



WEST TORONTO COMMUNITY HEALTH SERVICES (WTCHS)

West Toronto Community Health Centre (WTCHC) – 209 Mavety St.
HDR Architecture Associates Inc. Project No.: 10355669
WSP Project No.: 221-11662-00

ISSUED FOR MECHANICAL ADDENDUM, ADD-M03

October 21st, 2024

INCLUDE IN YOUR BID AMOUNT FOR THE FOLLOWING ITEMS OF ADDITION, DELETION OR CLARIFICATION. INDICATE IN THE SPACE PROVIDED ON THE BID FORM THAT YOU HAVE RECEIVED AND INCLUDED FOR THE REQUIREMENTS OF THIS ADDENDUM.

1. ISSUED LOC

1.1 LOC

1.1.1 Added specification sections 23 22 00, 23 74 17 (A), & 23 74 17 (B).

2. ISSUED SPECIFICATIONS

2.1 SECTION 23 22 00 STEAM AND CONDENSATE PIPING

2.1.1 Refer to attached new Spec 23 22 00.

2.2 SECTION 23 74 17(A) ROOF TOP PACKAGED AIR HANDLING UNITS (RTU-1,2,3)

2.2.1 Refer to attached Spec 23 74 17 (A).

2.3 SECTION 23 74 17(B) ROOF TOP PACKAGED AIR HANDLING UNITS (RTU-4,5)

2.3.1 Refer to attached Spec 23 74 17 (B).

2.4 SECTION 25 05 05 AUTOMATIC CONTROL SYSTEMS

2.4.1 Refer to attached Spec 25 05 05 for changes.

3. ISSUED DRAWINGS

Following drawings are issued with and form part of this addendum (include for additional work and/or revisions as shown/noted):

3.1 M-450 LEVEL B01 – HYDRONIC PIPING

3.1.1 Added sensors and controller.



3.2 M-501 MECHANICAL CONTROLS I

3.2.1 Revised detail 1, Mechanical room ventilation control diagram

3.2.2 Replaced detail 2 of CUH with Natural gas generator monitoring points .

3.3 M-601 DOMESTIC WATER SCHEMATIC

3.3.1 Revised note.

3.4 M-604 HEATING SCHEMATIC

3.4.1 Added temperature sensors and Energy meter.

3.5 M-701 MECHANICAL SCHEDULES 1

3.5.1 Added heat tracing schedule.

END OF ADD-M02

SECTION 23 22 00

STEAM AND CONDENSATE PIPING

1. General

1.01 REFERENCE STANDARDS

- .1 American Society of Mechanical Engineers (ASME):
 - .1 ASME B1.20.1-[2013(R2018)], Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.1-[2020], Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .3 ASME B16.3-[2016], Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .4 ASME B16.5-[2017], Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard.
 - .5 ASME B16.9-[2018], Factory-Made Wrought Steel Buttwelding Fittings.
 - .6 ASME B16.25-[2017], Buttwelding Ends.
 - .7 ASME B16.34-[2020], Valves--Flanged, Threaded, and Welding End.
 - .8 ASME B16.48-[2020], Line Blanks.
 - .9 ASME B18.2.2-[2015], Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - .10 ASME B31.1-[2020], Power Piping.
 - .11 ASME B31.3-[2018], Process Piping.
 - .12 ASME BPVC-IX-[2021], BPVC Section IX - Welding, Brazing, and Fusing Qualifications.
- .2 American National Standards Institute/ American Water Works Association (ANSI/AWWA):
 - .1 ANSI/AWWA C111/A21.11-[17], Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .3 ASTM International (ASTM):
 - .1 ASTM A47/A47M-[99(2018)e1] , Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-[20], Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM A105/A105M-[21], Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .4 ASTM A106/A106M-[19a], Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - .5 ASTM A181/A181M-[22], Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 - .6 ASTM A216/A216M-[21], Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - .7 ASTM A307-[21], Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength.

- .4 CSA Group (CSA):
 - .1 CSA B51:[19], Boiler, Pressure Vessel, and Pressure Piping Code.
- .5 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
 - .1 MSS SP-45-[2020], Bypass And Drain Connections.

1.02 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
 - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

1.03 QUALITY ASSURANCE

- .1 Verify work is performed in accordance with requirements of AHJ and applicable following codes:
 - .1 ASME B31.1.
 - .2 ASME B31.3.
 - .3 CSA B51.
- .2 Canadian Registration Number: Valves and similar items for use in systems with pressure rating above 103 kPa to be stamped with Canadian Registration Number (CRN).
- .3 Grooved Products: Supply grooved joint couplings, fittings, valves, grooving tools and specialties from single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.04 TECHNICAL STANDARDS AND SAFETY AUTHORITY (TSSA) OR LOCAL EQUIVALENT AHJ REGISTRATIONS

- .1 Determine TSSA or local equivalent AHJ registrations for system piping and equipment.
- .2 Obtain authority registrations.

