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 others or by the City.

.7 Install control valves, control dampers, thermal wells, and other devices on piping and ducts supplied under this contract.

.8 Clauses that include the word "Clearwell" in the heading shall only be applicable to the mechanical provisions and requirements that are part of the Clearwell Structure. This includes the Clearwell substructure, superstructure, Inlet Building, and/or Outlet Structure.

1.2 Coordination of Work

.1 Cooperate and coordinate with other contractors on the Site.

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

1.3 Permits

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

1.4 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.

1.5 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 (“) (NPS)	mm (“) (NPS)	mm (inch) (“)
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”

1.6 Shop Drawings

.1 Refer to Section 01300 – Submittals.

1.7 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”).

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

1.8 Excavation and Backfill

.1 Refer to requirements of Division 2.

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

1.9 Installation of Equipment

.1 Pipe all equipment drains to buckets.

.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.

1.10 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.

1.11 Connections to Existing Services

.1 Maintain liaison with Contract Administration 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 forty eight (48) hours notice for all service shutdowns.

.3 Interruptions and shutdowns of existing services shall be by the City.

1.12 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.

1.13 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.

1.14 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

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

1.15 Access Doors

.1 Access doors shall be steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door.

1.16 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

1.17 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.

1.18 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 in Article 1.19 of this Section.

.3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm (0.75") 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") 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 Contract Administration. 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") 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, and control)	blue	D.
Fire dampers	red	F.D.

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

1.19 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
Condensate	Green	Orange	Cond.
Domestic Cold Water	Light Blue	None	Dom. Cold Wat.
Engine Exhaust	Aluminum	Orange	Exh.
Fuel Oil	Brown	Orange	Fuel Oil
Glycol Return	Green	Orange	Glycols R.
Glycol Supply	Green	Orange	GlycolS
Vent	Aluminum	Red/Orange	Vent

.3 Identification Symbols and Colours for Equipment:

	Pipe Colour	Stripe Colour	Symbol
Hangers, Brackets, Hanger Rods	Black Machinery Enamel		
Pumps - Regular	Aluminum	None	None
Supports	Black	None	None
Valves Uninsulated	High Heat Aluminum		

.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.
Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

1.20 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.

.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.

1.21 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.

1.22 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 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.

.3 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the 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.

.4 List of acceptable Manufacturers/Suppliers:

.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	McQuay, Trane, Hakkon
.4	Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Nailor
.5	Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison
.6	Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
.7	Coils – Heating and Cooling	Trane, Aerofin, Engineered Air, McQuay
.8	Dampers - Control, Backdraft	Ruskin, Tamco
.9	Eye Wash Fountains	Western, Haws
.10	Fans – Centrifugal Roof Exhausters	Penn, Greenheck, Cook, Northern Blower
.11	Fans – Centrifugal	Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern
.12	Filters	Cambridge, AAF, Pacific, FARR
.13	Flexible Connectors – Ducting	Thermaflex, G.I. Industries Type IHP
.14	Flexible Connectors – Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason

.15 Gauges – Air	Dwyer, Magnehelic
.16 Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
.17 Grooved Mechanical Pipe Joints	Victaulic, Shurjoint, Groove-lok (only where permitted)
.18 DX Condensing Units	Lennox, AAON, Carrier, Trane, McQuay
.19 Insulation – Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
.20 Louvres	Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex
.21 Piping Hangers and Saddles	Grinnell, Myatt
.22 Pumps – Vertical In-Line and Base Mounted	Armstrong, Aurora, B & G, Taco, Grundfos, Viking
.23 Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
.24 Thermometers	Trerice, Marsh, Ashcroft, Winters
.25 Valves – Butterfly	Jenkins, Keystone, DeZurik, Centreline, Dresser, Crane, Bray, Toyo, Grinnell
.26 Valves, Bronze – Check, Ball	Jenkins, Toyo, Crane, Milwaukee
.27 Valves – Pressure Reducing	Armstrong, Bell & Gossett, Taco, Fisher
.28 Valves – Relief	Armstrong, Bell & Gossett, Taco
.29 Valves – Silent Check	Val-matic, APCO, StreamFlo
.30 Vent Caps	Jenn-Air, Penn Ventilator
.31 Vent Sets	Greenheck, Trane, Sheldons, Buffalo, New York, Brundage, Loren Cook, Lau

1.23 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. Supply and Install 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 colour code specified.

.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 (NOT USED)

END OF SECTION

TESTING

1. GENERAL

1.1 Scope

.1 Test refrigerant piping

.2 Test low velocity ducts

.3 Test equipment

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

.1 Air handling units

.2 Fans

.3 VSD units

.4 Control components

.5 Emergency showers and eye wash stations

.6 Pumps

.6 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.

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

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

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

.10 Use Manufacturer's starting personnel where required to ensure integrity of Manufacturer's warranty.

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

.12 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.)

.13 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.

.14 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.

.15 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.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Pressure Tests

.1 Provide equipment, materials and labour for tests and pay expenses. Use calibrated test instruments 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 an eight (8) 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 Water Piping: test to 1.5 times maximum working pressure or 1033 kPa, whichever is greater, water pressure measured at system low point.

.4 Natural Gas: test as required by current edition of CAN/CSA-B149.1, and authority having jurisdiction.

.5 Ducts: test ducts as per current edition of SMACNA Manual for low pressure ductwork.

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

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

.8 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.

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

.3 Confirm voltages and operating amperages at full load.

.4 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 the 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.

3.3 Procedures

.1 Procedures shall be identified in the following 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

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

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 Supply and Install 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 Supply and 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 Supply and Install 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 Professional Engineer Registered in the Province of Manitoba to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanized 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 Supply and Install hangers so they cannot become disengaged by movements of supported pipe.

.11 Supply and Install copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping. Provide galvanized hangers and supports for galvanized 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 Clearwell Pipe Hangers and Supports

.1 Type 1 – Pipe Hanger (Stainless Steel):

.1 Upper Attachments:

.1 Concrete Inserts: heavy duty, stainless steel body, fibreglass bars, polypropylene disc.

.2 Standard of acceptance: Grinnell fig. 283.

.2 Hanger Rods:

.1 304 stainless steel rod, threaded both ends, threaded one end, or continuous threaded.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Pipe Attachments:

.1 304 stainless steel adjustable clevis with nipple spacer and vertical adjustment nuts above and below clevis.

.2 Type 2 – Pipe Hanger (Galvanized Steel):

.1 Upper Attachment:

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

.2 Standard of acceptance: Grinnell fig. 282.

.2 Hanger Rods:

.1 Galvanized steel rod, threaded both ends, threaded one end, or continuous threaded.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.3 Pipe Attachments:

.1 Galvanized carbon steel adjustable clevis with nipple spacer and vertical adjustment nuts above and below clevis.

.2 Standard of acceptance: Grinnell fig. 260.

.3 Type 3 – Offset Pipe Support:

.1 Clamp:

.1 304 stainless steel clamp and hardware.

.4 Size inserts to suit threaded hanger rods.

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

2.4 Hanger Rods

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

2.5 Duct Hangers and Supports

.1 Conform to current edition of SMACNA handbooks.

2.6 Flashing

.1 Steel Flashing: 0.85 mm minimum thickness galvanized 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.

2.7 Sleeves

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

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

.3 Ducts: form sleeves with galvanized steel.

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

2.8 Pipe Seals

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

2.9 Finishes on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanized or factory primed with alkyd red oxide primer to CAN/CGSB – 1.40 Anticorrosive Structural Steel Alkyd Primer.

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 and 65 mm	3.0 m	2.4 m	10 mm
80 mm and 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 Clearwell Pipe Hangers and Supports

.1 Pipe Hanger Schedule:

Application	Type
Hanger Inside Clearwell	1
Hanger Inside Inlet and Outlet Building	2
Hanger Inside Sump Pit	1
Wall Support Inside Clearwell	3
Wall Support Inside Sump Pit	3

.2 Support PVC piping in accordance with Manufacturer's recommendations:

.3 Install hangers to provide minimum 12 mm (½") clear space between finished covering and adjacent Work.

.4 Place a hanger within 300 mm (12") of each horizontal elbow.

.5 Use hangers which are vertically adjustable 40 mm (1½") minimum after piping is erected.

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

3.4 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

3.5 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.

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 CAN/CSA-B149.1, Natural Gas and Propane Installation Code.

.4 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, CAN/CSA B70
.2	Sanitary drainage, and vent, inside building, below ground	Cast iron, CAN/CSA B70 PVC-DWV, CAN/CSA B182
.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	Natural gas, propane	Steel, Sch.40, ASTM A53 Grade B
.5	Diesel Fuel	Steel, Sch. 40, ASTM A53 Grade B
.6	Diesel Fuel (Underground)	OPW Inc PISCES CPN series double-wall primary pipe inside crush-resistant AXP series double-wall access pipe.
.7	Engine Exhaust	Steel, Sch. 40, ASTM A53 Grade B

.8	Clearwell Washdown Water	Sch. 40, PVC, conforming to CSA B137.0, ASTM D 1785.
.9	Clearwell Sump Pump Discharge	Sch. 40, PVC, conforming to CSA B137.0, ASTM D 1785.

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
.3	Sanitary drainage and vent, outside building	Cast iron	Hub & spigot
		PVC- Gravity Sewer	Hub & spigot with gasket
		Concrete	Hub & spigot
.4	Domestic water service	PVC	Hub & spigot, with "O" ring
		Copper pipe	No joints permitted underground
.5	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
.6	Diesel Fuel	Steel, same sch. as pipe	Socket welded
.7	Diesel Fuel (Underground)	NO BURIED JOINTS ALLOWED	
.8	Engine Exhaust	Steel, same sch. as pipe	Butt weld or flanged
.9	Clearwell Washdown Water	PVC	Sch. 40 socket conforming to ASTM D2466.
			Sch. 80 threaded conforming to ASTM D

			2464.
.10	Clearwell Sump Pump Discharge	PVC	Sch. 40 socket conforming to ASTM D2466. Sch. 80 threaded conforming to ASTM D 2464.
.11	Use long radius elbows for steel and cast iron water piping, including grooved mechanical fittings.		
.12	Generator to rigid pipe fuel flex connector	Sensor Flexonics BSN Stainless Steel Flex Connectors	NPT nipples

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 galvanized couplings for galvanized pipe. Victaulic brand or Grinnel Gruv-Lok only

2.4 Clearwell Flanges and Solvents

.1 Flanges: PVC conforming dimensionally to ANSI/ASME B16.1, for 1.03 MPa (150 psi): slip-on full faced, solvent welded to pipe.

.2 Gaskets: Neoprene, 3 mm ($^1/_8$") thick.

.3 Bolts and Nuts: To ASTM A-193 B8M Studs, Class 2 and ASTM A-194 8M hex nuts.

.4 Solvent: to ASTM D 2564.

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 Socket weld diesel fuel piping including branch connections. Screw or weld piping for natural 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 galvanized couplings with galvanized 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% 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% 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

	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						
HEADER	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

BRANCH PIPE SIZE

3.6 PVC Piping Systems

.1 As indicated and in accordance with instructions of PVC Manufacturer’s recommendations.

.2 Joints:

.1 Solvent weld throughout except at flanges and unions.

.2 Make joints in accordance with ASTM D 2855, and to Manufacturer's recommendations, using both primer and solvent welding cement.

.3 Make connections to other materials or fittings using appropriate adapters and to manufacturer's recommendations.

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

.4 Install piping material specified as inside the building to 2 m (6.5 ft) outside of building.

END OF SECTION

VALVES AND STRAINERS

1. GENERAL

1.1 Scope

.1 Ball valves

.2 Check valves

.3 Plug cocks

.4 Drain valves

.5 Diesel fuel solenoid 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 Natural Gas Systems

.1 Valves

.1 Conform to CGA Standard 3.16.

.2 Steel plug type gas valve.

.3 Iron body, non-lubricated eccentric bronze plug, permanently lubricate bearing bushings lever handle.

.4 Standard of acceptance: DeZurik 400 Series.

.2 Building Pressure Regulator

.1 Self operated gas pressure regulator. Cast iron body. Size for full gas load to reduce gas pressure from 137.9 kPa (20 psi) to 3.5 kPa (14" w.c.). Body rating 1030 kPa (150 psi). Manufacturer: Fisher.

2.2 Clearwell Washdown Water System

.1	Valve Code:		Gate - Isolation
	Size Range:	40 mm to 200 mm ($1^1/_2$" to 8")	
	Pressure Rating:	ANSI Class 150 Flanges	
	Body & Bonnet Mat'l:	PVC conforming to CSA B137.0	
	Valve Style:	One piece body, non-rising stem	
	Trim:	Polypropylene to ASTM D-4101	
	Bolting:	Stainless steel	
	Packing:	EPDM to CSA B137.0	
	Operator:	50mm (2") municipal operating nut with stainless steel extensions	
	Temperature Range:	0 to 50°C (32 to 122°F)	
	Standard of Acceptance:	'Chemline' CGA Series.	
.2	Valve Code:		Ball - Drain
	Size Range:	13 mm to 50 mm ($^1/_2$" to 2")	
	Pressure Rating:	1.03 MPa (150 psi)	
	Body & Bonnet Mat'l:	PVC conforming to CSA B137.0	
	Valve Style:	Full port, two way blocking, true union, double stem blow-out proof o-rings, socket ends	
	Trim:	PVC conforming to CSA B137.0	
	Bolting:	--	
	Packing:	EPDM to CSA B137.0	
	Operator:	Tee handle	
	Temperature Range:	0 to 50°C (32 to 122°F)	
	Standard of Acceptance:	'Ipex' Type VK or 'Chemline' Type 21	
.3	Valve Code:		Hose – Ball Valve
	Size Range:	65 mm ($2^1/_2$")	
	Pressure Rating:	1.03 MPa (150 psi)	
	Body & Bonnet Mat'l:	PVC conforming to CSA B137.	
	Valve Style:	Full port, two way blocking, true union, double stem blow-out proof o-rings, socket ends	
	Trim:	PVC conforming to CSA B137.0	
	Bolting:	--	
	Packing:	EPDM to CSA B137.0	
	Operator:	Tee handle - PVC	
	Temperature Range:	0 to 50°C (32 to 122°F)	
	Standard of Acceptance:	'Ipex' Type VK or 'Chemline' Type 21	

2.3 Clearwell Sump Discharge

.1	Valve Code:		Gate - Isolation
	Size Range:	65 mm to 200 mm ($2^1/_2$" to 8")	
	Pressure Rating:	ANSI Class 150 Flanges	
	Body & Bonnet Mat'l:	PVC conforming to CSA B137.0	
	Valve Style:	One piece body, non-rising stem	
	Trim:	Polypropylene to ASTM D-4101	
	Bolting:	Stainless steel	
	Packing:	EPDM to CSA B137.0	
	Operator:	Handwheel	
	Temperature Range:	0 to 50°C (32 to 122°F)	
	Standard of Acceptance:	'Chemline' CGA Series.	
.2	Valve Code:		Ball - Isolation
	Size Range:	13 mm to 50 mm (1/2 in to 2 in)	
	Pressure Rating:	1.03 MPa (150 psi)	
	Body & Bonnet Mat'l:	PVC conforming to CSA B137.0	
	Valve Style:	Full port, two way blocking, true union, double stem blow-out proof o-rings, socket ends	
	Trim:	PVC conforming to CSA B137.0	
	Bolting:	--	
	Packing:	EPDM to CSA B137.0	
	Operator:	Tee handle	
	Temperature Range:	0 to 50°C (32 to 122°F)	
	Standard of Acceptance:	'Ipex' Type VK or 'Chemline' Type 21	
.3	Valve Code:		Check
	Size Range:	40 mm to 200 mm ($1^1/_2$" to 8")	
	Pressure Rating:	620 kPa (90 psi)	
	Body & Bonnet Mat'l:	PVC conforming to CSA B137.0	
	Valve Style:	Double leaf check valve, flanged	
	Trim:	PVC conforming to CSA B137.0	
	Bolting:	--	
	Packing:	EPDM to CSA B137.0	
	Operator:	--	
	Temperature Range:	0 to 40°C (32 to 104°F)	
	Standard of Acceptance:	'Chemline' Series TC	

2.4 Clearwell Sump Discharge

.1	Valve Code:		Solenoid Valve
	Size Range:	32 mm ($1^1/_4$")	
	Pressure Rating:	150 psi	
	Body & Bonnet Mat'l:	Brass	
	Valve Style:	Inline	

Connection:	Threaded
Operator:	Solenoid
Voltage:	120/1/60
Watt Rating:	6.1
Service:	Diesel, Light Oil
Standard of Acceptance:	ASCO 8210G008

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 the NBC.

