3 Dampers shall be rated for a minimum of 1993 Pa8 (inch wg)

.4 Dampers shall be rated for air velocities up to 20.3 m/sec (4000 fpm)

.5 Blade style for rectangular dampers shall be airfoil (SEVCD-33) constructed of double skin 316 stainless steel. To present a lower resistance to airflow.

.6 A stainless steel housing shall be provided for actuators, NEMA 4X watertight and dust tight.

.7 Where specifically indicated on the drawings, equipment schedules (section 15999) or located outdoors, dampers shall be supplied complete with heat tape option -40°C (-40°F) construction with heated actuators. The heat tape shall be wrapped around the frame of the damper to keep the linkage from freezing under cold moisture laden conditions.

.2 Round Dampers

.1 Industrial grade control dampers meeting the following Specifications shall be furnished and installed where shown on plans and/or as described in schedules.

.2 Dampers shall consist of a round channel frame, single axle, and single circular blade fabricated from 316 stainless steel. Damper axle shall be continuous pivoting in externally mounted bronze sleeve bearings bolted to each side of the damper frame.

.3 Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper suitable for pressures to 3400 Pa (13.5 inch wg), velocities to 26.5 m/s (5150 fpm), and temperatures to 204°C (400°F). Testing and ratings to be in accordance with AMCA Standard 500-D.

.4 Dampers shall be equipped with blade seals for low EPDM synthetic rubber for 121°C (250°F) maximum temperature. Axles shall be equipped with Viton o-rings for clean air. Frame and blade gauges and axle diameters shall be at a minimum equal to those of the model which is the basis of design. Testing and ratings shall be per AMCA Standard 500-D.

.5 Basis of design is Greenheck model HCDR-250 316 stainless steel construction.

.3 Electronic Damper Operators:

.1 Proportional actuator, spring return:

.1 Electronic direct coupled type which require no crankarm and linkage.

.2 Power supply: 24 VDC

.3 Provide proportional damper control in response to 4 to 20 mA control input with the addition of a 500 ohms resistor.

.4 Designed so that may be used for either clockwise or counter-clockwise failsafe operation.

.5 Use a brushless DC motor and be protected from overload at all angles of rotation.

.6 Run time shall be constant and independent of torque.

.7 Two (2) SPDT, 6A, 250 VAC position switches, switching points fully adjustable over full actuator rotation.

.8 UL listed and CSA certified

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one (1) damper operator per damper section.

.3 Standard of acceptance: Belimo

2.3 Backdraft Dampers

.1 Greenheck model HB-230

.2 316 stainless steel construction

.3 Pressures up to 3363 Pa (13.5 inch wg)

.4 Velocity up to 26 m/sec (5150 fpm)

.5 Temperature -40°C to 121°C (-40°F to 250°F)

2.4 Fire Dampers

.1 Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less:

.1 NFPA 90A rated for 1.5 hour service

.2 Blades, frame, and mounting angles same material as ductwork

.3 Accordion style folded blades

.4 74°C fusible link

.5 Approved for installation with 2-hour fire rating

.6 Rated, manufactured, tested, and approved in accordance with UL 555

.7 Blades out of airstream when open (Type B)

.8 Furnish with sleeved frame for duct connections

.9 Labeled for use in dynamic mode

.10 Furnish dynamic and horizontal mounted dampers with springs for proper closure

.11 Corrosive Service Dampers: Type 316 stainless steel

.12 Manufacturers and Products:

.1 Nailor-Hart; Model 0130, Type B

.2 Ruskin; IBD20, Type B

.2 Duct Mounted Fire Dampers in Walls with 3-Hour or Greater Fire Rating:

.1 NFPA 90A rated for 3-hour service

.2 Blades, frame, and mounting angles

.3 Accordion style folding blades

.4 74°C fusible link

.5 Approved for installation in 4-hour wall

.6 Rated, manufactured, tested, and approved in accordance with UL 555

.7 Blades out of air stream when open (Type B)

.8 Furnish with sleeved frame for duct connection

.9 Labeled for use in dynamic mode

.10 Furnish dynamic and horizontal mounted dampers with springs for proper closure

.11 Corrosive Service Dampers: Type 316 stainless steel

.12 Manufacturers and Products:

.1 Nailor-Hart; Model 0530, Type B

.2 Ruskin; IBD23, Type B

.3 Ceiling Grille and Diffuser Fire Dampers:

.1 UL Listed assembly with frame

.2 Butterfly type blades

.3 74°C fusible link

.4 Radiation type damper

.5 Manufacturers and Products:

.1 Nailor-Hart; Model 0722 or 0716

.2 Ruskin; Type CFD Series

2.5 Balancing Dampers

.1 Fabricate of 316L stainless steel, minimum 1.6 mm (16 gauge). Full blade-length shafts of hollow square construction with blades rigidly fastened along entire blade length.

.2 Lockable quadrant type operating mechanism with end bearings on accessible rectangular ducts up to 400 mm (16 inch) deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425 mm (17 inch) and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275 mm (11 inch) deep, construct of single blade (butterfly) type.

.5 On rectangular ducts 300 mm to 400 mm (12 inch to 16 inch) deep, construct of two opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425 mm (17 inch) deep, construct of multiple opposed blades mechanically interlocked with blades no greater than 200 mm deep and pivots equally spaced.