1.05 MAINTENANCE MATERIALS

- .1 Provide spare parts as follows:
 - .1 Gaskets for flanges: One for every ten flanges. Minimum one.
- .2 Tools:
 - .1 Supply special tools for maintenance of systems and equipment.

2. Products

2.01 GENERAL

- .1 Products and execution requirements of this Section are intended for low pressure steam humidification and accompanying condensate return piping systems.
- .2 Pipe sizing and applications: As noted, and suiting intended applications.
- .3 Valve sizing, operators and applications: As noted, and suiting intended applications.
- .4 Valve Packing: Free of asbestos fibers and selected for pressure-temperature service of valve.

2.02 LOW PRESSURE PIPING, FITTINGS, JOINTS AND UNIONS

- .1 Low Pressure: Up To 103 kPa.
- .2 Carbon Steel Pipe:
 - .1 In accordance with ASTM A53/A53M, Grade B, seamless.
 - .2 Schedule 40 for steam.
 - .3 Schedule 80 for condensate.
- .3 Fittings:
 - .1 Pipe Flanges: Cast iron in accordance with ASME B16.1, Class 125.
 - .2 Screwed Fittings: Malleable iron in accordance with ASME B16.3, Class 150.
 - .3 Steel Pipe Gaskets, Flanges and Flanged Fittings: In accordance with ASME B16.5.
 - .4 Buttwelding Fittings: Steel in accordance with ASME B16.9.
 - .5 Unions: Malleable iron in accordance with ASME B16.3 and ASTM A47/A47M.
- .4 Joints:
 - .1 NPS 2 (DN 50) and Under: Screwed fittings with lead-free dope and PTFE tape.
 - .2 NPS 2-1/2 (DN 65) and Over: Welding fittings and flanges in accordance with ASME BPVC-IX.
 - .3 Flanges: Plain or raised face. Flange gaskets in accordance with ANSI/AWWA C111/A21.11.
 - .4 Pipe Thread: Taper.
 - .5 Bolts and Nuts: Carbon steel in accordance with ASME B18.2.2.
 - .6 Buttwelding Ends: In accordance with ASME B16.25.
- .5 Unions:
 - .1 Screwed Piping:
 - .1 Steam:
 - .1 Malleable iron, ground joint, brass to iron or bronze to bronze seat screwed unions and union elbows.
 - .2 Minimum pressure rating of 1725 kPa steam at 260°C.
 - .2 Condensate:
 - .1 Malleable iron, ground joint, factory tested screwed unions and union elbows with brass to iron seat.
 - .2 Minimum pressure rating of 2068 kPa WOG (non-shock).
 - .2 Welded Piping:

- .1 Steam: Forged carbon steel slip-on raised face welding flange unions in accordance with ASTM A105/A105M, 150 lb. Class.
- .2 Condensate: Welding flange unions as specified above for welded low pressure steam piping but 300 lb. Class.

2.03 LOW PRESSURE VALVES

- .1 Features:
 - .1 Low Pressure: Up To 103 kPa.
 - .2 Typically valves to be rising stem in mechanical rooms and non-rising in other areas. Prior to ordering, review requirements with Consultant.
 - .3 Connections:
 - .1 NPS 2 (DN 50) and Smaller: Screwed ends, unless otherwise noted.
 - .2 NPS 2 1/2 (DN 65) and Larger: Flanged and welded ends, unless otherwise noted.
- .2 Ball Valves (For shut-off and isolating equipment):
 - .1 NPS 2 (DN 50) and Under:
 - .1 Class 125, 860 kPa Working Stem Pressure (WSP) rated, forged brass or bronze full bore, chrome plated forged brass ball, PTFE seat and gland packing, screwed ends and carbon steel handle.
 - .2 NPS 2 1/2 (DN 65) and Over:
 - .1 Class 125, 860 kPa WSP rated, cast iron, flanged, cast iron Teflon fused ball, blow-out proof stainless steel stem, reinforced Teflon seats, and steel handle which is lockable in fully open and fully closed positions.
- .3 Gate Valves (For isolating equipment, control valves, pipelines):
 - .1 NPS 2 (DN 50) and Under:
 - .1 Class 125, 860 kPa WSP rated, screwed, bronze, brass rising stem, screwed-in cast bronze bonnet, cast bronze disc, and zinc or aluminum die-cast handwheel.
 - .2 NPS 2 1/2 (DN 65) to NPS 8 (DN 200):
 - .1 Class 125, 860 kPa WSP rated, flanged, cast iron, bronze rising stem, cast iron disc and cast or ductile iron handwheel.
- .4 Globe Valves (For throttling, flow control, emergency bypass):
 - .1 NPS 2 (DN 50) and Under:
 - .1 Class 125, 860 kPa WSP rated, cast bronze, screwed, rising stem, union bonnet, reinforced PTFE disc, and zinc or aluminum die-cast handwheel.
 - .2 NPS 2 1/2 (DN 65) and Over:
 - .1 Class 125, 860 kPa WSP rated, cast iron, flanged, bronze rising stem, cast iron disc and cast or ductile iron handwheel.
- .5 Check Valves:
 - .1 NPS 2 (DN 50) and Under:
 - .1 Class 125, "Y" pattern.
 - .2 Cast bronze, swing type.
 - .3 Forged brass screwed cap, cast bronze seat.
 - .4 Threaded ends.