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 Contract 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 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 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.

.3 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.

.4 High Temperature Exhaust: Formed rigid hydrous calcium silicate insulation, molded to conform to piping, “K” value maximum 0.42 Btu-in/(hr-ft^2-°F) at 200°F.

.5 Recovery Jackets:

.1 0.4 mm aluminium sheet for piping where specified.

.2 Solvent welded PVC with UV inhibitor.

.6 Recovery Jackets (High Temperature Exhaust only):

.1 20 ga. embossed aluminum sheet engine exhaust.

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 insulation throughout, including equipment rooms. 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% 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 High Temperature Exhaust: Tightly butt insulation with staggered joints secured with metal bands or wire. Cover fittings with equivalent thickness of insulation.

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
Condensate Drains	All sizes	19	Aluminum
Engine Exhaust, pipe, and muffler	All sizes	100	Aluminum

Note: Pipe insulation for piping installed in 38 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

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 Contract 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.

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 insulation throughout, including equipment rooms. 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 galvanized 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 galvanized steel with 24% 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
Supply Air Ducts (AHU-H222A only)	25	Aluminum

END OF SECTION

PUMPS

1. GENERAL

1.1 Scope

.1 All pumps except where integral with a manufactured piece of equipment.

.2 Pumps controls where self contained.

1.2 Submittals

.1 Submit with Shop Drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. IncludeNPSH curve when applicable. Show pump weights, motor and pump operating or efficiencies and electrical power characteristics.

1.3 Quality Assurance

.1 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

2.2 Sump Pump

.1 Type: Completely submersible centrifugal.

3. EXECUTION

3.1 Installation

.1 Provide air cock and drain connection on horizontal pump casings.

.2 Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 100 mm (4”) and over.

.3 Check and align pumps prior to start-up.

3.2 Performance

.1 Refer to the Pump Schedule.

END OF SECTION

PLUMBING GENERAL

1. GENERAL

1.1 Scope

.1 Cleanouts

.2 Storm and sanitary sewer service connections

.3 Water service connections

.4 Natural gas service connections

.5 Backflow preventers

.6 Vacuum breakers

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.

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.

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 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.

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

END OF SECTION

FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers

.2 Fire extinguisher 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 ULC and/or CSA approved.

.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 (Clearwell only): 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 (Generator Building only): 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 9.0 kg type only): surface type 16 gauge steel construction with 12 gauge fully opening door in adjustable frame, 5 mm (0.2”) 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.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Electric Unit Heaters.

.2 Related accessories and specialties.

1.2 Quality Assurance

.1 Terminal heat transfer units shall be the product of a manufacturer regularly engaged in the production of such units who issues complete catalogue data on such products.

1.3 Submittals

.1 Submit, in addition to Shop Drawings, a schedule of Electric Unit Heaters indicating location, size, and output provided.

2. PRODUCTS

2.1 General

.1 Factory apply baked primer coat on metal surfaces of enclosure or cabinet of unit heaters.

2.2 Electric Unit Heaters

.1 Casing: Phosphate coated steel and epoxy printed.

.2 Elements: tabular elements with overheat protection.

.3 Fan and Motor: Direct drive propeller type, statically and dynamically balanced, complete with permanently lubricated ball bearing motors.

.4 Air Outlet: Adjustable air flow louvers.

.5 Mounting: Complete with wall mounting bracket.

3. EXECUTION

3.1 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

AIR COOLED CONDENSING UNITS

1. GENERAL

1.1 Scope

.1 Air cooled refrigerant condensing unit package (two required):

.1 Supply and install two (2) separate cooling loops for air handling unit AHU-H222A.

.2 Each package will be a closed system and consist of a minimum of a roof top mounted condensing unit, refrigerant piping, accessories, controls, sensors, refrigerant, supports and stands.

.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.

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 galvanized 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 compressors 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 Refrigerant

.1 Refrigerant R-22 shall NOT be used.

.2 Refrigerant R-407 and R-410A may be used for the system.

2.6 Controls

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

3. EXECUTION

3.1 Installation

.1 Each condenser shall be securely mounted and supported on a 300 mm high equipment curb or galvanized metal stand.

.2 Each loop shall tie into one of two cooling coils located in the air handling unit.

3.2 Performance

.1 Refer to equipment schedules.

END OF SECTION

SPECIFICATION TITLE

1. GENERAL

1.1 Scope

.1 Heat Tape/Trace components, accessories and installation material for a complete operating system.

1.2 General Requirements

.1 Provide heat tape where indicated on Mechanical Drawings and specified herein.

.2 FM Approved constant wattage cable.

1.3 Submittals

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

.1 Manufacturer's data sheets on each product to be used including:

.1 Preparation instructions and recommendations.

.2 Storage and handling requirements and recommendations.

.3 Installation methods.

.2 Materials of construction: indicate material and wire gauge.

.3 Power consumption and required power supply.

2. PRODUCTS

2.1 Heat Tracing/Tape

.1 Parallel zone system, two conductor stranded copper bus wires covered with FEP Teflon or fluoropolymer inner insulation. Resistance heating cable connection to alternate bus wires covered with extruded FEP Teflon insulating jacket and a stainless steel braided overjacket.

.2 Heating capacity: 20 W/m (6 W/Ft)

.3 For use with 120 V power supply.

.4 Standard of Acceptance:

.1 Delta-Therm PF Series Catalog No. PF-6-SB

.2 Contact Information:

Delta-Therm Corporation
398 W. Liberty St. P. O. Box 345, Wauconda, IL 60084. ASD.
Toll Free Tel: (800) 526-7887.
Tel: (847) 526-2407.
Fax: (847) 526-4456.
Email: heat@delta-therm.com.
Web: http://www.delta-therm.com.

2.2 Controls

.1 Heat tracing shall turn on to prevent frost build up on the intake of the gravity hood for AHU-H242A.

.2 System shall be controlled via the Inlet Building main Controller.

.3 Heat tape will turn “on” when the O/A temperature sensor reads an air temperature between -5 to 5°C and turned “off” otherwise.

3. EXECUTION

3.1 Installation

.1 Follow Manufacturer’s installation instructions and guidelines for :

.1 General installation, set-up, and preparation of the heat trace and associated components

.2 Proper end termination of cable with proper termination kits

.3 Proper power and control connections

.2 Heat trace shall be installed directly on the bird screen of the intake gravity hood.

.3 Heat trace may be installed above (preferred) or below the screen with stainless steel clamps every 75 mm for the entire perimeter of the intake hood.

3.2 Quality Control

.1 Test continuity of heating cable.

.2 Perform insulation resistance (megger) test on each heater section before, during, and after pavement placement. Minimum acceptable megger reading shall be 10 megohms.

.3 Measure voltage and current at each unit after installation is complete.

.4 Submit written test report showing values measured on each test for each cable.

END OF SECTION

INDOOR PREMANUFACTURED AIR HANDLING UNITS

1. GENERAL

1.1 Scope

.1 Indoor air handling units, custom pre-manufactured type.

1.2 Quality Assurance

.1 It is the intent of this Specification that the Manufacturer provides 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 recognized 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.

.5 Fans shall be to AMCA standards, and bear AMCA “certified” seal.

.6 Coils shall be ARI certified, and bear ARI seal.

.7 Provide all motors with thermal overload protection. Provide thermisters in motor windings. All motors shall be high efficiency type and shall be inverter duty for use with VFD’s.

.8 Start-up of unit shall be executed by Manufacturer's personnel.

.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 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 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.

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

.7 Vibration isolator Shop Drawings.

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

.9 Damper Shop Drawings.

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

.11 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 fans complete with backdraft dampers

.2 Cooling coils

.3 Summer prefilter

.4 Winter prefilter frame

.5 Final filter

.6 Motorised outdoor air section

.7 Motorised return air section

.8 Access sections

2.2 Cabinet

.1 Exterior Panels: minimum 18 gauge satin coat galvanized steel with air-dried enamel finish.

.2 Walls and Ceilings: interlocking construction with at least two breaks at each interlocking joint. Wall and ceiling joints to be broken inward. All panel joints to be caulked. Casing depth to match the specified insulation thickness. Inside surfaces shall be clean and flush, free of exposed flanges.

.3 Base: 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 50 mm thick fibrous glass acoustic insulation, 48 kg/m³ (3 lb/ft^3) density. Line interior of all panels with 22 gauge perforated galvanized steel liner.

.2 Insulate underside of unit floor with 50 mm thick rigid fibrous glass insulation 48 kg/m³ (3 lb/ft^3) density. Hold in place insulation with welded pins 400 mm on centre.

2.3 Access Doors

.1 Provide hinged man sized access doors. Door construction to be the same as casing. Provide minimum two (2) ventlock latches per door openable from both sides. Door hinge to be continuous cadmium plated piano hinge with brass pin. Doors to be sealed with automotive type 13 mm closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame. (Neoprene or foam gaskets are not acceptable). Door sizes to be 750 x 1800 mm or as limited by height of unit. Provide access doors for the following sections:

.1 Fan section

.2 Cooling coil section

.3 Final filter section

.4 Prefilter section

.5 Mixing section

.6 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.

2.5 Drain Pans

.1 On units without stacked coils, provide a single fabricated 16 gauge galvanized 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 humidifier section. Provide a drain pan to drain the fresh air intake or mixing plenum. Pipe all drains to the exterior side of unit.

2.6 Fan

.1 Provide fans complete with motors and drives within the fan section of the AHU.

.2 Fans to be double width, forward curved centrifugal type. Fan to be both statically and dynamically balanced. Wheel shall be constructed of high strength steel, welded construction, with straight bored cast iron hub keyed and set screwed to a turned, ground and polished (TGP) solid steel shaft conforming to ASTM A-108 and QQ-S-637 for 1045 TGP rounds.

.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 VSD’s with matched motors, where scheduled.

.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. Use concrete filled inertia bases on all fans 19 kW (25 hp) and over.

.7 Provide OSHA/WCB safety screens (removable) around plug fans, at fan inlets, around all drives and belts.

2.7 Filters

.1 Refer to Section 15865 – Air Filters, for detailed filter specifications.

.2 Summer Prefilter: 50 mm pleated filter, average efficiency 25 to 30% on ASHRAE Test Standard 52-76. Non-woven cotton and synthetic fabric media. FARR 30/30.

.3 Winter Prefilter: Frame only.

.4 Mounting racks to be galvanized, to suit specified filter type.

.5 Limit filter velocity based on face area to less than 2.5 m/s (500 fpm).

.6 Provide one 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.

2.8 Coil Section

.1 Enclose coils in coil section with headers and U-bends fully contained within the casing.

.2 Extend coil supply and return header connections, 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 3.0 m/s (600 fpm).

2.9 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 Utilise damper sections which extend across unit width plane with maximum width not exceeding 1200 mm per section.

2.10 Dampers

.1 Low leakage type dampers.

.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, return and supply dampers shall be integral part of the AHUs and shall be supplied and installed by the AHU manufacturer at the factory.

.8 Damper operators shall be supplied by control subcontractor and installed by the AHU manufacturer at the factory, in accordance with instructions from control subcontractor.

2.11 Refrigeration/Electrical

.1 Refer to Section 15700 – Air Cooled Condensing Units for remote condenser specifications.

.2 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.

.3 Refrigeration piping and specialties:

.1 Refer to Section 15700 – Air Cooled Condensing Units.

3. EXECUTION

3.1 Assembly

.1 Units are to be one-piece construction.

.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 – Piping Insulation.

3.2 Air Handling Unit Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

GAS FIRED UNIT HEATERS

1. GENERAL

1.1 Scope

.1 Gas fired unit heaters.

1.2 Quality Assurance

.1 Conform to requirements of CGA, CSA, Provincial and Municipal Codes and be CSA listed.

1.3 Extended Warranty

.1 Provide ten year extended warranty on heat exchangers.

1.4 Submittals

.1 Provide Shop Drawings of unit heater, including controls wiring diagrams.

2. PRODUCTS

2.1 Type

.1 Provide self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, exchanger, gas burner and controls.

2.2 Construction

.1 Cabinet: Heavy gauge galvanized steel with baked enamel finish, easily removed and secured access doors, glass fibre insulation and reflective liner.

.2 Heat Exchanger: Aluminised steel of welded construction.

.3 Supply Fan: Centrifugal type rubber mounted with belt drive, adjustable variable pitch motor pulley, rubber isolated hinge mounted 1750 rev/min motor.

2.3 Burner

.1 Gas Burner:Sealed combustion type with direct from outdoors combustion air, equipped with combination gas valve and pressure regulator incorporating manual shut-off, pilot valve, automatic 100% shut-off and thermocouple pilot safety device.

.2 Gas Burner Safety Controls: Thermocouple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.

2.4 Burner Operating Controls

.1 Low voltage, adjustable room thermostat, controls burner operation to maintain room temperature setting.