.7 On round ducts, construct of single blade (butterfly) type. On 500 Pa (2 inch wg) class and on all dampers over 300 mm (12 inch) diameter, fabricate with full blade-length shaft.

.8 Construct damper blades for medium and high pressure systems to block air passage 70 percent maximum. Provide complete with locking type handles.

.9 Provide over ride limiting stops on all operating mechanisms.

.10 Identify the air flow direction and blade rotation and open and close positions on operating mechanism.

.11 On round ductwork install operating mechanism on a steel mounted base firmly secured to the ductwork.

.12 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.6 Flexible Connections

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 150 mm (6 inch) wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150 mm (6 inch) intervals. Flexible connection airtight at 500 Pa (2 inch wg).

.2 Do not use flexible connections to connect kitchen ductwork to kitchen fans where the fan is mounted inside the building enclosure. Fan connections in these cases shall be governed by NFPA 96 (flanged connections).

3. EXECUTION

3.1 Application

.1 Provide access door minimum 450 mm x 350 mm (18 in x 14 inch) or 50 mm (2 inch) smaller than duct dimension for cleaning and inspection at positions indicated by Drawings and as follows:

.1 Both sides of turning vanes in all ducts

.2 At each fire damper location

.3 At each side of all heating or cooling coils

.4 At all locations of internally duct mounted devices including automatic dampers, damper motors and control sensors and devices.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.3 At each point where ducts pass through fire separation duct shall be sealed with non-combustible material.

.4 Provide motorized dampers where indicated on Drawings comes with appropriately sized actuators.

.5 Provide balancing dampers at points on supply and exhaust systems where branches are taken from larger ducts as required for proper air balancing.

.6 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on Drawing.

.7 All fire dampers are to be left in the closed position for balancing Contractor to fix open.

END OF SECTION

AIR OUTLETS

1. GENERAL

1.1 Scope

.1 Diffusers

.2 Grilles and registers

.3 Outside louvres

.4 Diffuser boots

.5 Goosenecks

1.2 Quality Assurance

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.3 Project Conditions

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting Shop Drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.4 Submittals

.1 Submit Shop Drawings with complete catalogue information, materials of construction, dimensions and accessories for all air outlets, louvres and components in this Specification Section, and as scheduled.

.2 Submit colour selection charts of finishes for approval prior to fabrication.

AIR OUTLETS

2. PRODUCTS

2.1 General

.1 Base air outlet application on space noise level of NC 30 maximum.

.2 Provide supply outlets with sponge rubber seal around the edge.

.3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.4 Provide plaster frame for diffusers located in plaster surfaces.

.5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

.6 Refer to Air Outlet Schedule for specifications of air outlets.

2.2 Outside Louvres

.1 Louvres 100 mm deep with blades on 45° slope with centre baffle and return bend heavy channel frame, birdscreen with 15 mm square mesh.

.2 Fabricate of 1.6 mm (16 gauge) galvanised steel blades and frame. Provide welded assembly.

.3 Finish in factory baked enamel. Colour shall be selected by the Architect.

2.3 Goosenecks

.1 Fabricate goosenecks of minimum 1.3 mm (18 gauge) galvanised steel.

.2 Mount on minimum 300 mm high curb base where size exceeds 225 mm x 225 mm.

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matte black.

3.2 Sizing

.1 Size outside air louvres as indicated on Drawings.

.2 Size air outlets as indicated on Drawings.

3.3 Air Outlets Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

AIR FILTERS

1. GENERAL

1.1 Scope

.1 Panel filters

.2 Cube filters

.3 Pleated filters

1.2 Quality Assurance

.1 Filters shall be product of and supplied by one manufacturer.

.2 Filter media shall be UL listed, Class I or Class II.

.3 Filter components assembled to form filter banks shall be products of same manufacturer.

.4 All filters except HEPA shall be in accordance with ASHRAE Standard 52.76.

.5 Filters containing asbestos, urea formaldehyde or fibreglass will not be accepted.

1.3 Alternatives

.1 Size, media face area, material, test efficiency, initial and final air resistance of alternative manufacturers shall be as specified.

1.4 Submittals

.1 Provide Shop Drawings of all filters, and filter racks/housings.

2. PRODUCTS

2.1 Frames

.1 Fabricate filter frames and supporting structures of galvanised steel or extruded aluminum with necessary gasketting between frames and walls. Provide holding frames 1.6 mm (16 gauge), "T" section construction.

.2 Provide standard size frames to provide interchangeability of filter media of other manufacturers.

2.2 Panel Filters

.1 Media: the air filter shall consist of a 3 ply panel filter element in a uniform non woven structure. The filter shall be fabricated from variable denier Dacron fibres offering a graduated media with minimum loft of 40 mm and shall be progressively bonded with a fire retardant latex binder.

.2 The filter shall contain a non migrating tackifier impregnated between the second and third ply to prevent unloading of the tackifier downstream.

.3 Holding Frames: 1.3 mm (18 gauge) minimum galvanised frame with expanded metal grid on leaving air side and steel rod grid on air entering side, hinged with pull and retaining handles.

.4 The filter shall be Class II listed by UL.

.5 The filter shall have an average dust spot efficiency of 45 percent (ASHRAE 52-76) at 2.5 m/s (500 fpm) maximum face velocity at a final resistance of 125 Pa (0.5 inch wg).