- .2 NPS 2 1/2 (DN 65) and Over:
 - .1 Class 125, swing type.
 - .2 Cast iron body and cover, bronze trim.
 - .3 Cast iron disc and bronze seat.
 - .4 Flanged ends and bolted cover.

2.04 CONDENSATE COOLER

- .1 Features:
 - .1 Factory fabricated, constructed of welded steel.
 - .2 Suitable for wall or floor mounting suiting intended applications.
 - .3 Round type 304 stainless steel tank with mounting hardware.
 - .4 Sensor and union kit assembly in cooled condensate outlet with capillary to cold water inlet.
 - .5 Brass cold water inlet strainer and stainless steel check valve.
 - .6 Cold water spray nozzle with thermostatic control permitting controlled volume of domestic cold water to quench flash steam and sub-cool condensate to maximum 65°C before being dumped to drain.
 - .7 Performance: 37.9 LPM @ 149°C with water flow of 98 LPM @ 413 kPa - Maximum 10°C.

2.05 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Gate Valves:
 - .1 Crane.
 - .2 Velan.
 - .3 Beric.
 - .4 Spirax Sarco.
- .2 Globe Valves:
 - .1 Crane.
 - .2 Velan.
 - .3 Beric.
 - .4 Kitz.
 - .5 Spirax Sarco.
- .3 Check Valves:
 - .1 Crane.
 - .2 Velan.
- .4 Strainers:
 - .1 Spirax Sarco.
 - .2 Toyo Valve.
 - .3 Armstrong International.
 - .4 Kitz.
 - .5 Watts Industries.
 - .6 Mueller.

- .5 Condensate Cooler:
 - .1 Spirax Sarco Model JC Series.
 - .2 Gestra.
 - .3 Armstrong International.

3. Execution

3.01 PREPARATION

- .1 Lay out work in accordance with lines and grades suiting installations.
- .2 Verify lines, levels, and dimensions against established benchmarks. Report discrepancies to Consultant.
- .3 Submit drawings showing relative locations of various services.

3.02 INSTALLATION OF PIPING

- .1 Install piping work in accordance with Section 23 05 15 – Common Installation Requirements for HVAC Pipework.
- .2 Connect branch lines into top of mains.
- .3 Install piping in direction of flow with slopes as follows:
 - .1 Steam: 1:240.
 - .2 Condensate Return: 1:70.
 - .3 Suiting intended applications in accordance with manufacturer instructions.
- .4 Make provision for thermal expansion and preventing trapping.
- .5 Drip Pocket: Line size.
- .6 Install flexible connections in steam and feedwater connections to each steam boiler and equipment as noted. Install flexible connections in accordance with manufacturer instructions.
- .7 Coordinate installation of firestopping around piping passing through fire separations with Section 07 84 10 - Comprehensive Firestopping. Verify compatibility of fire stopping system with surface temperature of pipe or insulation.
- .8 Provide for pipe movement suiting intended applications, and in accordance with expansion joint manufacturer installation instructions.
- .9 Branch Take-offs:
 - .1 Use welding tees.
 - .2 Where reducing tees of proper size are unavailable, use available tees with reducers. Tees with increasers not acceptable.
 - .3 Weldolets: Used at drip legs only, provided ratio of outlet size to pipe size is 0.5 or smaller.
- .10 Cap open ends of piping during installation. Remove foreign material from inside piping.
- .11 Grade nominally horizontal piping in direction of flow, to high point for air removal and to low point for condensate drainage.
- .12 Flanges: Tighten bolts evenly with torque wrench to manufacturer recommendations.

- .13 Review with Consultant, revisions to location of piping.
- .14 Connections to Equipment:
 - .1 Use flanged valves for isolation and ease of maintenance and assembly.
 - .2 Use double swing joints and swing joints when equipment mounted on vibration isolation and when piping subject to movement.
- .15 Anchors and Guides:
 - .1 Locate anchors and guides in accordance with manufacturer recommendations.
 - .2 Align piping at expansion joints and guides, avoiding damage by movement of piping against fixed structures.
 - .3 Coordinate requirements with Structural Consultant.
- .16 Expansion Loops and Expansion Joints:
 - .1 Provide supports suiting intended applications, in accordance with manufacturer recommendations to maintain drainage and venting.
 - .2 Install lubrication facilities in locations for ease of servicing.
- .17 Boiler Feedwater Piping: From deaerating heater assembly to steam boilers, provide piping as specified for low pressure steam piping.