.2 High limit control, with fixed stop at maximum permissible setting, de-energises burner on excessive bonnet temperature and energises burner when temperature drops to lower safer value.

.3 Control supply fan in accordance with bonnet temperatures and independent of burner controls. Include manual switch for continuous fan operation.

3. EXECUTION

3.1 Installation

.1 Unit shall be suspended from roof structure as recommended by Manufacturer.

3.2 Performance

.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 – General Mechanical Provisions.

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.

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% with no objectionable operating characteristics.

.4 Fan suppliers to provide replacement sheaves for balancing purposes. Sheaves of the wrong size will be returned to the supplier.

.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 VSD 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 in Section 15999 – List of Schedules VFD's as per Division 16 requirements.

.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 Section 15999 – List of Schedules.

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" wg) and velocities less than 10 m/s (2000 fpm).

.2 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.

2. PRODUCTS

2.1 Materials

.1 Ducts: galvanized steel lock forming quality, having galvanized 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 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.

3.2 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 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.

3.3 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.

.11 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.

.12 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.

.13 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.14 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.

.15 Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 4° convergence downstream.

.16 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.

.17 Weld all stainless steel ductwork and ensure a smooth finish on all interiors.

.18 Provide drains in fresh air sections with deep seal traps.

.19 Set plenum doors 150 mm above floor. Arrange door swings so that fan static holds door in closed position.

END OF SECTION

DUCT ACCESSORIES

1. GENERAL

1.1 Scope

.1 Duct Access doors

.2 Balancing Dampers

.3 Backdraft Dampers

.4 Flexible connections

1.2 Quality Assurance

.1 Access doors shall be ULC labelled.

.2 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

.3 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”) 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”), two hinges and two compression latches with outside and inside handles for sizes up to 600 x 1200 mm (24” x 48”) and an additional hinge for larger sizes.

2.2 Balancing Dampers

.1 Fabricate of galvanized 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 deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425 mm and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275 mm deep construct of single blade (butterfly) type.

.5 On rectangular ducts 300 to 400 mm deep construct of two opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425 mm 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”wg) class and on all dampers over 300 mm diameter fabricate with full blade-length shaft.

.8 Construct damper blades for medium and high pressure systems to block air passage 70% 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.

.13 Electronic Damper Operators:

.1 Proportional and 2 position actuator, spring return:

.1 Electronic direct coupled type which require no crankarm and linkage.

.2 Power supply: 120 VAC (or as indicated in Section 15999 – List of Schedules).

.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 Construct of minimum 1.3 mm aluminum channel frame.

.2 Construct of minimum 0.6 mm aluminum blades, complete with stiffeners along trailing edge. Fabricate single blade dampers for duct sizes to 240 mm, multiblade dampers for ducts greater than 240 mm.

.3 Provide full blade-length shafts complete with brass or nylon bearings.

.4 Provide neoprene anti-clatter blade strips on pivot side of blades.

.5 Construct blade connecting linkage of minimum 2.0 mm aluminum rod with eyelet, pin bearings, and adjustable counter weight to assist blade opening action.

.6 Maximum blade length of 750 mm.

.7 Backdraft damper suitable for 10 m/s face velocity.

2.4 Flexible Connections

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 150 mm (6”) wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150 mm (6”) intervals. Flexible connection airtight at 500 Pa (2” 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 Provide flexible connections between generator, radiator, and discharge plenum.

3. EXECUTION

3.1 Application

.1 Provide access door minimum 450 x 350 mm (18" x 14") or 50 mm (2") 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 side of all heating or cooling coils

.3 At all locations of internally duct mounted devices including automatic dampers, damper motors and control sensors and devices.

.2 At each point where ducts pass through fire separation duct shall be sealed with non-combustible material.

.3 Provide motorized dampers where indicated on Drawings comes with appropriately sized actuators.

.4 Provide balancing dampers at points on supply and exhaust systems where branches are taken from larger ducts as required for proper air balancing.

.5 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on Drawing.

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.

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) galvanized steel blades and frame. Provide welded assembly.

.3 Finish in factory baked enamel.

.4 See Equipment list in Section 15999 – List of Schedules.

2.3 Goosenecks

.1 Fabricate goosenecks of minimum 1.3 mm (18 gauge) galvanized steel.

.2 Mount on minimum 300 mm high curb base where size exceeds 225 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 in Section 15999 – List of Schedules.

END OF SECTION

AIR FILTERS

1. GENERAL

1.1 Scope

.1 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 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 galvanized 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 Pleated Filters

.1 Media: the filter shall be constructed of non-woven reinforced cotton rayon. A diamond grid with 98% 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% 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 in Section 15999 – List of Schedules.

END OF SECTION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ANSI: X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).

.2 ASHRAE:

.1 135, Data Communication Protocol for Building Automation and Control Networks.

.3 EIA:

.1 TIA-232-F, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

.2 485, Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.

.4 FM.

.5 ISO: 8802-3, Information Technology - Telecommunication and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Carrier Sense Multiple Access with Detection (CSMA/CD) Access Method and Physical Layer Specifications.

.6 NEMA: 250, Enclosures for Electrical Equipment (1,000 V Maximum).

.7 NFPA:

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

.8 UL: 916, Standard for Safety Energy Management Equipment.

.9 ULC.

.10 CSA.

.11 Canadian Electrical Code.

1.2 Definitions

.1 The terms “HVAC Control System”, “Automatic Temperature Control System”, “Building Automation System”, and “Environmental Management and Control System” shall be considered equivalent and used interchangeably for the purposes of this Contract.

.2 Algorithm: A software procedure for solving a recurrent mathematical or logical problem.

.3 Analog: A continuously varying signal or value (temperature, current, velocity, etc.).

.4 Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.

.5 Control Wiring:

.1 Includes necessary power wiring to HVAC control devices, digital controllers including terminal units and actuators.

.2 Wiring, high or low voltage other than power wiring required for proper operation of mechanical systems.

.3 Includes conduit, wire, and wiring devices to install complete control system including motor control circuits, interlocks, thermostats, PE and EP switches and like devices.

.4 Includes wiring from DDC cabinet to all sensors and controlled equipment indicated on Drawings and/or in the Points List summary or specified herein and required to execute sequence of operation.

.6 Control Process: Software required to complete control loop from input signal to interlock logic and process calculation to final output signal control.

.7 Deadband: Temperature range over which no heating or cooling energy is supplied, such as 22 to 25°C; as opposed to single point changeover or overlap, or a range from set point over which no control action is taken.

.8 DDC: Consists of microprocessor-based controllers with control logic performed by software. Analog-to-digital (A/D) converters transform analog values into digital signals that microprocessor can use.

.9 Power Wiring: Line voltage wiring to mechanical equipment. Line voltage wiring that also serves as control circuit, such as line voltage thermostat or involves interlocking with damper shall be considered control wiring.

.10 Abbreviations that may be used in this Section:

.1 AC: Air Conditioning.

.2 ATC: Automatic Temperature Control.

.3 BAS: Building Automation System.

.4 CMOS: Complementary Metal Oxide Semiconductor.

.5 DDC: Direct Digital Control.

.6 DX: Direct Expansion.

.7 EP: Electro-Pneumatic

.8 EEPROM: Electronic Erasable Programmable Read Only Memory.

.9 EMCS: Environmental Management and Control System.

.10 HCP: HVAC Control Panel.

.11 HMI: Human-Machine Interface.

.12 HOA: Hand-Off-Auto (Switch).

.13 HVAC: Heating, Ventilation, and Air Conditioning.

.14 IP: Current (I) - Pressure (P), as in IP transducer.

.15 LCD: Liquid Crystal Display.

.16 LED: Light Emitting Diode.

.17 PE: Pneumatic-Electric

.18 PLC: Programmable Logic Controller.

.19 RAM: Random Access Memory.

.20 RTD: Resistance Temperature Detectors.

.21 VAV: Variable Air Volume.

.22 W3: Nonpotable Water.

1.3 System Description

.1 General Requirements:

.1 Supply and Install control wiring, power wiring, conduit, hardware, and electrical work associated with the HVAC control system.

.2 Supply and Install control wiring between HVAC control panel contacts and field control devices, such as dampers and motor starter control coil contacts.

.3 Supply and Install controls necessary for entire system to have fail-safe operation.

.4 Control sequences and functions including alarms, monitoring and resetting functions, and operational sequences shall not be limited to point schedules and sequences of operation.

.5 Provide sequences and functions as required to deliver a fully functioning HVAC system.

.2 Control System Type:

.1 The control system used in this Project shall be:

.1 Networked DDC Control System (NETWORKED DDC):

.2 Microprocessor-based DDC Control System utilizing standalone DDC controllers.

.3 Information within control system can be utilized by any control component over high-speed network.

.4 User interface via computer workstation and/or portable terminal.

.3 Performance Requirements: Design control system and equipment to perform under the following conditions:

.1 Temperature, Ambient:

.1 Summer maximum 32 DB/22 WB °C.

.2 Winter minimum -35 DB °C.

.3 Based on ASHRAE Handbook Fundamentals weather data for the City of Winnipeg, Manitoba.

.2 Temperature, Indoor:

.1 Heated and Ventilated Process Areas: Summer maximum 39°C; Winter minimum 10°C.

1.4 Submittals

.1 Submittals:

.1 Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.

.2 Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 280 x 432 mm.

.3 Complete Drawings and schematics of proposed control system, including panel power requirements.

.4 System operating sequences to be programmed, in exact English language.

.5 Complete points list.

.6 Interfaces with HVAC equipment.

.1 Schematic diagram of each equipment item.

.2 Indicate location of each control item in equipment.

.3 Show equipment manufacturer controls where installed.

.7 Panel face layout drawings.

.8 Damper actuator sizing calculations, in schedule form.

.9 Automatic control valve sizing calculations, in schedule form.

.2 Information Submittals:

.1 Table identifying which member of Contractor's team is responsible for furnishing and setting in-place power wiring and control wiring of each item or component of HVAC equipment.

.2 Recommended procedures for protection and handling of equipment and materials prior to installation.

.3 Certificates:

.1 Manufacturer's Certificate of Compliance.

.2 Manufacturer's Certificate of Proper Installation.

.4 Draft maintenance agreement.

.5 Confirmation that Subcontractor has received, and coordinated with all approved HVAC equipment submittals.

.6 Experience and qualifications of Subcontractor's proposed representative who will supervise installation, adjustment, and calibration of control systems.

.7 Performance test plan and schedule.

.8 Test Results:

.1 Functional and performance test documentation.

.2 Component calibration sheets for each instrument and panel component.

.9 O&M data: In accordance with Section 01730 – Operation and Maintenance Data. In addition, include the following detailed information:

.1 O&M instructions for control system as furnished and installed, including control of associated mechanical and electrical equipment.

.2 Record of system adjustments and calibration methods.

.3 Performance test results.

1.5 Quality Assurance

.1 Materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards of UL, ULC, and CSA.

.2 Codes and Standards: Meet requirements of applicable standards and codes, except when more detailed or stringent requirements are indicated by Contract Documents, including requirements of this Section.

.1 UL: Products shall be UL 916-PAZX listed and ULC listed.

.2 Networked DDC Control Systems shall comply with ASHRAE 135 (BACnet).

.3 Qualifications of HVAC Controls System Subcontractor:

.1 Minimum of fifteen (15) years' experience in design, installation, and maintenance of fully electronic building automation systems.

.2 Minimum of ten (10) years' experience in design, installation, and maintenance of computer based, direct digital control, facility automation systems.

.3 Minimum of five (5) years' experience as Manufacturer's authorized representative in design, installation, and maintenance of Manufacturer's system and products.

.4 Capable of furnishing factory-trained technicians, competent to provide instruction, routine maintenance, and emergency service onsite within 4 hours after receipt of request.

.5 Factory trained certified engineering and commissioning staff, and complete offsite training facilities.

.6 Necessary facilities to provide City with complete maintenance, periodic inspection, and service contract. Refer to Paragraph, MAINTENANCE.

.4 Compatibility:

.1 System shall have documented history of compatibility by design for minimum of fifteen (15) years. Future compatibility shall be supported for no less than ten (10) years.

.2 Compatibility shall be defined as:

.1 Ability to upgrade existing field panels to current level of technology, and extend new field panels on previously installed network.

.2 Ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers, or protocol converters.

1.6 Delivery, Storage, and Handling

.1 Corrosion Protection:

.1 Control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through use of corrosion-inhibiting vapour capsules.

.2 Prior to shipment, capsules shall be provided within shipping containers and equipment as recommended by capsule Manufacturer.

.3 During construction period, capsules shall be replaced in accordance with capsule Manufacturer's recommendations.

1.7 Maintenance

.1 Maintenance Service Agreement:

.1 Furnish a draft maintenance agreement, prepared and signed by the Controls Supplier, to provide the necessary preventive maintenance to keep the various control systems in proper working condition.

.2 Fully describe the maintenance work to be performed and estimate cost of the maintenance during the one (1) year correction period and the subsequent year.

.3 This service contract shall include twenty four (24) hour emergency service, seven (7) days per week.

2. PRODUCTS

2.1 Manufacturers

.1 Materials, equipment, and accessories specified shall be products of the following manufacturers, unless indicated otherwise:

.1 Landis Division of Siemens Building Technology, Inc.

.2 Johnson Controls.

.3 Honeywell.

2.2 Materials

.1 General:

.1 Products used in this installation shall be new, currently under manufacture, and shall have been applied in similar installations for minimum of two (2) years.

.2 System shall not be used as test site for new products, unless explicitly approved by Contract Administrator's representative, in writing.

.2 Control Components:

.1 Control the equipment to operate within the specified range to obtain specified capacities.

.2 Sensitivity to maintain control points close enough to set point for acceptable offset, without cycling equipment more frequently than recommended by Manufacturer.

.3 Field or computer adjustable to actual set point ranges. Adjustable to other settings that will provide proper operation of entire control system.

.3 Controls Interfacing:

.1 Interface controls properly with factory supplied components of mechanical systems. Coordinate special control interfacing requirements.

.2 For equipment that requires special interfacing with control system, provide equipment with integral controls or provide accessory devices required for operation of total mechanical system.

.3 Coordinate interfaces with electrical work as necessary.

.4 Provide electric, electronic, and mechanical devices as required to properly interface with prewired control panels furnished with HVAC equipment and with other mechanical and electrical components.

2.3 Labelling

.1 All products, namely electrical materials, devices, appliances, and equipment used, shall be indicated as acceptable by established standards of UL, ULC, FM, and CSA.

.2 Valid label affixed to item shall provide indication of product acceptance by required agencies.

.3 HVAC control panels and control components that consist of multiple components shall bear UL, ULC, and CSA listing mark on unit.