2.3 Cube Filters

.1 Media: The air filter shall consist of a 3 ply filter element in a uniform non woven weave structure.

.2 The filter shall be fabricated from variable denier Dacron fibres offering a graduated media with a minimum loft of 25 mm and shall be progressively bonded with a fire retardant latex binder.

.3 The filter shall be welded around an internal wire header that requires no additional hardware to install in the frame. The filter shall contain non migrating tackifier impregnated between 2nd and 3rd plys to prevent unloading of tackifier downstream.

.4 The filter shall have an efficiency of 45 percent based on ASHRAE 52-76 at 2.0 m/s (400 fpm) maximum face velocity.

.5 The filter shall be Class II listed by UL.

2.4 Pleated Filters

.1 Media: the filter shall be constructed of non-woven reinforced cotton rayon. A diamond grid with 98 percent open area shall provide support for the media. The media shall be bonded to media support to ensure pleat stability. A rigid, moisture resistance heavy duty kraft board shall enclose the media. The filter pack shall be bonded to the inside periphery of the frame to eliminate air bypass.

.2 The efficiency shall be 30 to 35 percent based on ASHRAE 52-76 up to 2.5 m/s (500 fpm) for 25 mm and 50 mm thick and up to 3.0 m/s (600 fpm) for 100 mm thick.

3. EXECUTION

3.1 Installation

.1 Construct and install filters to prevent passage of unfiltered air. Provide felt, rubber or neoprene gaskets.

.2 Do not operate fan system connected to filter banks until filters (temporary or permanent) are in place. Provide new filters at take-over by the City. Replace filters used during construction.

.3 Provide filter banks in arrangement shown with removal and access indicated.

3.2 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

UNIT HEATERS

1. GENERAL

1.1 Related Work

.1 Electric Heating and Cooling Controls: Section 16851

1.2 Product Data

.1 Submit product data in accordance with Section 16010 - Electrical General Requirements.

.2 Product data to include:

.1 Mounting methods

.2 Physical size

.3 Layout and diagrams of unit heaters

.4 kW rating, voltage, phase

.5 Cabinet material thicknesses

.6 Finish.

.3 Refer to Unit Headers Schedule in Section 15999

1.3 Operation and Maintenance Data

.1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Section 15010 - General Requirements.

2. PRODUCTS

2.1 Unit Heaters

.1 Unit heater: horizontal discharge complete with adjustable louvers finished to match cabinet.

.2 Fan type unit heaters with built-in high-heat limit protection.

.3 Fan motor: totally enclosed, permanently lubricated ball bearing type with resilient mount. Built-in fan motor thermal overload protection.

.4 Hangers: as indicated.

.5 Elements: mineral insulated stainless steel sheath with aluminum, single or continuous helical brazed fins.

.6 Cabinet: steel, fitted with four (4) brackets for rod or wall mounting. Phosphatized and finished with baked enamel in standard colour.

2.2 Controls

.1 Built in thermostat and support controls.

3. EXECUTION

3.1 Installation

.1 Suspend unit heaters from ceiling or mount on wall as indicated.

.2 Power and control connections, by Division 16.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 15990 - Testing, Adjusting and Balancing.

.2 Test cut-out protection when air movement is obstructed.

.3 Test fan delay switch to assure dissipation of heat after element shut down.

.4 Test unit cut-off when fan motor overload protection has operated.

.5 Ensure that heaters and controls operate correctly.

END OF SECTION

CONTROL SEQUENCES

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 The relationships between the points, systems and building are described in the control sequences.

.3 Review with the Contract Administrator during the Shop Drawing stage to finalise the control sequences for each system.

2. PRODUCTS

.1 Not Applicable

3. EXECUTION

.1 Provide data base for all hardware points listed for system operation to meet Specification operating sequences.

4. SEQUENCE OF OPERATION

4.1 Blower Room

.1 The blower room is cooled by outside air. There are four (4) blowers and corresponding cooling equipment for each blower (4 cooling loops). Cooling equipment consists of four (4) motorized outside air inlet dampers, four (4) roof mounted exhaust fans c/w isolation dampers and VFDs, and temperature sensors located at the air discharge of the blowers. Upon a call for cooling as sensed by the space temp. sensor, the motorized outside air damper shall modulate open, the exhaust fan isolation damper shall open and the exhaust fan shall run through the VFD to maintain temperature at set point. The outside air damper shall modulate open and the exhaust fan shall speed up in response to increasing temperature. In the event that any one of blower cooling loops fail, the remaining cooling loops shall compensate by speeding up the exhaust fans and bringing more outside air in through the outside air dampers. A cooling loop failure alarm shall be indicated on the DCS.

.2 The outside air dampers and their corresponding exhaust fan isolation dampers shall be closed when the exhaust fan is off.

.3 The blower room is kept heated by electric unit heaters.

4.2 Exhaust Fan Room

.1 The exhaust fan room is cooled by outside air. Cooling equipment consists of an outside air inlet damper, a roof mounted exhaust fan complete with isolation damper and VFD, and a temperature sensor located at the air discharge of the blower. Upon a call for cooling as sensed by the temp. sensor, the motorized outside air damper shall modulate open, the exhaust fan isolation damper shall open and the exhaust fan shall run through the VFD to maintain temperature at set point. The outside air damper shall modulate open and the exhaust fan shall speed up in response to increasing temperature.