3.03 INSTALLATION OF VALVES

- .1 Prior to installation, review valve locations and orientation with Consultant. Confirm proper orientations with valve manufacturers.
- .2 Install isolating valves at branch take-offs, at pieces of equipment and suiting intended applications.
- .3 Install globe valves around gate valves of NPS 8 and over.
- .4 Install in accordance with manufacturer recommendations.
- .5 Install butterfly valves between weld neck flanges, providing full compression of liner.
- .6 Install drain valve at base of each piping riser, in drain connections to equipment and suiting intended applications. At bottom of risers provide minimum 200 mm long, minimum 25 mm diameter capped dirt pockets with drain valves.
- .7 Install pressure relief valves. Pipe discharge of each steam safety relief valve to atmosphere through properly sized drip pan elbow.
- .8 Depending upon piping configuration and ease of operation, on horizontal pipes install valves with stem horizontal or above.
- .9 Install valves accessible for operation and maintenance, without removing adjacent piping or equipment.

3.01 IDENTIFICATION

- .1 Provide product with engraved lamicoid nameplates.
- .2 Equipment Main Nameplates: Size 4 unless otherwise noted and engraved as noted.

END OF SECTION

SECTION 23 74 17 (A)
ROOF TOP PACKAGED AIR HANDLING UNITS (RTU-1,2,3)

1. PART 1 - GENERAL

1.1 GENERAL

1.1.1 Conform to General Provisions For Mechanical Divisions Section 20 05 05 and Basic Materials and Methods Section 20 05 10.

1.2 SUBMITTALS

- 1.2.1 Submit shop drawings/product data sheets for all air handling units. Include following:
- 1. 2. 1.1. computer generated and certified fan performance curves;
 - 1.2.1.2. computer generated psychometric chart for each cooling coil;
 - 1.2.1.3. certified sound power data for discharge, radiated, and return positions by octave band;
 - 1.2.1.4. hardware for section-to-section site connections as applicable;
 - 1.2.1.5. dimensioned layouts;
 - 1.2.4.6. product data sheets for fan motors.
- 1.2.2 Submit manufacturer's colour chart to indicate standard colour range of paint finishes. Supply 4 L (3.5 qt) of touch-up paint with each air handling unit.
- 1.2.3 Submit spare air filters as specified in Part 2 of this Section.
- 1.2.4 Supply reviewed copies of air handling unit/curb assembly shop drawings or product data sheets to trade who will cut roof openings for ductwork, and ensure openings are properly sized and located.
- 1.2.5 Submit with delivery of each unit a copy of factory inspection report, and include a copy of each report with O&M Manual project close-out data.
- 1.2.6 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.2.7 Indicate the following: complete specifications; wiring diagrams (showing all interconnections); weight; performance details.

1.03 QUALITY ASSURANCE

- .1 Roof mounted modular air handling equipment is to be rated (capacity, performance, efficiency and sound) and certified in accordance with requirements of following American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute Standards, and Air Movement and Control Association International Inc. Standards:
 - .1 AHRI 410, Forced-Circulation Air-Cooling and Air-Heating Coils;
 - .2 ANSI/AHRI 430, Performance Rating of Central Station Air-Handling Units;
 - .3 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .4 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.
- .2 Roof modular air handling equipment is also to be in accordance with requirements of following Codes, Standards, and Regulations:
 - .1 CAN/CSA C22.2 No. 236/UL 1995, Heating and Cooling Units;
 - .2 ANSI/ASHRAE/IES 90.1, Energy Standard for Buildings Except Low Rise Residential Buildings;
 - .3 CSA or ETL certification and labelling for all electrical components;
 - .4 governing local Codes and Regulations.
- .3 Acceptable manufacturers are:
 - .1 Daikin;
 - .2 Trane Canada Inc.;
 - .3 Johnson Controls York;
 - .4 Engineered Air.
 - .5 Valent.

2. PRODUCTS

2.1 GENERAL

2.1.1 Base bid shall be gas fired DX cooled packaged roof top units with integral controls and sensors. For considerations of alternates, cost savings must be shown on the tender form at time of closing. Contractors shall be responsible for all cost for all trades associated with any substitutions.

2.1.2 Furnish as shown on plans.

2.1.3 The complete unit shall be cETLus listed.

2.1.4 The unit shall be ASHRAE 90.1-2016 compliant and labeled.

2.1.5 Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-32 Refrigerant and oil.

2.1.6 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

2.1.7 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door.

2.1.8 Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

2.1.9 Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values.

2.1.10 All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

2.1.11 Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.2 Casing

2.2.1 Panel construction shall be double-wall construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 1" thick with an R-value of 7.0, and shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 5.0 inches w.g.

2.2.2 Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.

2.2.3 Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.