2.4 Service Conditions

.1 Refer to Section 01600 – Material and Equipment, Division 16 – Electrical Requirements, and Electrical Drawings for classification of areas as hazardous, corrosive, wet, indoor dry, and dust-tight.

.2 Use materials and methods, and enclose devices in NEMA enclosure types suitable for classification indicated, and as required by Canadian Electrical Code.

.3 Exhaust ductwork shall be considered same classification as area served.

.4 Instruments within 900 mm of ducts conveying air from spaces classified as Class I, Division 1 or 2 (in accordance with the Canadian Electrical Code) shall be suitable for same area classification as space exhausted.

2.5 Electrical Components and Accessories

.1 Electrical components shall be provided in accordance with requirements of Division 16, Electrical.

2.6 Field Components and Instruments

.1 Refer to HVAC controls detailed specification, Section 15901 – HVAC Controls, Field Components, and Instruments.

2.7 Microelectronic Control Components

.1 Refer to HVAC controls detailed specification, Section 15902 – Microelectronic Control Components.

2.8 Accessories

.1 Corrosion-inhibiting vapour capsules as manufactured by:

.1 Northern Instruments; Model Zerust VC.

.2 Hoffman; Model A-HCI

.2 Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 45 kg.

.3 Equipment Identification Plates:

.1 Provide 16 gauge stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 6 mm high engraved block type equipment identification number and letters indicated in this Specification and as shown.

.2 Provide adjacent to the following control devices, and for equipment whose function is not readily apparent.

.1 Night low limit thermostats

.2 Manual override timers

.3 START/STOP switches

.4 Emergency STOP switches

.5 Special purpose devices

.6 HVAC control panels

2.9 Equipment Finish

.1 Provide materials and equipment with Manufacturer's standard finish system. Provide Manufacturer's standard finish color, except where specific color is indicated.

.2 If Manufacturer has no standard color, provide gray finish as approved by the Contract Administrator.

3. EXECUTION

3.1 Sequences of Operation

.1 The Electrical Room:

.1 Cooling

.1 The AHU-H222A is equipped with an economizer section (outside air and return air dampers) to provide the first stage of cooling. When outside temperatures are below the indoor set point temp the outside air and return air dampers modulate to maintain space temperature at set point. The AHU is equipped with two (2) supply fans (primary and back-up duty) each fan has its own motor. Both fans are VFD controlled and normally operate together at the same speed. If one fan fails the other shall speed up to compensate. In addition the AHU is equipped with two (2) DX cooling coils and two (2) condensers CU-H224A & CU-H225A. Should

outside air temperatures rise above the indoor temp set point the AHU outside air damper shall close, the return air damper open and each condenser started in sequence to maintain space temp at set point. In the event that a fan or condenser fails an alarm shall be indicated on the BAS. The BAS shall modulate the speed of the exhaust fan EF-H226A via the VFD to maintain space static pressure at slightly positive (+0.05" wg).

.2 Heating:

.1 The BAS shall modulate the AHU outside and return air dampers and supply fan speeds in sequence to maintain space temp at set point. Separate heating only thermostats which operate the gas fired unit heaters, UH-H218A & UH-H218B, in the electrical room shall bring on the unit heaters in the event the AHU can not maintain space temp.

3.2 Generator room sequence of operation

.1 Cooling when diesel generators are on:

.1 When the BAS receives a signal that a generator has started the combustion air damper section shall open fully. This damper is a fail open damper, spring to open, (upon loss of power or control signal this damper fails open). The return dampers are also normally open. The exhaust and outside air dampers are normally closed.

.2 With the generator running, when the space temperature rises above set point, as sensed by a temperature sensor adjacent to the generator, each individual outside air and corresponding exhaust damper section opens in sequence. At the same time the return air dampers modulate closed. This sequence continues as space temperature rises until all outside air and exhaust dampers are open and the return dampers are fully closed. Note that O/A and Ex/A dampers do not modulate but are instead staged open/closed whereas the return air dampers modulate open/closed. When the generator is shut down, as sensed by the BAS the cool down sequence of operation is engaged, as follows.

.2 Cool Down Sequence, after generators are shut down:

.1 After the generator has been shut down there is residual heat that must be removed. To accomplish this, the BAS opens all O/A, Ex/A, and R/A dampers fully and turns on the corresponding roof mounted exhaust fan. The dampers and exhaust fan stay operating until space temp has returned to set point at which point the O/A and Ex/A dampers close, the R/A dampers open and the exhaust fan shuts off. Note that the exhaust fan is equipped with a 2 position (open/closed) isolation damper that is open when the fan is running and closed when not running.

.2 Each O/A, Ex/A, and R/A damper is equipped with end switches to signal the BAS if it is open or closed. In the event a damper fails, the next damper in sequence shall operate and an alarm shall be indicated on the BAS. The exhaust fan shall be equipped with a current sensing relay to provide operating status and alarm if out of range. In addition hi and low temperature alarm limits shall be programmed into the BAS.

.3 There shall be an independent BAS controller for each generator cooling loop (3 loops, 1 loop per generator). These controllers shall be networked together to share information. Provide one completely programmed spare controller ready to replace a defective one.

.3 Heating:

.1 Gas fired unit heaters c/w heating only T'Stats are used to maintain space temperature at the heating set point and operate independently of the BAS. Should space temperature drop below the T'Stat set point, whether or not the generators are operating, the heaters shall come on.

.4 Ventilation:

.1 The generator room is ventilated and cooled when the generators are off by means of a cooling only T'Stat, controlling a side wall propeller exhaust fan and outside air inlet damper. Upon a rise in space temp above T'Stat setting the O/A damper shall open, and the sidewall propeller fan shall start (after fan damper opens).

.2 Manual room ventilation can also be supplied temporarily via a wind-up timer, which upon turning, activates the exhaust fan and damper.

3.3 Installation

.1 General:

.1 Install systems and materials in accordance with Manufacturer's instructions, rough-in drawings, and equipment details.

.2 Changes in location or installation of control devices or equipment shall be approved by the Contract Administrator before proceeding with the Work.

.3 Mount devices requiring manual reset and all other user serviceable control devices in readily accessible locations.

.2 Wiring:

.1 General:

.1 Install electric wire, cable, fittings, and conduit associated with systems specified in this section, in accordance with requirements of Canadian Electrical Code.

.2 Install control and interlock wiring separate from power wiring.

.3 Number code or color code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.

.4 Provide wire markers on each conductor in panel and at load connections. Identify circuit with control wire number.

.5 Restrain wiring in control panels by plastic ties or ducts.

.6 Hinge wiring shall be secured at each end so that any bending or twisting will be around longitudinal axis of wire and bend area shall be protected with sleeve.

.7 Arrange wiring neatly, cut to length, and remove surplus wiring. Provide abrasion protection for any wire bundles that pass through holes or across edges of sheet metal.

.8 Use Manufacturer's recommended tool with proper sized anvil for crimp terminations. No more than two (2) wires may be terminated in single crimp lug and no more than two lugs may be installed on single screw terminal.

.9 Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

.10 Properly support and run wiring in a neat manner.

.11 Run wiring parallel or at right angles to building structure.

.2 Concealment:

.1 Generally conceal wiring from view, except in mechanical rooms and areas where other conduit and piping are exposed; install exposed wiring and conduit to be as unobtrusive as possible.

.2 Install line voltage control wiring, wiring exposed to view, surface-mounted wiring, and wiring concealed within walls in conduit, in accordance with Division 16, Electrical.

.3 Install exposed and concealed low voltage control wiring systems in conduit.

.4 Wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

.5 Conduit shall be sized to suit the number, type, and size of conductors as specified in Section 16120 – HV Power Cables & 8 KV Shielded Cable Terminations, and Section 16122 – Wires and Cable 0-1000V.

.3 End-User Accessible Control Components:

.1 Do not mark room thermostats.

.2 Mount user adjustable control components (room thermostats, humidistats, temperature sensors, humidity sensors, etc.) level and at 1500 mm above finished floor unless indicated otherwise on the Drawings.

.4 Control Valves:

.1 Verify correctness of installation.

.2 Verify proper control action.

.3 Adjust limit switch settings.

.4 Adjust opening and closing speeds, and travel stops.

.5 Stroke control valves by means of associated controller.

.5 Control Dampers:

.1 Verify correctness of installation.

.2 Verify proper control action.

.3 Adjust limit switch settings.

.4 Adjust opening and closing speeds, and travel stops.

.5 Stroke control dampers by means of associated control output.

.6 Adjustable Frequency Drives:

.1 Verify control wiring installed to adjustable frequency drive.

.2 Calibrate and adjust remote speed control loop and feedback loop.

.3 Verify control actions and interlocks.

.4 Adjust minimum and maximum speed settings.

.5 Ramp adjustable frequency drive by simulation of associated controller output.

.7 DDC Controllers:

.1 Verify control wiring for correctness.

.2 Verify power wiring.

.3 Calibrate and adjust manual and auto control actions of controllers.

.4 Tune control loop.

.5 Stroke associated final element through controller output.

.6 Verify set points and alarm functions.

3.4 Field Quality Control

.1 Performance and Functional Testing:

.1 Tests and certification shall be as specified in Section 01450 – Quality Control.

.2 HVAC controls interface with process control system shall be coordinated with the Work of Section 17600 – PLC I/O Index.

3.5 Manufacturer's Services

.1 Manufacturer's Representative: Present at site or classroom as designated by City for minimum person-days listed below, travel time excluded:

.1 Five (5) person-days for installation, assistance, and inspection.

.2 Five (5) person-days for functional and performance testing and Manufacturer's Certificate of Proper Installation.

.3 Five (5) person-days for prestartup classroom or site training.

.4 Five (5) person-days for equipment (generator) start-up.

.5 Five (5) person-days for post-startup training.

3.6 Training

.1 Provide training of City's personnel to enable them to operate HVAC equipment in available modes, to adjust set points, and to interpret alarm signals.

.2 Training sessions shall be prepared in advance, and arranged for clear, effective transfer of information in minimum time.

3.7 Adjusting and Calibrating

.1 Control system shall be adjusted and calibrated by qualified Manufacturer's Representative.

.2 Calibrate control devices at time of installation to ensure measuring and reading accuracy.

.3 Adjustment Record:

.1 Prepare complete record of system adjustments for each control system.

.2 Indicate deviations from specified temperatures.

.3 Include copy of completed record in each copy of O&M Manual.

3.8 Cleaning and Touch-up Painting

.1 Touch-up scratches, scrapes, or chips in exterior surfaces with finish matching type, colour, consistency, and type of surface of original finish.

END OF SECTION

1. GENERAL

1.1 General

.1 This section is supplemental to Section 15900 – HVAC Instrumentation and Controls - General.

.2 The requirements of this Section shall be met in addition to those listed in Section 15900 – HVAC Instrumentation and Controls – General and Section 15902 – Microelectronic Field Components.

2. PRODUCTS

2.1 Control Dampers

.1 General:

.1 Specification applies to control dampers, except those specified to be furnished with equipment.

.2 Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

.2 High Performance Control Dampers (M):

.1 Frame: Frame: 127 x 25 mm by minimum 3.2 mm 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.

.2 Blades:

.1 Style: Airfoil-shaped, single-piece.

.2 Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.

.3 Material: Heavy duty 6063-T5 extruded aluminum.

.4 Width: Nominal 152 mm.

.3 Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

.4 Seals:

.1 Blade Seals: Extruded neoprene type for ultra-low leakage from -58 to 135°C. Mechanically attached to blade edge.

.2 Jamb Seals: Flexible metal compression type.

.5 Linkage: Concealed in frame.

.6 Axles:

.1 Minimum 13 mm diameter, hex-shaped, mechanically attached to blade.

.2 Material: Plated steel.

.7 Performance Data: As follows:

.1 Temperature Rating: Withstand -58 to 135°C.

.2 Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.

.3 Closed Position: Maximum pressure of 3.2 kPa at 305 mm blade length.

.4 Open Position: Maximum air velocity of 1,829 m/minute.

.5 Leakage: Maximum $0.6 m^3/minute/m^2$ at 1 kPa for size 1219 x 1219 mm.

.6 Pressure Drop: Maximum 0.01 kPa at 457 m/minute across 610 x 610 mm damper.

.8 Manufacturers and Products:

.1 Ruskin; Model CD-50.

.2 American Warming and Ventilating.

.3 TAMCO.

2.2 Control Damper Operators

.1 General:

.1 Select actual quantity of motors required to operate each damper in accordance with size of damper provided.

.2 Coordinate exact quantity of damper motors with electrical work to ensure that necessary wiring and conduit is provided for installation.

.3 Provide operators for motorized dampers and motorized louvers.

.2 Electric Damper Operators:

.1 Refer to Motorized Damper Schedule.

.2 Mounting: External side plate.

.3 Ample power and torque to overcome friction of damper linkage and air pressure acting on damper blades.

.4 Furnished with external adjustable stops to limit stroke and end switches to indicate open or closed feed back.

.5 Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.

.6 Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure or power failure, unless indicated otherwise.

.7 Operating Torque:

.1 Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120% of operating torque required by damper(s).

.2 Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 200 Pa air pressure on damper blades:

.1 Opposed-Blade Dampers: Minimum 6 Nm per square meter of damper area, unless higher values are recommended by damper Manufacturer.

.2 Parallel-Blade Dampers: Minimum 8.5 Nm per square meter of damper area, unless higher values are recommended by damper Manufacturer.

.8 Manufacturers:

.1 Belimo

.2 Neptronic

.3 Siemens Building Technologies

.4 Johnson Controls

.5 Honeywell

2.3 Electric Thermostats (TE)

.1 Modulating electric type, except where two-position action is required.

.2 Temperature Scale: Furnish 10 to 32°C dial.

.3 External adjustments.

.4 Adjustable sensitivity.

.5 Nonlocking cover.

.6 Insulating back where exterior wall mounting is indicated.

2.4 Electronic Sensors

.1 Temperature (TT):

.1 General Requirements:

.1 Sensors and transmitters shall be provided, as outlined in input/output summary and sequence of operations.

.2 Temperature sensor shall be resistance type, and shall be either two-wire 1,000-ohm nickel RTD or two-wire 1,000-ohm platinum RTD.

.3 The following point types (and accuracy of each) are required, and their associated accuracy values include errors associated with sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Room Temperature	± 0.3°C.
Duct Temperature	± 0.3°C.
All Others	± 0.4°C.

.2 Room Temperature (TT-1):

.1 Constructed for either surface or wall box mounting.

.2 Nonlocking wire protective guards for room temperature sensors installed in process areas.

.3 Shall have the following options when specified:

.1 Set point reset slide switch providing plus or minus 1.7°C (adjustable) range.

.2 Individual heating/cooling set point slide switches.

.3 Momentary override request pushbutton for activation of after-hours operation.

.4 Analog thermometer.