.2 In the event that the cooling loop fails, a cooling loop failure alarm shall be indicated on the DCS.

.3 The blower room is kept heated by an electric unit heater.

4.3 Sampling Room

.1 The sampling fan room is cooled by outside air. Cooling equipment consists of an outside air inlet damper, a roof mounted exhaust fan complete with isolation damper and VFD, and a temperature sensor located at the air discharge of the blower. Upon a call for cooling as sensed by the temp. sensor, the motorized outside air damper shall modulate open, the exhaust fan isolation damper shall open and the exhaust fan shall run through the VFD to maintain temperature at set point. The outside air damper shall modulate open and the exhaust fan shall speed up in response to increasing temperature.

.2 In the event that the cooling loop fails, a cooling loop failure alarm shall be indicated on the DCS.

.3 The sampling room is kept heated by an electric unit heater.

4.4 Electrical Room

.1 The Electrical room is cooled by outside air. Cooling equipment consists of a rooftop supply fan complete with isolation damper and VFD, a roof mounted exhaust fan complete with isolation damper and VFD, and a temperature sensor located in the space. Upon a call for cooling as sensed by the temp. sensor, the rooftop supply fan in conjunction with the exhaust fan shall speed up to maintain space temp. at set point. The motorized damper on the supply fan shall modulate open as the requirement for cooling increases. The exhaust fan isolation damper shall close when the fan is off. Both the supply and exhaust fans shall speed up in response to increasing space temperature.

.2 In the event that the cooling loop fails, a cooling loop failure alarm shall be indicated on the DCS.

.3 The Electrical room is kept heated by electric unit heaters.

4.5 Control Room

.1 The control room is heated, cooled and ventilated by a supply fan unit consisting of a return air / outside air mixing plenum, relief air vent, electric heater coil, DX cooling coil, and supply fan. The supply fan shall cycle on/off on a call for heating or cooling. Upon a call for cooling the outside air and return air damper shall modulate to provide economizer/free cooling (provided outside air temp. is below the space temp. set point). If outside temp is too high the outside air damper shall close, the return air damper shall open and the DX cooling shall be activated. Upon a call for heating the outside air damper shall modulate closed/return air damper open and the electric heating coil modulated ON via an SCR to maintain space temp at set point. During economizer cooling outside air is relieved through a gooseneck complete with backdraft damper.

4.6 Emergency Generator Room Ventilation

.1 When the emergency generator starts, the minimum outdoor air damper shall open.

.2 As the space temperature changes, the room thermostat shall modulate the outdoor air, exhaust air and recirculation air damper to maintain set point.

.3 Upon generator shutdown, the outdoor air, minimum outdoor air, and exhaust air dampers are closed and recirculation air damper is opened.

.4 Hard wired electric controls are to be used. All controls shall be on emergency power.

4.7 Heating System

.1 Boilers B _____ and B_____

.1 Boiler controls are provided by the boiler manufacturer. Provide tie-in points to Building Automation System, as indicated on the Points Schedule.

.2 Provide all safety or operational interlocks to boiler control panels as required.

.3 Boilers generate heating hot water at 93°C (200°F).

.4 Boiler lead lag selection is manual.

.5 Provide expansion tank with high and low level float switches tied to Building Automation System.

.2 Boiler Pumps P _____ and P _____

.1 P____ & P____ are 50 percent capacity each and are normally activated via the building automation system.

END OF SECTION

TESTING, ADJUSTING AND BALANCING

1. GENERAL

1.1 Related Documents

.1 All Division 15 Specification Sections, Drawings, and General Provisions of the Contract apply to Work of this Section, as do other documents referred to in this Section.

1.2 Scope of Work

.1 The Contractor will contract with and independent testing, adjusting, and balancing (TAB) agency to test, adjust, and balance the heating, ventilation, and air conditioning (HVAC) systems.

.2 The Work included in this Section consists of furnishing labour, instruments, and tools required in testing, adjusting and balancing the HVAC systems, as described in these specifications or shown on accompanying Drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

.3 The items requiring testing, adjusting, and balancing include the following:

.1 Air Systems:

.1 Supply Fan MUAs

.2 Exhaust Fans

.3 Zone branch and main ducts

.4 Diffusers, Registers and Grilles

.2 Hydronic Systems:

.1 Pumps

.2 System Mains and Branches

.3 Coils

1.3 Definitions, References, Standards

.1 AABC: the Associated Air Balance Council is a non-profit association of independent, certified agencies specializing in testing, adjusting, and balancing HVAC systems. The AABC National Standards, provides standards and operational criteria for HVAC systems.

.2 All Work shall be in accordance with the latest edition of the Associated Air Balance Council National Standards. If these contract documents set forth more stringent requirements than the AABC National Standards, these contract documents shall prevail.

1.4 Qualifications

.1 Agency Qualifications: the TAB Agency shall be a current member of the AABC.

1.5 Submittals

.1 Qualifications: the TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer certificate.

.2 Procedures and Agenda: the TAB agency shall submit the TAB procedures and agenda proposed to be used.

.3 Sample Forms: the TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

1.6 Testing Adjusting and Balancing Preparation and Coordination

.1 Shop Drawings, submittal data, up-to-date revisions, change orders, and other data required for planning, preparation, and execution of the TAB work shall be provided to the TAB agency no later than 30 days prior to the start of TAB work.