2.2.4 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.3 FILTERS

2.3.1 The filter section shall be provided with a 2 inch (50mm) MERV 8 prefilter and rack and a 4 inch (100mm) MERV 14 final filter and rack. A set of 2 inch (50mm) construction filters shall ship with the unit. Provide 2 sets of spare filters.

2.4 OUTDOOR / RETURN AIR SECTION

2.4.1 Unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in accordance with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges.

2.4.2 Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

2.5 SUPPLY FAN

2.5.1 Supply fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with fan blades that are continuously welded to the hub plate and end rim. The supply fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

2.5.2 All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment.

2.5.3 Supply fan and motor assembly combinations larger than 8 hp or 22" diameter shall be internally isolated on 1" deflection, spring isolators and include removable shipping tie downs.

2.5.4 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

2.5.5 The supply fan shall be capable of airflow modulation from 30% to 100% of the scheduled designed airflow. The fan shall not operate in a state of surge at any point within the modulation range.

2.6 EXHAUST FAN

2.6.1 Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.

2.6.2 The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

2.6.3 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.7 COOLING COIL

2.7.1 The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

2.7.2 The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

2.7.3 The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

2.7.4 The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

2.7.5 The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.8 CONDENSING SECTION

2.8.1 Outdoor coils shall be cast aluminum, micro-channel coils. Plate fins shall be protected and brazed between adjoining flat tubes such that they shall not extend outside the tubes. A sub-cooling coil shall be an integral part of the main outdoor air coil. Each outdoor air coil shall be factory leak tested with high- pressure air under water.

2.8.2 Fan motors shall be an ECM type motor for proportional control. The unit controller shall proportionally control the speed of the condenser fan motors to maintain the head pressure of the refrigerant circuit from ambient condition of 0-120°F. Mechanical cooling shall be provided to 0° F. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

2.8.3 The condenser fan shall be low noise blade design. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be of a composite material

2.8.4 The unit shall have scroll compressors. One of the compressors shall be an inverter compressor providing proportional control. The unit controller shall control the speed of the compressor to maintain the discharge air temperature. The inverter compressor shall have a separate oil pump and low oil safety protection.

2.8.5 Pressure transducers shall be provided for the suction pressure and head pressure. Temperature sensor shall be provided for the suction temperature and the refrigerant discharge temperature of the compressors. All of the above devices shall be an input to the unit controller and the values be displayed at the unit controller.

2.8.6 Each circuit shall be dehydrated and factory charged with R-410A Refrigerant and oil.

2.9 GAS HEATING SECTION

2.9.1 The rooftop unit shall include a natural gas heating section. The gas furnace design shall be one natural gas fired heating module factory installed downstream of the supply air fan in the heat section. The heating module shall be a tubular design with in-shot gas burners.

2.9.2 Each module shall have modulating heating control.

2.9.3 The heat exchanger tubes shall be constructed of stainless steel.

2.9.4 The module shall have an induced draft fan that will maintain a negative pressure in the heat exchanger tubes for the removal of the flue gases.

2.9.5 Each burner module shall have two flame roll-out safety protection switches and a high temperature limit switch that will shut the gas valve off upon detection of improper burner manifold

operation. The induced draft fan shall have an airflow safety switch that will prevent the heating module from turning on in the event of no airflow in the flue chamber.

2.9.6 The factory-installed DDC unit control system shall control the gas heat module. Field installed heating modules shall require a field ETL certification. The manufacturer's rooftop unit ETL certification shall cover the complete unit including the gas heating modules.

2.9.7 Coil shall be factory leak tested with high pressure air under water.

2.10 ELECTRICAL

2.10.1 Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized.

2.10.2 A terminal block shall be provided for the main power connection and a terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.

2.10.3 Each compressor and condenser fan motor shall be furnished with contactors and internal thermal overload protection. Supply fan motors shall be supplied with external overload protection.

2.10.4 A single non-fused disconnect switch, with 50kA short circuit current rating, shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.11 CONTROLS FOR APPLIED ROOFTOP

2.11.1 Each unit shall be equipped with a Daikin MicroTech® III microprocessor based control system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including scheduling, unit diagnostics and safeties.

2.11.2 The DDC control system shall permit starting and stopping of the unit locally or remotely. A set of contacts shall be provided for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.

2.11.3 The unit control system shall have the ability to communicate with an independent Building Management System (BMS) via a direct *BACnet Ethernet* or *BACnet MSTP* or *LonTalk* communication connection. The independent BMS system shall have access to "read only" variables and "read & write" variables. Communications shall not require field mounting of any

additional sensors or devices at the unit. The BMS system shall be capable of interacting with the individual rooftop controllers in the following ways:

- Monitor controller inputs, outputs, set points, parameters and alarms
- Set controller set points and parameters
- Clear alarms
- Reset the cooling and heating discharge air temperature set point
- Set the heat/cool changeover temperature
- Set the representative zone temperature

It will be the responsibility of the Systems Integrating Contractor to integrate the rooftop data into the BMS control logic and interface stations.