.3 Room Temperature Sensors with Integral Display (TS-2):

.1 Constructed for either surface or wall box mounting.

.2 Nonlocking wire protective guards for room temperature sensors installed in process areas.

.3 Integral LCD display and four button keypad with the following capabilities:

.1 Display room and outside air temperatures.

.2 Display and adjust room comfort set point.

.3 Display and adjust fan operation status.

.4 Timed override request pushbutton with LED status for activation of after-hours operation.

.5 Display controller mode.

.6 Password selectable adjustment of set point and override modes.

.4 Duct Temperature (TT-3):

.1 Accuracy: Plus or minus 1 degree F.

.2 Range:

.1 Heating: 4 to 60°C.

.2 Cooling: minus 1 to 38°C.

.3 Element:

.1 Rigid insertion, 300 mm length, through sealed opening in center of duct.

.2 Averaging, for ducts or plenums with any dimension greater than 908 mm. Sealed opening in duct. Sensing element incorporated in copper capillary a minimum of 6.1 m long, serpentined across full area of airflow.

.5 Outdoor Temperature (TS-5):

.1 Accuracy: Plus or minus 0.5°C.

.2 Range: Minus 4 to 60°C.

.3 Cover: Weathertight, with sealed conduit connection and sun shield.

.2 Differential Pressure (DP-1):

.1 General:

.1 Temperature compensated.

.2 Vary output voltage with change in differential pressure. Voltage shall vary linearly from 0 to 10 VDC according to differential pressure between high and low pressure ports.

.3 Sensing range shall be suitable for application with linearity of 1.5% of full scale and offset of less than 1% of full scale.

.4 Capable of withstanding up to 150% of rated pressure without damage.

.5 Compatible with 14 V to 30 VDC supply voltage range.

.2 Duct Air Static Differential Pressure:

.1 MAMAC transmitter.

.2 Dwyer A302 duct probe.

.3 Install static pressure fittings for differential pressure sensors and switches at a right angle to the flow.

.3 Space Air Static Differential Pressure: MAMAC transmitter.

2.5 Miscellaneous Devices

.1 General:

.1 RTD to voltage (0 to 5 V) converters with zero span adjustments for use with analog inputs.

.2 Limited range thermistors are acceptable provided they sense expected range for point at specified accuracy with 0 to 5 V output.

.3 Auxiliary contacts in each motor starter, Work of Division 16, Electrical.

.4 START/STOP relay module for either momentary or maintained switch action as indicated.

.2 Pilot Relays:

.1 Plug-in type.

.2 Interchangeable.

.3 Mounted on a circuit board.

.4 Wired to numbered terminal strips.

.3 Motorized Step Controllers: Furnish with adjustable (from -17 to -12°C) deadband between heating and cooling functions.

.4 Manual Timer (MT):

.1 1 hour, SPST, 120 V, 20 A.

.2 Spring wound.

.3 HOLD feature to override the time clock during off-hour operation.

.4 Install on front cover of HVAC Control Panel.

.5 Manufacturers and products:

.1 Marktime

.2 Dayton

.3 Nutone

3. EXECUTION

3.1 Installation

.1 Control Dampers:

.1 Install at locations indicated on Drawings and in accordance with Manufacturer's instructions.

.2 Install square and free from racking with blades running horizontally.

.3 Operate opposed blade dampers from a power blade or drive axle.

.4 Bracing:

.1 Install for multiple section assemblies to support assembly weight and to hold against system pressure.

.2 Install at every horizontal and vertical mullion.

3.2 Damper Schedule

.1 See Section 15999 – List of Schedules for Control Damper Schedule.

END OF SECTION

1. GENERAL

1.1 General

.1 This Section is supplemental to Section 15900 – HVAC Instrumentation and Controls – General, and Section 15901 – HVAC Controls, Field Components, and Instruments.

.2 The requirements of this Section shall be provided in addition to those listed in Section 15900 – HVAC Instrumentation and Controls - General.

1.2 Definitions

.1 ASCII: ANSI X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).

.2 BACnet: ASHRAE 135, BACnet, Data Communication Protocol for Building Automation and Control Networks.

.3 Distributed Control: System whereby control processing is decentralized and independent of central computer. Control system is built up of standalone controllers. Single controller failure shall not impact more than one system.

.4 Ethernet: ISO/IEC 8802-3. The most common high performance peer-to-peer LAN protocol.

.5 Integration:

.1 Ability of control system components from different manufacturers to connect together and provide coordinated control via real-time data exchange through common communications data exchange protocol.

.2 Integration shall extend to operator's workstation software, which shall support user interaction with control system components.

.3 Methods of integration include industry standard protocols, such as: BACnet, LonMark/LonTalk, OLE for Process Control (OPC), or integrator interfaces between manufacturer's systems.

.6 Interoperability: Ability of equipment to communicate mutually.

.7 Input/Output (I/O): Connections between computer and sensors and actuators.

.8 Human-Machine Interface (HMI): Method by which operator communicates with HVAC Control System. Allows operator to command, monitor, and program control system.

.9 Internet Protocol (IP): Network layer protocol originally created by Defense Advanced Research Project Agency to facilitate data communication between U.S. Defense Department and defense contractors, including universities and manufacturers

.10 Local Area Network (LAN): Network in which devices can communicate directly without going through intervening routers. LANs commonly used by DDC system Suppliers include Ethernet (ISO 8802-3), ARCNET, Echelon LonTalk, and EIA 485.

.11 Master-Slave/Token-Passing (MS/TP): One of the data link layers created specifically for use with BACnet messages.

.12 Network:

.1 System of distributed control units that are linked together on communication highway.

.2 Allows sharing of point information between control units.

.3 Provides central monitoring and control of entire system from any distributed control unit location.

.4 Primary networks provide peer-to-peer communications.

.5 Secondary networks provide either peer-to-peer, master-slave, or supervised token-passing communications.

.13 Peripheral: I/O equipment used to communicate with computer and make copies of system outputs. Peripherals include CRT, printer, tape deck, diskette.

.14 PID (Proportional, Integral, Derivative) Control Loop: Mathematical calculation used to evaluate control input and determine control output value required to maintain input value at set point. Shall have operator adjustable maximum rate of change, P and D gains, and loop response time delay. Loop shall be self-integrating so no integral constant is required and not be subject to integral windup.

.15 Transmission Control Protocol (TCP): Connection-oriented protocol used to convey multiple related messages (e.g., file transfers, Web pages, etc.).

.16 Abbreviations that may be used in this Section:

.1 BIOS: Basic Input Output System.

.2 DDC: Direct Digital Control.

.3 IBM: International Business Machines, Inc.

.4 LCD: Liquid Crystal Display.

.5 PC: Personal Computer.

.6 P&ID: Process and Instrumentation Diagram.

.7 PI: Pressure Indicator.

1.3 Quality Assurance

.1 Compatibility:

.1 System shall have documented history of compatibility by design for minimum of fifteen (15) years.

.2 Future compatibility shall be supported for no less than ten (10) years.

.3 Compatibility shall be defined as:

.1 Ability to upgrade existing microelectronic controllers to current level of technology, and extend new microelectronic controllers on previously installed network.

.2 Ability for any existing microelectronic controller microprocessor to be connected and directly communicate with new microelectronic controllers without bridges, routers, or protocol converters.

1.4 System Performance

.1 System shall conform to the following performance standards:

.1 Graphic Display:

.1 Minimum of 20 dynamic points.

.2 Current data displayed within 20 seconds of request.

.2 Graphic Refresh: System shall update dynamic points with current data within 30 seconds.

.3 Object Command:

.1 Maximum time between command of binary object by operator and reaction by device shall be 10 seconds.

.2 Analog objects shall start to adjust within 10 seconds.

.4 Object Scan: Changes of state and change of analog values shall be transmitted over high-speed network such that any data used or displayed at controller or workstation will be current, within prior 60 seconds.

.5 Alarm Response Time: Maximum time from when object goes into alarm to when it is annunciated at workstation shall not exceed 45 seconds.

.6 Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.

.7 Performance: Programmable Controllers shall be able to execute DDC PID control loops at selectable frequency from at least once every 5 seconds. Controller shall scan and update process value and output generated by this calculation at this same frequency.

.8 Multiple Alarm Annunciation: Workstations on network shall receive alarms within 5 seconds of each other.

.9 Reporting Accuracy: Table 1 lists minimum acceptable reporting accuracies for values reported by specified system.

Table I -- Reporting Accuracy

Measured Variable	Reported Accuracy
Space temperature	±0.5°C
Ducted air temperature	±1.0°C
Outside air temperature	±1.0°C
Water temperature	±0.5°C
Delta-T	±0.15°C
Relative humidity	±5% RH
Water flow	±5% of full scale
Air flow (terminal)	±10% of reading *Note 1
Air flow (measuring stations)	±5% of reading
Air pressure (ducts)	±25 Pa
Air pressure (space)	±3 Pa
Water pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM
Note 1: (10%-100% of scale) (cannot read accurately below 10%)	
Note 2: for both absolute and differential pressure	
Note 3: not including utility supplied meters	

2. PRODUCTS

2.1 Network Communication

.1 Control products for Networked DDC Control System shall comprise an interoperable network, a BACnet network. PC Workstations and Building Controller components shall meet ASHRAE 135, BACnet.

.2 Operator Workstations and Building Controllers shall be installed on a primary high-speed peer-to-peer ISO 8802-3 Ethernet network.

.3 Custom Application Controllers and Application Specific Controllers may be installed on either primary high-speed peer-to-peer ISO 8802-3 Ethernet network, or Secondary network.

.4 Provide all communication media, connectors, repeaters, hubs, and routers necessary for network.

.5 Building Controllers shall have communications port for connections with operator interfaces using BACnet Data Link/Physical layer protocol.

.6 Provide device on network with minimum 28,000 baud modem that will allow remote operator interface using BACnet Data Link/Physical layer protocol. Modem shall allow for communication with controllers on this network as described below.

.7 Communications services over network shall result in operator interface and value passing that is transparent to network architecture as follows:

.1 Connection of operator interface device to any one controller on network shall allow operator to interface with other controllers as if that interface were directly connected to other controllers.

.2 Data, status information, reports, system software, custom programs for controllers shall be available for viewing and editing from any controller on network.

.3 Database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on network.

.4 This value passing shall be automatically performed by controller when reference to point name not located in that controller is entered into controller's database.

.5 Operator/installer shall not be required to set-up any communications services to perform network value passing.

.8 Time clocks in controllers shall be automatically synchronized daily.

2.2 Network Human-Machine Interface

.1 Operator Interface:

.1 Furnish PC based operator workstation.

.2 Workstation shall be able to access all information in system.

.3 Workstation shall reside on same high-speed network as building controllers, and shall also be able to dial into system.

.2 Communications:

.1 Workstation information access shall use BACnet Protocol.

.2 Communication shall use ISO 8802-3 (Ethernet).

.3 Remote communications shall use BACnet Point to Point Physical/Data Link Layer Protocol.

.3 Hardware: Each operator workstation shall consist of the following:

.1 Personal Computer:

.1 Furnish one (1) IBM compatible PC.

.2 Features:

.1 Monitor: 432 mm, minimum, SVGA.

.2 CPU: Intel Pentium 4, minimum, and operate at a minimum of 3.0 GHz.

.3 RAM: 512 Megabytes, minimum.

.4 Diskette Drive: One with 1.44 Megabytes capacity.

.5 Optical Drive: 48X speed, CD-ROM.

.6 Hard Drive: 80 GigaByte capacity, minimum, with maximum access time of 9.0 milliseconds.

.7 Mouse: Two button.

.3 Furnish required serial, parallel, and network communication ports, and cables for proper system operation.

.2 Modem:

.1 Auto-dial telephone modem and associated cables as required for communication to remote buildings, and workstations.

.2 Transmit at minimum of 56,000 baud, and communicate over voice-grade telephone lines.

.3 Printer:

.1 Each workstation shall have one printer, with tractor feed, and associated cables.

.2 Capable of minimum 160 characters per second operation and compatible with standard parallel or serial communications.

.3 Supply one box of minimum 2000 sheets of printer paper and 2 printer ribbons or cartridges.

.4 BACnet:

.1 Workstation shall use Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135, to communicate with BACnet objects in network.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.4 System Software:

.1 Operating System:

.1 Commercially available, concurrent multitasking.

.2 Support use of other common software applications that operate under DOS or Microsoft Windows.

.3 Acceptable operating systems are Windows 2000 or Windows XP**.**

.2 System Graphics:

.1 Operator workstation software shall be graphically oriented.

.2 System shall allow display of up to 10-graphic screens at once for comparison and monitoring of system status.

.3 Provide method for operator to easily move between graphic displays and change size and location of graphic displays on screen.

.4 Able to be modified while on line.

.5 Operator with proper password level shall be able to add, delete, or change dynamic points on graphic.

.6 Dynamic points shall include analog and binary values, dynamic text, static text, video and animation files.

.7 Ability to show animation of equipment.

.3 Custom Graphics:

.1 Created with use of commonly available graphics packages, such as PC Paint.

.2 Graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF, and JPEG.

.3 Graphics generation package shall also provide capability of capturing or converting graphics from other programs such as Designer, or AutoCAD.

.4 Graphics Library:

.1 Complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators.

.2 Include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork.

.3 File format compatible with graphics generation package program.

.5 Engineering Units:

.1 Allow for selection of desired engineering units (i.e., SI) in system.

.2 Unit selection shall be able to be customized by locality to select desired units for each measurement.

.3 Engineering units on this project shall be SI.

.5 System Applications. Each workstation shall provide operator interface and offline storage of system information. Provide the following applications at each workstation:

.1 Automatic System Database Save and Restore:

.1 Store on hard disk copy of current database of each building controller.

.2 Database shall be updated whenever change is made in any panel in system.

.3 Storage of data shall be automatic and not require operator intervention.

.4 In the event of database loss in building management panel, first workstation to detect loss shall automatically restore database for that panel.

.2 Manual Database Save and Restore:

.1 System operator with proper password clearance shall be able to archive database from any system panel and store on magnetic media.

.2 Operator shall also be able to clear panel database and manually initiate download of specified database to any panel in system.

.3 System Configuration:

.1 Workstation software shall provide graphical method of configuring system.

.2 User with proper security shall be able to add new devices and assign modems to devices.

.3 This shall allow for future system changes or additions.

.4 Online Help:

.1 Context sensitive to assist operator in operation and editing of system.

.2 Available for all applications and shall provide relevant data for that particular screen.

.3 Additional help information shall be available through use of hypertext.

.5 Security:

.1 Each operator shall be required to log on to system with user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator.

.2 System supervisor shall have ability to set passwords and security levels for other operators.