.2 System installation and equipment start-up shall be complete prior to the TAB agency's being notified to begin.

.3 The building control system shall be complete and operational. The Contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

.4 All test points, balancing devices, identification tags, etc., shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

.5 Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

1.7 Reports

.1 Final TAB Report: the TAB agency shall submit the final TAB report for review by the Contract Administrator. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards.

.2 Submit six (6) copies of the Final TAB Report.

1.8 Deficiencies

.1 Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.

.2 The Work necessary to correct items on the deficiency listing shall be performed and verified by the Contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

2. INSTRUMENTATION

.1 All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

3. EXECUTION

3.1 General

.1 The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards.

.2 Adjustment tolerances shall be plus or minus ten percent unless otherwise stated.

.3 Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.

.4 All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for Work required, as listed in this Section, are a guide to the minimum information needed.

3.2 Air Systems

.1 The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following:

.1 TAB procedures in accordance with the AABC National Standards:

.1 For supply fans:

.1 Fan speeds: test and adjust fan rpm to achieve maximum or design air flow rate.

.2 Current and voltage: test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

.3 Pitot-tube traverse: perform a pitot-tube traverse of main supply and return ducts, as applicable to obtain total air flow rate.

.4 Outside air: test and adjust the outside air on applicable equipment using a pitot-tube traverse.

.5 If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 11°C (20°F) or use the difference between pitot-tube traverses of the supply and return air ducts.

.6 Static pressure: test and record system static profile of each supply fan.

.2 For exhaust fans:

.1 Fan speeds: test and adjust fan rpm to achieve maximum or design air flow rate.

.2 Current and voltage: test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.

.3 Pitot-tube traverse: perform a pitot-tube traverse of main exhaust ducts to obtain total air flow rate.

.4 Static pressure: test and record system static profile of each exhaust fan.

.3 For zone, branch and main ducts:

.1 Adjust ducts to within design air flow rate requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

.4 For diffusers, registers and grilles:

.1 Tolerances: test, adjust, and balance each diffuser, grille, and register to within ten percent of design requirements. Minimize drafts.

.2 Identification: identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

.5 For coils:

.1 Air temperature: once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling

coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

3.3 Hydronic Systems

.1 The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards:

.1 For pumps:

.1 Test and adjust domestic hot water and glycol pumps to achieve maximum or design flow rate. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations.

.2 Current and voltage: test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

.3 For system mains and branches:

.1 Adjust flow in pipes to achieve maximum or design flow rate.

.4 For coils:

.1 Tolerances: test, adjust, and balance all heat recovery coils within ten percent of design requirements.

.2 Verification: verify the type, location, final pressure drop and flow rate of each coil. This information shall be recorded on coil data sheets.

3.4 Optional Tab Services

.1 Preconstruction Plan Check and Review:

.1 The TAB agency shall review the project documents and contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within 30 days of document review.

.2 Jobsite Inspections:

.1 During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two times. (Typically, these are performed when 60 percent of the total system is installed and again when 90 percent of the total system is installed, prior to insulation of the duct and piping). The TAB agency shall submit a written report of each inspection.

.3 Verification of HVAC Controls:

.1 The TAB agency shall be assisted by the building control systems contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

.1 Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.

.2 Verify that all controlling instruments are calibrated and set for design operating conditions.

.4 Temperature Testing:

.1 To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than 1°C (2°F) from the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

.5 TAB Report Verification:

.1 At the time of final review, the TAB agency may be required to recheck, in the presence of the Contract Administrator, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the Contract Administrator. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed ten percent of the total number tabulated in the report.

.6 Building/Zone Pressurization:

.1 The TAB agency shall test and adjust building/zone pressurization by setting the design flows to meet the required flow direction and pressure differential. For positive pressure areas, it shall set the supply air to design flow, and gradually reduce the exhaust air rate to obtain the required flow or pressure difference. For negative pressure areas, it shall set the supply air to design flow, and gradually increase the exhaust air rate to obtain the required flow or pressure difference.