2.11.4 The controller shall have a 4 line x 20 character display with all information and instructions shown in plain English. A keypad shall allow information and controls to be accessed. The microprocessor shall have a programmable time clock, store current and past alarm conditions.

2.11.5 The display shall provide the following information:

- Unit status including # of stages or % capacity for fans, heating, cooling and economizer.
- Supply, return, outdoor, and space air temperature
- Duct and building static pressure; the control contractor is responsible for providing and installing sensing tubes
- Inverter compressor speed and refrigeration circuit pressures and temperatures
- Outside air damper position and economizer mode
- Cooling and heating changeover status
- Occupied, unoccupied, and dirty filter status
- Date and time schedules
- Alarm faults

2.11.6 The following set points shall be adjustable:

- Control mode (Off / Auto / Cool Only / Fan Only / Heat Only)
- Occupancy mode (Auto / Tenant Override / Occupied / Unoccupied)
- Changeover mode (return air, space temperature or network signal)
- Cooling and heating discharge air temperature control
- Compressor lockouts and timers
- Economizer changeover (enthalpy or dry bulb)

Scheduling

Building static pressure control

2.11.7 When heat recovery units are specified, the control of the energy recovery wheel shall form an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed on the rooftop units LCD display. All of these temperatures shall be made available through the BACnet interface.

2.11.8 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure set point.

2.11.9 Supply air reset options shall include; return air temperature, outdoor air temperature, space temperature, airflow (VAV), network signal, external signal (1-5 vdc or 0-20 mA)

2.11.10 The controller shall be complete with night setback control. The controller shall use its internal time clock for scheduling and have an adjustable override timer. (The unit shall be supplied with a wall mounted space sensor with an override button for field installation).

2.12 ROOF CURB

2.12.1 A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 24" high and include a nominal 2"×4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the National Roofing Contractors Association.

2.12.2 If units with digital scroll compressors are used instead of variable speed compressors, the installing contractor shall fill the roof curb with Roxul Safe and Sound Insulation and shall provide a picture of the curb prior to the unit being installed.

2.13 STARTUP SERVICE AND WARRANTY

2.13.1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction to the owner's personnel on the operation and maintenance of the unit. Factory technician to provide copy of start-up log to owner and to demonstrate operation and maintenance to owners' representative. The warranty period shall commence at the date of

initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

3. EXECUTION

3.1 INSTALLATION

3.1.1 Install unit flat and level on roof curb in accordance with manufacturers' installation literature.

3.1.2 Provide required rigging and hoisting/moving equipment required to move units to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.

3.1.3 Install and wire all control accessories and power wiring to the unit.

3.1.4 Hot water coil piping shall terminate in the vestibule. Install control valve in the vestibule.

3.1.5 Locate curbs on roof where required for installation and flashing into roof construction as part of roofing work of Division 07. Secure units in place, level, and plumb, on gasketing material.

END OF SECTION

SECTION 23 74 17 (B)
ROOF TOP PACKAGED AIR HANDLING UNITS (RTU-4,5)

1. PART 1 - GENERAL

1.1 GENERAL

1.1.1 Conform to General Provisions For Mechanical Divisions Section 20 05 05 and Basic Materials and Methods Section 20 05 10.

1.2 SUBMITTALS

1.2.1 Submit shop drawings/product data sheets for all air handling units. Include following:

1.2.1.1. computer generated and certified fan performance curves;

1.2.1.2. computer generated psychometric chart for each cooling coil;

1.2.1.3. certified sound power data for discharge, radiated, and return positions by octave band;

1.2.1.4. hardware for section-to-section site connections as applicable;

1.2.1.5. dimensioned layouts;

1.2.1.6. product data sheets for fan motors.

1.2.2 Submit manufacturer's colour chart to indicate standard colour range of paint finishes. Supply 4 L (3.5 qt) of touch-up paint with each air handling unit.

1.2.3 Submit spare air filters as specified in Part 2 of this Section.

1.2.4 Supply reviewed copies of air handling unit/curb assembly shop drawings or product data sheets to trade who will cut roof openings for ductwork, and ensure openings are properly sized and located.

1.2.5 Submit with delivery of each unit a copy of factory inspection report, and include a copy of each report with O&M Manual project close-out data.

1.2.6 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.

1.2.7 Indicate the following: complete specifications; wiring diagrams (showing all interconnections); weight; performance details.