.3 Each operator password shall be able to restrict operators' access for viewing and/or changing each system application, full screen editor, and object.

.4 Each operator shall automatically be logged off system if no keyboard or mouse activity is detected.

.5 Auto logoff time shall be set per operator password.

.6 System security data shall be stored in encrypted format.

.6 System Diagnostics:

.1 System shall automatically monitor operation of workstations, printers, modems, network connections, building management panels, and controllers.

.2 Failure of any device shall be annunciated to operator.

.7 Alarm Processing:

.1 Any object in system shall be configurable to alarm in and out of normal state.

.2 Operator shall be able to configure alarm limits, warning limits, states, and reactions for each object in system.

.3 Alarm Reactions:

.1 Operator shall be able to determine what actions, if any, are to be taken, by object (or point), during alarm.

.2 Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics.

.3 Each of these actions shall be configurable by workstation and time of day.

.4 Object in alarm that has not been acknowledged within operator specified time period shall be rerouted to alternate operator specified alarm receipt device.

.4 Binary Alarms:

.1 Each binary object shall be set to alarm based on operator specified state.

.2 Capability to disable alarming when associated equipment is turned off or is being serviced.

.5 Analog Alarms:

.1 Each analog object shall have both high and low alarm limits and warning limits.

.2 Alarming must be able to be automatically and manually disabled.

.8 Trend Logs:

.1 Operator shall be able to define custom trend log for any data in system.

.2 This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable.

.3 Trends shall start based on the hour. Each trend shall accommodate up to 64 system objects.

.4 System operator with proper password shall be able to determine how many samples are stored in each trend.

.5 Trend Data:

.1 Sampled and stored on building controller panel, and archived on hard disk.

.2 Able to be viewed and printed from operator interface software.

.3 Storable in tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.

.9 Alarm and Event Log:

.1 Operator shall be able to view logged system alarms and events from any location in system.

.2 Events shall be listed chronologically.

.3 Operator with proper security level may acknowledge and clear alarms.

.4 All that have not been cleared by operator shall be archived to hard disk on workstation.

.10 Object and Property Status and Control:

.1 Provide method for operator with proper password protection to view, and edit if applicable, status of any object and property in system.

.2 Statuses shall be available by menu, on graphics, or through custom programs.

.11 Clock Synchronization:

.1 Real time clocks in building control panels and workstations shall be synchronized on command of operator.

.2 System shall also be able to automatically synchronize system clocks daily from any operator-designated device in system.

.3 System shall automatically adjust for daylight savings and standard time, if applicable.

.12 Reports and Logs:

.1 Reporting package shall allow operator to select, modify, or create reports.

.2 Each report shall be definable as to data content, format, interval, and date.

.3 Report data shall be archived on hard disk for historical reporting.

.4 Ability for operator to obtain real time logs of designated lists of objects.

.5 Reports and logs shall be stored on PC hard disk in format that is readily accessible by other standard software applications, including spreadsheets and word processing.

.6 Reports and logs shall be readily printed to system printer.

.7 Operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.

.8 Custom Reports:

.1 Capable for operator to easily define any system data into daily, weekly, monthly, or annual report.

.2 Time and date stamped, and shall contain report title and name of facility.

.9 Standard Reports: The following standard system reports shall be provided for this Project. Reports shall be readily customized to this Project by the City.

.1 Electrical Meter Report:

.1 Monthly report showing daily electrical consumption and peak electrical demand for each building meter.

.2 Annual (12 months) summary report showing monthly electrical consumption and peak demand for each meter.

.6 Workstation Applications Editor:

.1 General:

.1 Each PC workstation shall support full screen editing of system applications.

.2 Editor for each application at PC workstation.

.3 Applications shall be downloaded and executed at appropriate controller panels.

.4 Full screen editor for each type controller and application that shall allow operator with proper password to view and change configuration, name, control parameters, and system set points.

.2 Scheduling:

.1 Editor for scheduling application shall be provided at each workstation.

.2 Monthly calendar for each schedule.

.3 Exception schedules and holidays shall be shown clearly on calendar.

.4 Capable of allowing several related objects to follow a schedule.

.5 Advance and delay time for each object shall be adjustable from this master schedule.

.6 Operator with proper password level shall be able to modify schedule.

.7 Schedules shall be able to be easily copied between objects and/or dates.

.3 Equipment Coordination:

.1 Full screen editor shall allow equipment to be grouped for proper operation as specified in sequence of operations.

.4 Custom Application Programming:

.1 Provide tools to create, modify, and debug custom application programming.

.2 Operator shall be able to create, edit, and download custom programs at same time that other system applications are operating.

.3 System shall be fully operable while custom routines are edited, compiled, and downloaded.

.4 Programming language shall have the following features:

.1 English language oriented and based on syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, programming language can be graphically based using function blocks as long as blocks are available that directly provide functions listed below, and that custom or compound function blocks can be created.

.2 Full screen character editor/programming environment. Editor shall be cursor/mouse driven and allow user to insert, add, modify, and delete code from custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

.3 Allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

.4 Editor/programming environment shall have debugging/simulation capability that allows user to step through program and to observe intermediate values and results. Debugger shall also provide error messages for syntax and execution errors.

.5 Support conditional statements (if/then/else/else-if) using compound Boolean (and, or, and not) and/or relations (equal, less than, greater than, not equal) comparisons.

.6 Support floating point arithmetic using the following operators: +, -, /, x, square root, and xy.

.7 The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.

.8 Predefined variables that represent clock time, day of week, and date. Variables that provide interval timing shall also be available. Language shall allow for computations using these values.

.9 Ability to predefined variables representing status and results of System Software, and shall be able to enable, disable, and change values of BACnet objects in system.

.7 Portable Operator's Terminal:

.1 Provide one portable operator's terminal capable of accessing system data.

.2 Ability to connect to any point on system network or directly to any controller for programming, set-up, and troubleshooting.

.3 BACnet:

.1 Shall use Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135, to communicate with BACnet objects in network.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.4 IBM compatible notebook-style PC, including software and hardware required. PC shall contain at minimum:

.1 1.6 GHz Intel Pentium Processor.

.2 256 MB RAM.

.3 40 GB Hard Drive.

.4 88 mm, 1.44 MB, Floppy Disk Drive.

.5 40X CDROM Drive.

2.3 Networked DDC Controllers

.1 Controller Software:

.1 General:

.1 Provide applications software for building and energy management.

.2 Software applications shall reside and run in system controllers.

.3 Editing of applications shall occur at operator workstation.

.2 System Security:

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict user to only objects, applications, and system functions as assigned by system manager.

.3 User logon/logoff attempts shall be recorded.

.4 System shall protect itself from unauthorized use by automatically logging off following last keystroke. Delay time shall be user definable.

.3 Scheduling:

.1 General:

.1 Provide capability to schedule each object or group of objects in system.

.2 Each schedule shall include capability for start, stop, optimal start, optimal stop, and night economizer actions.

.3 Each schedule may consist of up to ten (10) events.

.4 When group of objects are scheduled together, provide capability to define advances and delays for each member.

.2 Weekly Schedule: Separate schedules for each day of the week.

.3 Exception Schedule:

.1 Ability for operator to designate any day of the year as an exception schedule.

.2 Shall override standard schedule for that day.

.3 May be defined up to a year in advance.

.4 Once executed, it will be discarded and replaced by standard schedule for that day of the week.

.4 Holiday Schedule:

.1 Capability for operator to define up to 99 special or holiday schedules.

.2 May be placed on scheduling calendar and repeated each year.

.3 Operator shall be able to define length of each holiday period.

.5 Optimal Start/Stop:

.1 Calculate thermal characteristics of zone and start equipment prior to occupancy to achieve desired space temperature at specified occupancy time.

.2 Algorithm shall calculate separate sets of heating and cooling rates for zones that have been unoccupied for less than and greater than twenty four (24) hours.

.3 Ability to modify start/stop algorithm based on outdoor air temperature.

.4 Early start limit in minutes to prevent system from starting before operator determined time limit.

.4 Alarm Reporting:

.1 Operator shall be able to determine action to be taken in event of alarm.

.2 Alarms shall be routed to appropriate workstations based on time and other conditions.

.3 Alarm shall be able to start programs, be logged in event log, printed, display custom messages or graphics.

.5 Remote Communications:

.1 Ability to dial out in event of alarm.

.2 Receivers shall include PC Workstations and alpha-numeric pagers.

.3 Alarm message shall include name of calling location, device that generated alarm, and alarm message itself.

.4 Operator shall be ably to remotely access and operate system using dial-up communications in same format and method used on site under paragraph, Operator Interface.

.6 Maintenance Management: System shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

.7 PID Control:

.1 Algorithm with direct or reverse action, and anti-wind-up.

.2 Algorithm shall calculate time-varying analog value used to position output or stage series of outputs.

.3 Controlled variable, set point, and PID gains shall be user-selectable.

.4 Set point shall optionally be chosen to be reset schedule.

.8 Staggered Start: Shall prevent controlled equipment from simultaneously restarting after power outage. Order that equipment (or groups of equipment) is started, along with time delay between starts shall be user-selectable.

.9 System Calculations:

.1 Software to allow instantaneous power (e.g. kW), flow rates in L/s to be accumulated and converted to energy usage data.

.2 Algorithm shall calculate the following:

.1 Sliding-window kW demand value.

.2 Energy usage and weather data (heating and cooling degree days).

.3 Items shall all be available for daily, previous day, monthly and previous month.

.10 Anti-Short Cycling: Binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

.2 Building Controllers:

.1 General:

.1 Performance:

.1 Provide adequate number of Building Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Manage global strategies described in Article Controller Software.

.3 Microprocessor based, capable of stand-alone operation, and shall continue to provide control functions without being connected to network.

.2 Sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Building Controllers.

.4 Operating system of Controller shall manage input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have real time clock.

.6 Continually check status of its processor and memory circuits. If abnormal operation is detected, controller shall:

.1 Assume predetermined failure mode.

.2 Generate alarm notification.

.7 BACnet**:**

.1 Building Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications.

.1 Each Building Controller shall reside on primary high-speed peer to peer BACnet network using the ISO 8802-3 (Ethernet) or ARCNET Data Link/Physical layer protocol.

.2 Each Building Controller shall also perform BACnet routing if connected to secondary network of Custom Application and Application Specific Controllers.

.3 Building Controller shall provide service communications port for connection to Portable Operators Terminal using point-to-point BACnet physical/data link layer protocol.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65°C.

.2 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50°C.

.4 Keypad:

.1 Local keypad and display shall be provided for each controller.

.2 Provided for interrogating and editing data.

.3 Optional system security password shall be available to prevent unauthorized use of keypad and display.

.4 If the Manufacturer does not provide keypad display, provide portable operator terminal.

.5 Serviceability: Provide diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.6 Memory: Building Controller shall maintain BIOS and programming information in event of power loss for at least seventy two (72) hours.

.7 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90 to 110% of nominal voltage rating and shall perform orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 m (3 ft).

.8 Transformer: Power supply for Controller shall be rated at minimum of 125% of maximum power consumption, and shall be fused or current limiting type.

.3 Custom Application Controllers:

.1 General:

.1 Performance:

.1 Provide adequate number of Custom Application Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Shall manage local strategies described in Article Controller Software.

.3 Microprocessor based, capable of standalone operation, and shall continue to provide control functions without being connected to network.

.2 Sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Controllers.

.4 Operating system of Controller shall manage input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have real-time clock.

.6 Continually check status of its processor and memory circuits. If abnormal operation is detected, Controller shall:

.1 Assume predetermined failure mode.

.2 Generate alarm notification.

.7 BACnet:

.1 Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications:

.1 Each Controller shall reside on secondary BACnet network using MS/TP EIA 485, Data Link/Physical layer protocol**.**

.2 Controller shall provide service communications port for connection to Portable Operator's Terminal using BACnet Data Link/Physical layer protocol.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65°C.

.2 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50°C.

.4 Keypad:

.1 Local keypad and display shall be provided for each controller.

.2 Provided for interrogating and editing data.

.3 Optional system security password shall be available to prevent unauthorized use of keypad and display.

.4 If the Manufacturer does not provide keypad display, provide portable operator terminal.

.5 Serviceability: Provide diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.6 Memory: Controller shall maintain BIOS and programming information in event of power loss for at least 72 hours.

.7 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90 to 110% of nominal voltage rating and shall perform orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 m.

.8 Transformer: Power supply for Controller shall be rated at minimum of 125% of maximum power consumption, and shall be fused or current limiting type.

.4 Application Specific Controllers:

.1 General:

.1 Performance:

.1 Provide number of Application Specific Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Microprocessor based, capable of standalone operation and shall continue to provide control functions without being connected to network.

.2 Contain sufficient I/O capacity to control target system.

.3 BACnet:

.1 Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications.

.1 Each Controller shall reside on secondary BACnet network using MS/TP EIA 485, Data Link/Physical layer protocol.

.2 Controller shall provide service communications port for connection to Portable Operators Terminal using BACnet Data Link/Physical layer protocol. Connection shall be extended to space temperature sensor where shown.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.4 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65°C.

.5 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50°C.

.3 Serviceability: Provide diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.4 Memory: Controller shall use nonvolatile memory and maintain BIOS and programming information in event of power loss.

.5 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90 to 110% of nominal voltage rating and shall perform orderly shutdown below 80% nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 m.

.6 Transformer: Power supply for Controller shall be rated at minimum of 125% of maximum power consumption and shall be fused or current limiting type.

.5 Controller I/O Interface:

.1 Hard-wired I/O may tie into system through Building, Custom, or Application Specific Controllers.

.2 Protected such that shorting of point to itself, another point, or ground will cause no damage to Controller.

.3 Protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to Controller.

.4 Binary Inputs:

.1 Shall allow monitoring of on/off signals from remote devices.

.2 Shall provide wetting current of at least 12 mA to be compatible with commonly available control devices.

.5 Pulse Accumulation Input Points: Conform to requirements of Binary Input points and accept up to 2 pulses/second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

.6 Analog Inputs:

.1 Allow monitoring of low voltage (0 to 10 VDC), current (4 to 20 mA), or resistance signals (thermistor, RTD).

.2 Compatible with and field configurable to commonly available sensing devices.

.7 Binary Outputs:

.1 Provide for on/off operation or pulsed low voltage signal for pulse width modulation control.

.2 Binary outputs on custom and building controllers shall have three-position (on/off/auto) override switches and status lights.

.3 Selectable for either normally-open or normally-closed operation.

.8 Analog Outputs:

.1 Shall provide a modulating signal for control of end devices.

.2 Shall provide either 0-10 VDC or 4 to 20 mA signal as required to provide proper control of output device.

.3 Building or custom programmable controllers shall have status lights and two-position (auto/manual) switch and manually adjustable potentiometer for manual override.