END OF SECTION

1. LIST OF SCHEDULES

.1 Supply Fan Schedule

.2 Exhaust Air Fan Schedule

.3 Unit Heater Schedule

.4 Air Cooled Condensing Unit Schedule

.5 Diffusers Schedule

.6 Louvre Schedule

.7 Motorized Dampers

.8 Pre-packaged Pump Stations Schedule

.9 Plumbing Fixtures Schedule

.10 Emergency Eyewash/Polar Unit Schedule

LIST OF SCHEDULES

1.1 Supply Fan Schedule

Tag	C550-SF	C560-SF
Location	Blower Room	Roof
Area Served	Control Room	Electrical Room
Type	Air Handler	Make-up Air Unit
Manufacturer	Lennox	McQuay
Model	CBX26UH-036	OAH045GVAC
Supply Fan		
Tag		
High Volume, L/s (cfm)	609 (1290)	9439 (20000)
ESP, Pa (in.wg.)	100 (0.4)	249 (1.0)
Fan Type	2 speed blower	Centrifugal Forward Curved
Motor Power, W (hp)	249 (0.33)	11.2 (15)
Minimum Outdoor Air, L/s (cfm)	61 (129)	
Heating Section		
Type	Electric	
Heating Output, kW	5.0	
Power Supply	208/1/60	600/3/60
FLA / MCA / MOP	1.8 / 19.8 / 30	14.1
Lock Rotor Current, A		94
DX Coil		
Face Area, m^2 (ft^2)	0.45 (4.88)	
Rows	3	
FPM (FPI)	551 (14)	
Clg. Capacity, kW (TR)	10.5 (3.0)	
Condensing Unit	See C552-CU	
Arrangement		
Supply Outlet	Top	Side
Return Inlet	Bottom	
Physical Data		
Overall Depth/Length, mm	559	2692
Overall Width, mm	540	2692
Overall Height, mm	1295	1981
Overall Weight, kg	67	1461
Complete with:	• Side Return Unit Stand for raising unit off floor. Stand is adjustable. • Single-point Power Source Control Box. -Field install to external of unit. -Heavy gauge steel construction -Baked enamel finish -Prepunched mounted holes -Electrical inlet knockouts -Terminal strip -Removable cover	• 400mm high roof curb kit. • VFD duty motor • Anti-vibration springs • 30%, MERV 6 filters • Motorized Inlet dampers • Inlet hood • Insulation

1.2 Exhaust Air Fan Schedule

Tag	C521-EF	C522-EF	C523-EF
Function	Room Exhaust	Room Exhaust	Room Exhaust
Location	See drawing M1.02	See drawing M1.02	See drawing M1.02
Volume, L/s (cfm)	8495 (18000)	8495 (18000)	8495 (18000)
E.S.P. Press, Pa (in.wg.)	187 (0.75)	187 (0.75)	187 (0.75)
Fan Speed, RPM	1052	1052	1052
Motor Power, kW (hp)	5.6 (7.5)	5.6 (7.5)	5.6 (7.5)
Power Supply (V/Ph/Hz)	600/3/60	600/3/60	600/3/60
Drive	Belt Drive	Belt Drive	Belt Drive
Type	Vaneaxial Mushroom Roof Exhauster	Vaneaxial Mushroom Roof Exhauster	Vaneaxial Mushroom Roof Exhauster
Arrangement	Arrangement 9	Arrangement 9	Arrangement 9
Manufacturer	Northern Blower	Northern Blower	Northern Blower
Model	Series 7400 Design 7413 Size 3300	Series 7400 Design 7413 Size 3300	Series 7400 Design 7413 Size 3300
Control	VFD	VFD	VFD
Accessories & Remarks			

1.2 Exhaust Air Fan Schedule (Continued)

Tag	C524-EF	C528-EF	C530-EF
Function	Room Exhaust	Room Exhaust	Room Exhaust
Location	See drawing M1.02	See drawing M1.02	See drawing M1.02
Volume, L/s (cfm)	8495 (18000)	8495 (18000)	189 (400)
E.S.P. Press, Pa (in.wg.)	187 (0.75)	187 (0.75)	187 (0.75)
Fan Speed, RPM	1052	1052	2200
Motor Power, kW (hp)	5.6 (7.5)	5.6 (7.5)	0.19 (0.25)
Power Supply (V/Ph/Hz)	600/3/60	600/3/60	120/1/60
Drive	Belt Drive	Belt Drive	Belt Drive
Type	Vaneaxial Mushroom Roof Exhauster	Vaneaxial Mushroom Roof Exhauster	Centrifoil Mushroom Roof Exhauster
Arrangement	Arrangement 9	Arrangement 9	Arrangement 9
Manufacturer	Northern Blower	Northern Blower	Northern Blower
Model	Series 7400 Design 7413 Size 3300	Series 7400 Design 7413 Size 3300	Series 8000 Design 8093 Size 912
Control	VFD	VFD	On/off
Accessories & Remarks			

1.2 Exhaust Air Fan Schedule (Continued)

Tag	C580-EF
Function	Room Exhaust
Location	See drawing M1.02
Volume, L/s (cfm)	8495 (18000)
E.S.P. Press, Pa (in.wg.)	187 (0.75)
Fan Speed, RPM	1052
Motor Power, kW (hp)	5.6 (7.5)
Power Supply (V/Ph/Hz)	600/3/60
Drive	Belt Drive
Type	Vaneaxial Mushroom Roof Exhauster
Arrangement	Arrangement 9
Manufacturer	Northern Blower
Model	Design 7413 Size 3300
Control	VFD
Accessories & Remarks	

Accessories :

1. Gasketted bolted access door
2. Housing drain with plug
3. Totally enclosed belt guard
4. Shaft and bearing guard
5. Extended grease fittings
6. Fan base and vibration isolators
7. Weatherproof motor
8. Drive cover
9. Shaft seal

1.3 Unit Heater Schedule

Tag	C521-UH	C522-UH	C523-UH
Location	See drawing M1.02	See drawing M1.02	See drawing M1.02
Type	Electric	Electric	Electric
Capacity, kW	10	3	3
Air Flow, L/s (cfm)	760	465	465
Motor Power, W (hp)	37 (0.05)	37 (0.05)	37 (0.05)
Power Supply, V/Ph/Hz	600/3/60	600/3/60	600/3/60
Arrangement	Horizontal	Horizontal	Horizontal
Manufacturer	Caloritech	Caloritech	Caloritech
Model	GE108CT	GE038CT	GE038CT
Complete with:	Epoxy painted fan blade and motor	Epoxy painted fan blade and motor	Epoxy painted fan blade and motor