1.3 QUALITY ASSURANCE

1.3.1 Roof mounted modular air handling equipment is to be rated (capacity, performance, efficiency and sound) and certified in accordance with requirements of following American National Standards Institute/Air-Conditioning, Heating and Refrigeration

Institute Standards, and Air Movement and Control Association International Inc. Standards:

- 1.3.1.1 AHRI 410, Forced-Circulation Air-Cooling and Air-Heating Coils;
- 1.3.1.2 ANSI/AHRI 430, Performance Rating of Central Station Air-Handling Units;
- 1.3.1.3 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
- 1.3.1.4 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

1.3.2 Roof modular air handling equipment is also to be in accordance with requirements of following Codes, Standards, and Regulations:

- 1.3.2.1 CAN/CSA C22.2 No. 236/UL 1995, Heating and Cooling Units;
- 1.3.2.2 ANSI/ASHRAE/IES 90.1, Energy Standard for Buildings Except Low Rise Residential Buildings;
- 1.3.2.3 CSA or ETL certification and labelling for all electrical components;
- 1.3.2.4 governing local Codes and Regulations.

1.3.3 Acceptable manufacturers are:

- 1.3.3.1 Daikin;
- 1.3.3.2 Trane Canada Inc.;
- 1.3.3.3 Johnson Controls York;
- 1.3.3.4 Engineered Air.
- 1.3.3.5 Valent.

2. PRODUCTS

2.1 GENERAL

- 2.1.1 Base bid shall be Daikin. For considerations of alternates, cost savings must be shown on the tender form at time of closing. Contractors shall be responsible for all cost for all trades associated with any substitutions.
- 2.1.2 The complete unit shall be cETLus listed.
- 2.1.3 Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-32 Refrigerant and oil.

- 2.1.4 The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.
- 2.1.5 All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door.
- 2.1.6 Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
- 2.1.7 Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values.
- 2.1.8 All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.
- 2.1.9 Warranty: The manufacturer shall provide 12-month parts only warranty. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence at startup or six months after shipment, whichever occurs first.

2.2 CASING

- 2.2.1 Panel construction shall be double-wall thermally broken construction for all panels. All floor panels shall have a solid galvanized steel inner liner on the air stream side of the unit to protect insulation during service and maintenance. Insulation shall be a minimum of 2" thick with an R-value of 13.0 for units 30 tons and over, and 1" thick with an R-value of 7 for units below 30 tons. Insulation shall be 2 part injected foam. Panel design shall include no exposed insulation edges. Unit cabinet shall be designed to operate at total static pressures up to 8.0 inches w.g.
- 2.2.2 Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished panel surfaces to withstand a minimum 1000-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance.
- 2.2.3 Service doors shall be provided on the fan section, filter section, control panel section, and heating vestibule in order to provide user access to unit components. All service access doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system. Removable service panels secured by multiple mechanical fasteners are not acceptable.
- 2.2.4 The unit base shall overhang the roof curb for positive water runoff and shall seat on the roof curb gasket to provide a positive, weathertight seal. Lifting brackets shall be provided on the unit base to accept cable or chain hooks for rigging the equipment.

2.3 GAS FIRED HUMIDIFICATION

- 2.3.1 Where indicated on drawings, provide an insulated 48 inch long, blank compartment located after the discharge plenum and out of the air stream. This section shall be complete with insulation, double wall construction, 1 kW electric baseboard heater with thermostat and a service light. This section shall contain a factory installed gas fired humidifier. Provide sealed combustion make-up air and B venting. Water supply and drain shall be provided through the base of the unit by the mechanical contactor. Solenoid valves are to be installed below the roof deck, on the water feed and drain lines serving the humidifier. Upon loss of power to the rooftop, the water feed solenoid shall close and the drain solenoid shall open, draining the humidifier tank below the roof deck.
- 2.3.2 The RTU manufacturer shall factory mount the steam distribution grid in the discharge air plenum. Provide minimum absorption distance downstream as scheduled. Refer to separate Humidifier Specification for details on the Humidifier.
- 2.3.3 Installing contractor shall provide a separate 115/60/1 – 25 Amp electric power supply to the humidification section of the unit.

2.4 FILTERS

- 2.4.1 The filter section shall be provided with a 2 inch MERV-8 prefilter.
- 2.4.2 Final filters shall be 4" inch cartridge MERV-14 final filter on units below 30 tons, and 12" MERV-14 on units above 30 tons.

2.5 OUTDOOR / RETURN AIR SECTION

- 2.5.1 Unit shall be provided with a Metal Mesh pre-filter in the outdoor air hood/section to prefilter large particulate to prevent early filter clogging.
- 2.5.2 Unit shall be provided with a 100% Outside Air damper. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. Control of the dampers shall be by a factory installed direct coupled actuator.
- 2.5.1 Where noted on drawings, unit shall be provided with an outdoor air economizer section. The economizer section shall include outdoor, return, and exhaust air dampers. The economizer operation shall be fully integral to the mechanical cooling

and allow up to 100% of mechanical cooling if needed to maintain the cooling discharge air temperature. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same durable paint finish as the main unit. The hood shall include moisture eliminator filters to drain water away from the entering air stream. The outside and return air dampers shall be sized to handle 100% of the supply air volume. The dampers shall be parallel blade design. Damper blades shall be gasketed with side seals to provide an air leakage rate of 1.5 cfm / square foot of damper area at 1" differential pressure in according with testing defined in AMCA 500. A barometric exhaust damper shall be provided to exhaust air out of the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges.