3. EXECUTION

3.1 General

.1 Refer to Section 15900 – HVAC Instrumentation and Controls - General for requirements.

END OF SECTION

CLEARWELL 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.

.4 This Section applies only to the Clearwell Inlet Building air-handling unit.

2. PRODUCTS (NOT USED)

3. EXECUTION

.1 Provide data base for all hardware points listed for system operation to meet Specification operating sequences.

4. CONTROL SEQUENCES

4.1 Air Handling Units (AHU-H242A)

.1 The AHU is a constant volume unit running continuously.

.2 System Start/Stop

.1 The air handling unit will normally be energized and de-energized via a stand-alone control unit. The fan shall stop if the freeze-stat indicates a low temperature condition in the AHU.

.3 Minimum Outdoor Damper Position

.1 The minimum outdoor damper position shall be fixed at 10% and shall modulate open in response to mixed air temperature.

.2 Upon supply fan being energized, the outdoor air damper opens to minimum position. A separate analogue output is provided from stand-alone control unit to set the position of the minimum outdoor air damper.

.4 Mix Air Control:

.1 Mix air dampers position shall be modulated to maintain mix air temperature at setpoint during free-cooling mode.

.2 Mix air dampers shall revert to a minimum outside air position (10%) and maximum return air positon (90%) as calculated via the stand-alone control unit during all other modes.

.5 Freeze-Stats

.1 Provide averaging type freeze-stat in each AHU at location indicated. Upon sensing a low temperature, the supply fan shall stop, and all outdoor and exhaust air dampers shall close. The freeze stat must be reset manually.

.2 During a cold start-up of the AHU the freeze-stat shall be bypassed for three (3) minutes to allow the AHU to warm-up.

.6 Heating Mode: When the space temperature drops below setpoint 16°C (61°F) the stand-alone control unit shall energize and modulate, via the SCR, the air handling unit electric heating coil. When the space temperature is satisfied the stand-alone control unit shall de-energize the air handling unit electric heating coil.

.7 Free-cooling Mode: When the outside air temperature permits the air handling unit shall operate on free-cooling mode. The stand-alone control unit shall modulate the outside air and return air damper to maintain a discharge temperature of 13°C (55°F). Free-cooling shall not be energized until the space temperature reaches 22°C (72°F).

.8 Summer/Winter Change Over:

.1 Summer/winter changeover shall be implemented by the AHU stand-alone control unit.

.2 When the outside air temperature is above 13°C (55°F) the system shall be in summer mode.

.3 When the outside air temperature is below 10°C (50°F) the system shall be in winter mode.

.9 Infrared Radiant Heater Control:

.1 The stand-alone control unit shall turn on the two Infrared Radiant Heaters IRH-1 and IRH-2, when the outdoor air temperature is between -5°C and 5°C.

.2 The Infrared Radiant Heaters shall be off at all other temperatures.

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) Subcontractor to test, adjust, and balance the 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 AHUs

.2 Exhaust Fans

.3 Diffusers, Registers and Grilles

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 AABC 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 thirty (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 10% 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 10% 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 Additional 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 thirty (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% of the total system is installed and again when 90% 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 (2) hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than 1°C (2°F) from the thermostat or control set point 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 10% 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

LIST OF SCHEDULES

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LIST OF SCHEDULES

3.1 Air Handling Unit Schedule

Tag	**AHU-H222A**	
Location	Mechanical Room	
Area Served	Electrical/Mechanical Room	
Type	Air Purification System	
Manufacturer	HAAKON	
Model		
Arrangement	Horizontally Mounted on concrete pad	
Supply Fan	2 Supply fans in system c/w 2 backdraft dampers and 2 motors	
Volume, L/s (cfm)	3540 (7500)	3540 (7500)
ESP, Pa (in.wg.)	935 (3.75)	935 (3.75)
Fan Type	BAF DW	BAF DW
Fan Speed, rpm	1750	1750
Motor Power, kW (hp) each	5.6 (7.5)	5.6 (7.5)
Power Supply	575/3/60	575/3/60
Minimum Outdoor Air, L/s (cfm)	434 (920)	
DX Coil	2 Cooling coils in system, separate circuits	
Size, H x L, mm	2@ 610x2290	
Media	R407 or R410	
Face Area, m^2 (ft^2)	2.8 (30)	
Rows	3	
Face Velocity, m/s (fpm)	2.54 (500)	
Air side P.D. Pa (in.wg.)	74.6 (0.3)	
EAT DB, ºC (°F)	24 (75)	
EAT WB, ºC (°F)	17.2 (63)	
LAT DB, ºC (°F)	16.3 (61.3)	
LAT WB, ºC (°F)	14 (57.2)	
Filter Section		
Type	Merv 7-2”	
Velocity m/s (fpm)	2.4 (469)	
size	8@ 610x610	
Physical Data		
Overall Length, mm	3355	
Overall Width, mm	2860	
Overall Height, mm	1615	
Overall Weight, kg	6350	
Accessories & Remarks	Motorized damper for outside air & return air, CU-H224A, CU-H225A will be connected to this system to provide cooling via DX coils. Each fan to be complete with separate motor.	

3.2 Exhaust Air Fan Schedule

Tag	EF-H226A	EF-H227A	EF-H228A
Function	Electrical Room Exhaust	Crawl Space Exhaust	Generator Room Exhaust For ventilation
Location	Mechanical Room Roof	Electrical Room Wall	Generator Room North Wall
Volume, L/s (cfm)	7080 (15000)	80 (170)	945 (2000)
E.S.P. Press, Pa (in.wg.)	250 (1)	125 (0.5)	125 (0.5)
Fan Speed, RPM	1568	1207	1010
Motor Power, kW (hp)	5.6 (7.5)	0.2 (0.25)	0.37 (0.50)
Power Supply (V/Ph/Hz)	575/3/60	115/1/60	208/3/60
Drive	Belt	Belt	Belt
Type	Vaneaxial Power Roof Exhaust	Centrifugal Inline Fan	Side Wall Propeller
Arrangement	Arrangement 9		
Manufacturer	Northern Blower	Greenheck	Greenheck
Model	Series 7400 Design 7412 size 2700	BSQ80-4	SB-2H24-5
Control	VFD	On/Off	On/Off
Accessories & Remarks	Steel Casing with Access Door, Mounting Curb Base, Windguard (C/W Hinged Motorized Damper, Weather Hood and inlet Screen, See schedule 1.9 VFD-H226B	Galvanized Steel Housing, Access Panel, Aluminium backdraft damper, Inlet and Discharge collars, Wall Mounting bracket	Steel housing, motor side guard, Motorized damper c/w aluminium guard and louver

3.2 Exhaust Air Fan Schedule (Continued)

Tag	EF-H229A	EF-H230A	EF-H231A
Function	Generator GN-E901A Exhaust	Generator GN-E902A Exhaust	Generator GN-E903A Exhaust
Location	Generator Room Roof	Generator Room Roof	Generator Room Roof
Volume, L/s (cfm)	3070 (6500)	3070 (6500)	3070 (6500)
E.S.P. Press, Pa (in.wg.)	125 (0.5)	125 (0.5)	125 (0.5)
Fan Speed, RPM	1541	1541	1541
Motor Power, kW (hp)	1.5 (2)	1.5 (2)	1.5 (2)
Power Supply (V/Ph/Hz)	575/3/60	575/3/60	575/3/60
Drive	Belt	Belt	Belt
Type	Vaneaxial Mushroom Roof Exhaust	Vaneaxial Mushroom Roof Exhaust	Vaneaxial Mushroom Roof Exhaust
Arrangement	Arrangement 9	Arrangement 9	Arrangement 9
Manufacturer	Northern Blower	Northern Blower	Northern Blower
Model	Series 7400 Design 7413 size 2000	Series 7400 Design 7413 size 2000	Series 7400 Design 7413 size 2000
Control	On/Off	On/Off	On/Off
Accessories & Remarks	Steel Casing with Access Door, Mounting Curb Base, Windguard (C/W Hinged Motorized Damper, Weather Hood and inlet Screen	Steel Casing with Access Door, Mounting Curb Base, Windguard (C/W Hinged Motorized Damper, Weather Hood and inlet Screen	Steel Casing with Access Door, Mounting Curb Base, Windguard (C/W Hinged Motorized Damper, Weather Hood and inlet Screen

3.3 Gas Fired Unit Heater Schedule

Tag	UH-H205A `	UH-H210A `	UH-H215A
Location	Generator Room	Generator Room	Generator Room
Gas Input, kW (MBH)	35.2 (120)	35.2 (120)	35.2 (120)
Heating Output, kW (MBH)	29.2 (99.6)	29.2 (99.6)	29.2 (99.6)
Thermal Efficiency (%)	83	83	83
Fan Type	Direct Drive	Direct Drive	Direct Drive
Fan Motor Power, kW (hp)	0.56 (0.75)	0.56 (0.75)	0.56 (0.75)
Fan Motor Power Supply, V/Ph/Hz	208/1/60	208/1/60	208/1/60
Maximum Discharge Air Temp. Rise, ^{o}C (^{o}F)	24 (75)	24 (75)	24 (75)
Minimum Discharge Air Temp. Rise, ^{o}C (^{o}F)	7 (45)	7 (45)	7 (45)
Maximum Air Volume l/s (cfm)	967 (2049)	967 (2049)	967 (2049)
Minimum Air Volume l/s (cfm)	580 (1230)	580 (1230)	580 (1230)
Maximum Velocity m/s (fpm)	5.2 (1020)	5.2 (1020)	5.2 (1020)
Minimum Velocity m/s (fpm)	3.1 (612)	3.1 (612)	3.1 (612)
Manufacturer	Reznor	Reznor	Reznor
Model No.	UDBS-125	UDBS-125	UDBS-125
Accessories & Remarks	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls

Notes:

1. All selections based on maximum 14” W.C. gas inlet pressure to appliance.

2. All units shall be complete with packaged wall mounted heating only thermostat.

3. All units shall be supplied c/w exhaust gas vent chimney and combustion air intake directly from outside.

1.3 Gas-Fired Unit Heater Schedule (Continued)

Tag	UH-H216A	UH-H217A	UH-H218A
Location	Generator Room	Generator Room	Electrical Room
Gas Input, kW (MBH)	35.2 (120)	35.2 (120)	30.8 (105)
Heating Output, kW (MBH)	29.2 (99.6)	29.2 (99.6)	25.6 (87.2)
Thermal Efficiency (%)	83	83	83
Fan Type	Direct Drive	Direct Drive	Direct Drive
Fan Motor Power, kW (hp)	0.56 (0.75)	0.56 (0.75)	0.56 (0.75)
Fan Motor Power Supply, V/Ph/Hz	208/1/60	208/1/60	208/1/60
Maximum Discharge Air Temp. Rise, ^{o}C (^{o}F)	24 (75)	24 (75)	24 (75)
Minimum Discharge Air Temp. Rise, ^{o}C (^{o}F)	7 (45)	7 (45)	7 (45)
Maximum Air Volume l/s (cfm)	967 (2049)	967 (2049)	846 (1793)
Minimum Air Volume l/s (cfm)	580 (1230)	580 (1230)	508 (1076)
Maximum Velocity m/s (fpm)	5.2 (1020)	5.2 (1020)	4.5 (892)
Minimum Velocity m/s (fpm)	3.1 (612)	3.1 (612)	2.7 (535)
Manufacturer	Reznor	Reznor	Reznor
Model No.	UDBS-125	UDBS-125	UDBS-100
Accessories & Remarks	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls

Notes:

1. All selections based on maximum 14” W.C. gas inlet pressure to appliance.
2. All units shall be complete with packaged wall mounted heating only thermostat.
3. All units shall be supplied c/w exhaust gas vent chimney and combustion air intake directly from outside.

3.3 Gas Fired Unit Heater Schedule (Continued)

Tag	UH-H219A
Location	Electrical Room
Gas Input, kW (MBH)	30.8 (105)
Heating Output, kW (MBH)	25.6 (87.2)
Thermal Efficiency (%)	83
Fan Type	Direct Drive
Fan Motor Power, kW (hp)	0.56 (0.75)
Fan Motor Power Supply, V/Ph/Hz	208/1/60
Maximum Discharge Air Temp. Rise, ^{o}C (^{o}F)	24 (75)
Minimum Discharge Air Temp. Rise, ^{o}C (^{o}F)	7 (45)
Maximum Air Volume l/s (cfm)	846 (1793)
Minimum Air Volume l/s (cfm)	508 (1076)
Maximum Velocity m/s (fpm)	4.5 (892)
Minimum Velocity m/s (fpm)	2.7 (535)
Manufacturer	Reznor
Model No.	UDBS-100
Accessories & Remarks	Sealed Junction Box, Fully Gasketed Door Panel with Safety Door Switch, Blower with Multispeed Taps and a Transformer for 24 Volt Controls

Notes: 1. All selections based on maximum 14” W.C. gas inlet pressure to appliance.