Tag	C524-UH	C525-UH	C526-UH
Location	See drawing M1.02	See drawing M1.02	See drawing M1.02
Type	Electric	Electric	Electric
Capacity, kW	5	3	3
Air Flow, L/s (cfm)	550	465	465
Motor Power, W (hp)	37 (0.05)	37 (0.05)	37 (0.05)
Power Supply, V/Ph/Hz	600/3/60	600/3/60	600/3/60
Arrangement	Horizontal	Horizontal	Horizontal
Manufacturer	Caloritech	Caloritech	Caloritech
Model	GE058CT	GE038CT	GE038CT
Complete with:	Epoxy painted fan blade and motor	Epoxy painted fan blade and motor	Epoxy painted fan blade and motor

1.4 Air Cooled Condensing Unit Schedule

Tag	C552-CU
Service	Connected to C550-SF
Location	Roof
Manufacturer	Lennox
Model	13ACX-036
Capacity, kW (Tons)	10.5 (3.0)
Refrigerant Type	R-410A
Compressors	
Rated Load Amps	16.6
Power Factor	0.98
L.R.A.	79
Condenser Motor	
F.L.A.	1.0
L.R.A.	1.9
Electrical (V/ph/Hz)	208/1/60
MOP / MCA	35 / 21.9
Complete with:	• Stand-off kit • Isolation pad

1.5 Diffusers Schedule

Tag	Manufacturer Model No.	Neck Size (mm)	Finish	Fastening
SA-A	E.H. Price SCD Series	See Drawings	None	
SA-B	E.H. Price 510D-12x10/F/L/A/B12			
RA-A	E.H. Price 80 Series Egg Crate Face	See Drawings	None	Counter-sunk

Finishes:

1. Off-white baked enamel
2. Aluminum baked enamel
3. Aluminum prime coat
4. Brushed finish and clear acrylic coat
5. White baked enamel
6. White powder coat

LIST OF SCHEDULES

1.6 Louvre Schedule

Tag	Manufacturer Model No.	Frame	Core	Size – mm (in) Width x Height	Cap. – l/s (cfm)	Vel. – m/s (fpm)	ΔP – Pa (in)	Fast.	Finishes	Options
LV-A	Airolite 638C1004x	Drainable	Drainable	See Drawings	See Drawings	2.3 (450)	(0.03)	Mtg. angle	3, 4	1, 2, 3
LV-B	Airolite 638C1004x	Drainable	Drainable	See Drawings	See Drawings	3.0 (600)	(0.06)	Mtg. angle	3, 4	1, 3

Finishes:
1. Baked enamel
2. Duranar
3. Duranar XL
4. Match adjacent panelling

Options:
1. Formed metal sill
2. Aluminum insect screen
3. Aluminum bird screen
4. Removable access door

1.7 Motorized Dampers

Tag	Manufacturer Model No.	Duct Size mm x mm (in x in)	Actuator Voltage	Remarks
C521-MD1	Greenheck SEVCD-33	1500 x 600 (60 x 24)	120/1/60	c/w heater kit
C521-MD2	Greenheck SEVCD-33	900 x 900 (36 x 36)	120/1/60	c/w heater kit
C522-MD1	Greenheck SEVCD-33	1500 x 600 (60 x 24)	120/1/60	c/w heater kit
C522-MD2	Greenheck SEVCD-33	900 x 900 (36 x 36)	120/1/60	c/w heater kit
C523-MD1	Greenheck SEVCD-33	1500 x 600 (60 x 24)	120/1/60	c/w heater kit
C523-MD2	Greenheck SEVCD-33	900 x 900 (36 x 36)	120/1/60	c/w heater kit
C524-MD1	Greenheck SEVCD-33	1500 x 600 (60 x 24)	120/1/60	c/w heater kit
C524-MD2	Greenheck SEVCD-33	900 x 900 (36 x 36)	120/1/60	c/w heater kit
C530-MD1	Greenheck SEVCD-33	300 x 200 (12 x 8)	120/1/60	c/w heater kit
C530-MD2	Greenheck SEVCD-33	350 x 350 (14 x 14)	120/1/60	c/w heater kit
C540-MD1	Greenheck SEVCD-33	1500 x 600 (60 x 24)	120/1/60	c/w heater kit
C540-MD2	Greenheck SEVCD-33	900 x 900 (36 x 36)	120/1/60	c/w heater kit
C550-MD1	Greenheck SEVCD-33	450 x 300 (18 x 12)	120/1/60	c/w heater kit
C560-MD1				Comes complete and installed with C560-SF
C580-MD1	Greenheck SEVCD-33	900 x 900 (36 x 36)	120/1/60	c/w heater kit
184-MD1	Greenheck SEVCD-33	600 x 600 (24 x 24)	120/1/60	c/w heater kit
284-MD2	Greenheck SEVCD-33	600 x 600 (24 x 24)	120/1/60	c/w heater kit