2. All units shall be complete with packaged wall mounted heating only thermostat.

3. All units shall be supplied c/w exhaust gas vent chimney and combustion air intake directly from outside.

3.4 Electric Unit Heater Schedule

Tag	UH-H219A
Location	Crawl Space
Type	Electric Forced Air
Capacity, kW (MBH)	5 (17.1)
Temp. Rise ºC (ºF)	22 (40)
Air Flow, L/s (cfm)	227 (480)
Motor Speed, RPM	1550
Motor Power, W (hp)	0.037 (0.05)
Power Supply, V/ph/Hz	600/3/60
Manufacturer	Reznor
Model	EGE
Accessories	Complete with: • Wall Bracket • Thermostat Kit (5°C to 38°C

3.5 Pump Schedule

Tag	SMP-H235A	SMP-H235B
Service	Sump System	Sump System
Location	Crawl Space Sump Pit	Crawl Space Sump Pit
Type	Submersible	Submersible
Impeller	Stainless Steel	Stainless Steel
Casing	Stainless Steel	Stainless Steel
Medium Pumped	Water	Water
Capacity, L/s (USgpm)	1.26 (20)	1.26 (20)
Total Head, kPa (ft wg.)	45 (15)	45 (15)
Maximum Operating Temp., ºC (ºF)	21 (70)	21 (70)
Pump Speed, RPM	1635	1635
Suction/Discharge Sizes, mm	50 female NPT	50 female NPT
Motor Power, kW (hp)	0.37 (0.5)	0.37 (0.5)
Power Supply, V/ph/Hz	115/1/60	115/1/60
Manufacturer	Groundfos	Groundfos
Model	AP12	AP12
Accessories & Remarks	Duplex Control Panel	

3.6 Air Cooled Condensing Unit Schedule

Tag	CU-H224A	CU-H225A
Service	Electrical/Mechanical	Electrical/Mechanical
Location	Mechanical Room Roof	Mechanical Room Roof
Manufacturer	Aaon	Aaon
Model	CA-10	CA-10
Capacity, kW (MBH)	38.2(130.3)	38.2(130.3)
Efficiency – EER (COP)	12.6 (3.7)	12.6 (3.7)
Number of Condensing Fans	1	1
Fan & Motor - RPM	1050	1050
Number of Compressor	2	2
Compressors Type	Scroll	Scroll
Refrigerant Type	R407 or R410	R407 or R410
Electrical Load - FLA/MCA/MOP	15.9/17.6/20	15.9/17.6/20
Electrical Supply (V/ph/Hz)	575/3/60	575/3/60
Unit Depth – mm (in)	1106 (43.5)	1106 (43.5)
Unit Length – mm (in)	1961 (77.2)	1961 (77.2)
Unit Width – mm (in)	1112 (43.75)	1112 (43.75)
Shipping Weight kg (lbs)	409 (902)	409 (902)
Accessories & Remarks	C/W hail guards	C/W hail guards

3.7 Diffusers Schedule

Tag	Manufacturer Model No.	Border/ Frame	Core	Module Size (mm)	Neck Size (mm)	Finish	Fastening	Options	Remarks
SA-1	E.H. Price 600	32 mm Frame		N/A	See Drawings	3	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

3.8 Louver Schedule

Tag	Manufacturer Model No.	Frame	Core	Size – mm (in) Width x Height	Cap. – l/s (cfm)	Vel. – m/s (fpm)	ΔP – Pa (in)	Frame Size	Finishes	Options
LV-A	CB605X	Drainable	Drainable	See Drawings	See Drawings	4.3 (850)	(0.15)	130 mm	1	1, 2,4,5
LV-B	CB605X	Drainable	Drainable	See Drawings	See Drawings	7.6 (1500)	(0.15)	130 mm	1	1, 2,4,5

Finishes: 1. PPG Duranar XL colour UC52061XL Concord Blue Metallic.

Options:
1. Extruded Aluminium
2. Aluminium insect screen
3. Aluminium bird screen
4. Continuous Blade
5. Nominal 53% free area

Notes:
1. LV-A louvers are for air intake into building.
2. LV-B louvers are for air exhaust out of building.
3. Louvers shall appear continuous from wall opening to wall opening. Refer to Mechanical Drawing WG-H0120 and Architectural Drawing WG-B0301.

3.9 Gravity Hood Schedule

Tag	GRH-H232A
Service	Relief
Location	Electrical Room
Volume – 1/s (cfm)	7080 (15000)
Static Press – Pa (inch wg)	99.5 (0.40)
Throat Size – mm (inch)	915x1220 (36x48)
Throat Area - m^2 (ft^2)	1.1 (12)
Curb Cap – mm (inch)	1120x1420 (44x56)
Hood Dimensions	
Width - mm (inch)	1475 (58)
Length - mm (inch)	1525 (60)
Height - mm (inch)	485 (19)
Manufacturer	Greenheck
Model No.	Fabra Hood FHR
Options	1, 2, 3, 4

Finishes:
1. Back draft damper
2. Roof curb
3. Galvanized steel bird screen
4. Fibreglass hood insulation

3.10 Variable Frequency Drive Schedule

Tag	VFD-H222C	VFD-H222D	VFD-H226B
Service	AHU-H222A	AHU-H222A	EF-H226A
Driven Motor, kW (hp)	7.5	7.5	7.5
Power Supply, V/ph/Hz	575/3/60	575/3/60	575/3/60
Manufacturer	See Division 16	See Division 16	See Division 16
Model No.	See Division 16	See Division 16	See Division 16

3.11 Motorized Damper Schedule

Tag	MD-H201A	MD-H206A	MD-H211A
Service	Generator Air Inlet	Generator Air Inlet	Generator Air Inlet
Location	Generator Room South Wall	Generator Room South Wall	Generator Room South Wall
Damper size mm (in)	1220x1220 (48x48)	1220x1220 (48x48)	1220x1220 (48x48)
Number of dampers	12	12	12
Model	9000 Series	9000 Series	9000 Series
Manufacturer	TAMCO	TAMCO	TAMCO
Actuator	Belimo AF120-S	Belimo AF120-S	Belimo AF120-S
Number of actuators	12	12	12
Accessories & Remarks	Outside air damper with 6 Horizontal Jackshafts for generator GN-E901A	Outside air damper with 6 Horizontal Jackshafts for generator GN-E902A	Outside air damper with 6 Horizontal Jackshafts for generator GN-E903A

Tag	MD-H202A	MD-H207A	MD-H212A
Service	Generator Air Return	Generator Air Return	Generator Air Return
Location	Generator Discharge Chamber Wall	Generator Discharge Chamber Wall	Generator Discharge Chamber Wall
Damper size mm (in)	1525x1220 (60x48)	1525x1220 (60x48)	1525x1220 (60x48)
Number of dampers	4	4	4
Model	9000 Series	9000 Series	9000 Series
Manufacturer	TAMCO	TAMCO	TAMCO
Actuator	Belimo AF120-S	Belimo AF120-S	Belimo AF120-S
Number of actuators	4	4	4
Accessories & Remarks	Return air damper for generator GN-E901A	Return air damper for generator GN-E902A	Return air damper for generator GN-E903A

1.11 Motorized Damper Schedule (Continued)

Tag	MD-H203A	MD-H208A	MD-H213A
Service	Generator Air Exhaust	Generator Air Exhaust	Generator Air Exhaust
Location	Generator Room North Wall	Generator Room North Wall	Generator Room North Wall
Damper size mm (in)	1525x1525 (60x60)	1525x1525 (60x60)	1525x1525 (60x60)
Number of dampers	4	4	4
Model	9000 Series	9000 Series	9000 Series
Manufacturer	TAMCO	TAMCO	TAMCO
Actuator	Belimo AF120-S	Belimo AF120-S	Belimo AF120-S
Number of actuators	4	4	4
Accessories & Remarks	Exhaust air damper for generator GN-E901A	Exhaust air damper for generator GN-E902A	Exhaust air damper for generator GN-E903A

Tag	MD-H220A
Service	Generator Air Inlet
Location	Generator Room South Wall @ Top of Door
Damper size mm (in)	915x610 (36x24)
Number of dampers	1
Model	9000 Series
Manufacturer	TAMCO
Actuator	Belimo AF120-S
Number of actuators	1
Accessories & Remarks	Outside air damper for generator room ventilation

3.12 Emergency Potable Eyewash Schedule

Tag	EEW-H238A	EEW-H238B	EEW-H238C
Service	Electrical Room	Electrical Room	Electrical Room
Location	Electrical Room	Electrical Room	Electrical Room
Type	Potable eye wash unit	Potable eye wash unit	Potable eye wash unit
Manufacturer	Haws	Haws	Haws
Model No.	7500EB	7500EB	7500EB
Accessories & Remarks	9082 bacterlostatic water preservative additive	9082 bacterlostatic water preservative additive	9082 bacterlostatic water preservative additive

3.13 Piping Transition Sump Schedule

Tag	PTS-H234A	PTS-H234B
Service	Feed to diesel fuel pump	Diesel fuel supply
Location	Generator Room	Between 2 Fuel Storage tanks
Type	Above-grade / below grade piping transition sump	Above-grade / below grade piping transition sump
Manufacturer	OPW Inc.	OPW Inc.
Model No.	PISCES PST 4630	PISCES PST 4630
Accessories & Remarks	Complete with: • Conical Seal Entry Fittings • Backfill Guards • Height Extender	Complete with: • Conical Seal Entry Fittings • Backfill Guards • Height Extender

2.1 Air Handling Unit Schedule

Tag	AHU-H242A
Location	Inlet Building
Area Served	Inlet Building
Type	In door
Manufacturer	McQuay
Model	CAH008FVAC
Supply Fan	
Tag	SF-1
Volume ***(cfm)****(L/S)*	(3700) (1750)
ESP ***(in.wg.)****(Pa)*	(1.00) (249)
Fan Type	Centrifugal
Fan Speed (rpm)	1087
Motor Power ***(HP)****(KW)*	(3.0) (2.2)
Power Supply	575/60/3
Return Fan	
Tag	
Volume ***(cfm)****(L/S)*	
ESP ***(in.wg.)****(Pa)*	
Fan Type	
Speed (rpm)	
Motor Power ***(HP)****(KW)*	
Power Supply	
Minimum Outdoor Air (cfm)	1000

2.1 Air Handling Unit Schedule (Continued)

Heating Section	
Type	Electric
Heating Output ***(MBH)****(KW)*	6.1
Temperature rise ***(°F)****(°C)*	49.5 (27.5)
DX Coil	
Tag	
Size, H x L ***(in)****(mm)*	
Face Area ***(ft²)****(m²)*	
Rows / FPI	
Face Velocity ***(fpm)****(m/s)*	
Air side P.D. ***(in.wg.)****(Pa)*	
Clg. Capacity ***(ton)****(KW)*	
EAT DB/WB ***(°F)****(°C)*	
LAT DB/WB ***(°F)****(°C)*	
Condensing Unit	
No. of Cond. Fans	
Cond. Fan Power ***(HP)****(KW)*	
No. of Compressors	
Power Supply	
Minimum Circuit Ampacity	69
Arrangement	
Supply Outlet	Top
Return Inlet	End
Outdoor Air Inlet	Top
Relief Air Outlet	-
Physical Data	
Overall Length ***(in)****(mm)*	188 (4775)
Overall Width ***(in)****(mm)*	58 (1473)
Overall Height ***(in)****(mm)*	34 (864)
Overall Weight ***(lb)****(kg)*	2015 (914)

2.2 Pump Schedule

Tag	P-T410A	P-T420A
Function	Weeping Tile Sump	Weeping Tile Sump
Location	Sump Pump Building	Sump Pump Building
Type	Submersible	Submersible
Impeller mm (in)	111 (4.37)	111 (4.37)
Casing	Stainless steel	Stainless steel
Medium Pumped	Seepage	Seepage
Design Pressure kPa (psi)	-	-
Maximum Operating Temp. ºC (ºF)	-	-
RPM	3450	3450
Design Flow Rate l/s (USgpm)	7.5 (119)	7.5 (119)
Discharge Head M (ft/pi)	9.8 (32)	9.8 (32)
Discharge Size mm (in.)	50 (2)	50 (2)
Motor Power kW (HP)	1.1 (1-1/2)	1.1 (1-1/2)
Power Supply (V/ph/Hz)	575/3/60	575/3/60
Manufacturer	Barnes	Barnes
Pump Model	2SEV-1552L	2SEV-1552L
Control Panel Model	DB-5035D	DB-5035D
Accessories	7.6 M power cord, Suspended mechanical float switch c/w bracket	7.6 M power cord, Suspended mechanical float switch c/w bracket

2.3 Grilles, Registers and Diffusers Schedule

Tag	**Manufacturer Model No.**	**Border /Frame**	**Core**	**Module Size (mm)**	**Neck Size (mm)**	**Finish**	**Fastening**	**Options**	**Remarks**
S-1	E.H. Price RCD series		Adjus-table	See Drwgs	See Drwgs	5	Counter-sunk screw		
R-1	E.H. Price 82 series		Egg-crate	See Drwgs	See Drwgs	2	Counter-sunk screw		

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

2.4 Louver 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
L-1	Airolite 638C1006X		Storm-proof	See Dwgs.	See Dwgs.	214 (700)	25 (.1)	Mtg angle	2	1,2
L-2	Airolite 609B6X		Storm-proof	See Dwgs.	See Dwgs.	245 (800)	25 (.1)	Mtg angle	2	1,2

Finishes: 1. Baked enamel 3. Duranar XL
2. Duranar 4. Match adjacent panelling

Options: 1. Formed metal sill 3. Aluminum bird screen
3. Aluminum insect screen 4. Removable access door

2.5 Gravity Hood Schedule

Tag	GRH-H232A
Service	Intake
Location	Inlet Building
Volume – 1/s (cfm)	1595 (3380)
Static Press – Pa (inch wg)	29.9 (0.12)
Throat Size – mm (inch)	350 x 1050 (14 x 42)
Throat Area - m^2 (ft^2)	.38 (4.08)
Curb Cap – mm (inch)	550 x 1250 (22 x 50)
Hood Dimensions	
Width - mm (inch)	737 (29)
Length - mm (inch)	1525 (60)
Height - mm (inch)	406 (16)
Manufacturer	Greenheck
Model No.	Fabra Hood
Options	2, 3, 4

Options: 1. Back draft damper 3. Galvanized steel bird screen
2. Roof curb 4. Fibreglass hood insulation

Note: 1. Roof curb shall be constructed out of non-combustible products.

2. Heat Tracing to be installed on birdscreen for frost protection. Refer to Section 15750 – Heat Tracing for details.

LIST OF SCHEDULES

3.1 Pump Schedule

Tag	P-T301A	P-T302A
Service	Sump System	Sump System
Location	Cell 1 Treated Water Valve Chamber	Cell 3 Treated Water Valve Chamber
Type	Submersible	Submersible
Impeller	Two Vane	Two Vane
Casing	Cast Iron	Cast Iron
Medium Pumped	Water	Water
Capacity, L/s (USgpm)	1.6 (25)	2.8 (45)
Total Head, kPa (ft wg.)	59.7 (20)	134.4 (45)
Maximum Operating Temp., ºC (ºF)	21 (70)	21 (70)
Pump Speed, RPM	15550	3450
Discharge Sizes	$1^1/_2$" NPT	2" NPT
Motor Power, kW (hp)	0.25 ($^1/_3$)	0.37 ($^1/_2$)
Power Supply, V/ph/Hz	120/1/60	120/1/60
Manufacturer	Myers	Myers
Model	ME3H-11p	ME505-11
Accessories & Remarks		Complete with: • WL20P1S0 Float

3.2 Electric Unit Heater Schedule

Tag	UH-T301A	UH-T302A
Location	Cell 1 Treated Water Valve Chamber	Cell 3 Treated Water Valve Chamber
Type	Electric Forced Air	Electric Forced Air
Capacity, kW (MBH)	5 (17.1)	5 (17.1)
Temp. Rise, C° (°F)	59.7 (20)	134.4 (45)
Air Flow, L/s (cfm)	227 (480)	227 (480)
Motor Speed, RPM	15550	1550
Motor Power, W (hp)	0.037 (0.05)	0.037 (0.05)
Power Supply, V/ph/Hz	600/3/60	600/3/60
Manufacturer	Reznor	Reznor
Model	EGE	EGE
Accessories & Remarks	Complete with: • Wall Bracket • Thermostat Kit (5°C to 38°C)	Complete with: • Wall Bracket • Thermostat Kit (5°C to 38°C)

END OF SECTION