1.8 Pre-packaged Pump Stations Schedule

Tag	**C570-SMP-1**	**C570-SMP-2**
Location	In West Sump Pit Outdoors	In West Sump Pit Outdoors
Type	Pre-packaged pump stations	Pre-packaged pump stations
Manufacturer	Flygt	Flygt
Sump Pit		Same pit as C570-SMP-1
Construction	FRP	
Overall Diameter, mm	1524	
Overall Height, mm	8000	
Connection Sizes, mm	75	
Vent size, mm	150	
Pump		
Model	CP-3045 Submersible Pump	CP-3045 Submersible Pump
Impeller diameter, mm	90	90
Discharge Size, mm	50	50
Motor Power, kW (HP)	1.3 (1.8)	1.3 (1.8)
Voltage/phase/Hz	600/3/60	600/3/60
Starting Current, amps	15	15
Rated Current, amps	2.0	2.0
RPM	3405	3405
Duty	Duty/Standby	Duty/Standby
Operating Conditions		
Capacity, L/s (USgpm)	54.9	54.9
Total Head, m (ft wc)	35	35
Fluid Pumped		
Type	Water	Water
Temperature, °C (°F)	15 (60)	15 (60)
Complete with	• Anti-floatation ballasts • Thermal contacts for pumps • Ladder • Intermediate ladder platform • Level regulators • PLC control panel	Same pit as C570-SMP-1

1.8 Pre-packaged Pump Stations Schedule (Continued)

Tag	**C571-SMP-1**	**C572-SMP-2**
Location	In East Sump Pit Outdoors	In East Sump Pit Outdoors
Type	Pre-packaged pump stations	Pre-packaged pump stations
Manufacturer	Flygt	Flygt
Sump Pit		Same pit as C570-SMP-1
Construction	FRP	
Overall Diameter, mm	1524	
Overall Height, mm	8000	
Connection Sizes, mm	75	
Vent size, mm	150	
Pump		
Model	CP-3045 Submersible Pump	CP-3045 Submersible Pump
Impeller diameter, mm	90	90
Discharge Size, mm	50	50
Motor Power, kW (HP)	1.3 (1.8)	1.3 (1.8)
Voltage/phase/Hz	600/3/60	600/3/60
Starting Current, amps	15	15
Rated Current, amps	2.0	2.0
RPM	3405	3405
Duty	Duty/Standby	Duty/Standby
Operating Conditions		
Capacity, L/s (USgpm)	54.9	54.9
Total Head, m (ft wc)	35	35
Fluid Pumped		
Type	Water	Water
Temperature, °C (°F)	15 (60)	15 (60)
Complete with	• Anti-floatation ballasts • Thermal contacts for pumps • Ladder • Intermediate ladder platform • Level regulators • PLC control panel	Same pit as C570-SMP-1

1.9 Plumbing Fixtures Schedule

Tag	SK-1 (Sink)
Location	See drawing M1.01
Type	Sampling Sink w/ anti-splash rim & drain board
Construction	Type 304 Stainless Steel, 14 gauge, grade 18-8
Width *mm (inch)*	1143 (45)
Depth *mm (inch)*	533 (21)
Height *mm (inch)*	889 (35)
Manufacturer	Aristaline
Model No.	SSS1827SDSR
Facet	
Manufacturer	Sloan
Model No.	SL-0231
Connection Size	½" NPT female
Cartridge	ceramic
Faucet Features	• Cast brass construction • Swivel spout • Adjustable inlets • Wing handles with color coded index buttons • Polished chrome finish

Tag	HR-1 (Hose Reel)
Location	See drawing M1.01
Type	Swivel style spring loaded retractable hose reel
Manufacturer	Nederman
Model No.	Series 884
Reel w/ Hose Part No.	30810484
Complete with:	• 20mm diameter, 15 meter long hose • Factory adjusted spring-power for the corresponding hose • Ratchet style hose lock • Ball bearing drum and swivel • Pivoting wall bracket (Part No. 30231991)
Other accessories	Hose Nozzle • ULC listed, 20 mm, adjustable "twist-to-open" type fire hose type nozzle, rated at 0.5 L/s at 689 Pa • Nozzle end shall have bumper • Pistol grip or trigger type nozzles not accepted • Standard of Acceptance: Bison Fire Protection, Model 1030G

1.9 Plumbing Fixtures Schedule (Continued)

Tag	HB-1 (Hose Bibb)
Location	See drawing M1.01
Connection size	20 mm (3/4" NPS)
Body Construction	Bronze or red brass
Remarks:	• Bronze body globe valve • renewable composition disc • threaded inlet • "garden hose" thread outlet • rating 2070 kPa water • replaceable hexagonal disc • hose thread spout
Acceptable Manufacturers	Jenkins, Dahl, Crane, Toyo, Mifab

Tag	FD-1 (Floor Drain)
Location	See drawings
Make	Zurn
Model	ZX-415-A5-AR-P-Y

LIST OF SCHEDULES

1.10 Emergency Eyewash/Polar Unit Schedule

Tag	EES-1/EES-2	EES-3
Location	See Drawing M1.01	See Drawing M1.01
Type	Fully enclosed combination emergency eyewash and shower unit	Combination emergency eyewash and shower unit
Manufacturer	Haws	Haws
Model No.	8710-21.31	8300
Blending System Model	TWBS.SH	
Complete with:	• 20-gpm shower head • 5-gpm eye/face wash heads • 4-gpm drench hose • Freeze/scald valves • Flow activated alarm system w/ flow switch • Blending system • 4 kW electric water heater element • 3-kW forced air space heater • Interior lights	• 20-gpm shower head • 1.2-gpm eyewash heads • Foot treadle and push flag • Shower Pull Rod
Remarks	CSA certified to meet ANSI Z358.1	CSA certified to meet ANSI Z358.1

END OF SECTION