- 2.5.2 Control of the dampers shall be by a factory installed direct coupled actuator. Damper actuator shall be of the modulating, spring return type. A comparative enthalpy control shall be provided to sense and compare enthalpy in both the outdoor and return air streams to determine if outdoor air is suitable for "free" cooling. If outdoor air is suitable for "free" cooling, the outdoor air dampers shall modulate in response to the unit's temperature control system.

2.6 SUPPLY FAN

- 2.6.1 All Supply, Return Fans shall be configured in an array with a minimum number fans specified in the schedule for each unit.
- 2.6.2 All Fans shall be dynamically balanced as an assembly in planes as per DIN / ISO 21940 to balancing grade G 6.3 or better or provide 2" Spring isolation for each fan.
- 2.6.3 All fans shall be provided with totally enclosed maintenance-free ball bearings and permanent lubrication. Bearings shall be selected for a minimum life in excess of 350,000 hrs (L50) at selected operating point.
- 2.6.4 ECM Supply and Return Fans
- 2.6.5 All fans shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The fan shall be a direct drive fan mounted to the motor shaft. Belts and sheaves are not acceptable due to the additional maintenance.
- 2.6.6 The fan motor shall be a totally enclosed electrically commutated motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

2.7 COOLING COIL

- 2.7.1 The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and a sloped drain pan.
- 2.7.2 The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 4 rows. All cooling coils shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
- 2.7.3 Each refrigeration circuit shall be equipped with a thermostatic expansion valve for control refrigerant flow control.
- 2.7.4 The refrigerant suction lines shall be fully insulated from the expansion valves to the compressors
- 2.7.5 The distributor tubes shall be sleeved or coated to provide longevity and protection from leaks.
- 2.7.6 The drain pan shall be stainless steel and designed to comply with ASHRAE- 62.1 double sloped requirements drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked cooling coils shall be provided with a secondary drain pan piped to the primary drain pan.
- 2.7.7 Insulation under the drain pan should be a closed cell structure to prevent moisture from wicking under the drain pan. Fiberglass is not allowed.

2.8 CONDENSING SECTION

- 2.8.1 All Units shall provide the Energy Efficiency specified EER and IEER per the schedule equipment or higher.
- 2.8.2 Condenser fans shall be direct drive, axial type designed for low tip speed and vertical air discharge. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
- 2.8.3 Condenser coils shall be an all aluminum design, and mounted on polymer brackets, to minimize di-electric corrosion. The aluminum tube shall be a micro channel design with high efficiency aluminum fins. Fins shall be brazed to the tubing for a direct bond. Each condenser coil shall be factory leak tested with high-pressure air under water.

- 2.8.4 Condenser coils shall be protected from incidental contact to coil fins by a coil guard. Coil guard shall be constructed of cross wire welded steel with PVC coating
- 2.8.5 Head Pressure Control
- 2.8.6 Units shall have positive head pressure control by SpeedTrol™ condenser fan speed modulation to provide cooling operation to ambient temperatures down to 25° F. Fan speed control shall be field adjustable.
- 2.8.7 Each unit shall have a variable speed scroll compressor on the lead refrigeration circuit. Each compressor shall be complete with gauge ports, crankcase heater, sight-glass, anti-slug protection, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission
- 2.8.8 Each unit shall have two independent refrigeration circuits for redundancy. Each circuit shall be complete with a low pressure control, filter-drier, liquid moisture indicator/sight-glass, thermal expansion valve, and a manual reset high pressure safety switch. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sight-glasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and factory charged with Refrigerant 32A and oil.
- 2.8.9 Each unit shall have at least 4 compressor stages of cooling capacity control for better part load control as required by ASHRAE 90.1-2013.

2.9 GAS HEATING SECTION

- 2.9.1 The gas furnace design shall be factory installed downstream of the supply air fan in the heat section.
- 2.9.2 The heat exchanger shall include a 439 grade Stainless steel. Aluminized steel heat exchangers are not acceptable. The heat exchanger design shall collect condensate in a collection point and have a condensate drain.
- 2.9.3 The furnace will be supplied with a modulating induced draft burner. The burner shall be controlled for low fire start. The burner shall be capable of continuous modulation between 5% and 100% (20:1 control) of rated capacity.
- 2.9.4 The burner shall be specifically designed to burn natural gas and shall include a micro-processor based flame safeguard control, combustion air proving switch, pre-purge timer and spark ignition. Status and alarm codes are available at the unit controller via a network connection and are available for BAS integration.
- 2.9.5 Provide with a 15 year gas heat exchanger warranty

2.10 ELECTRICAL

- 2.10.1 Each unit shall be wired and tested at the factory before shipment. Wiring shall comply with CSA standards. All wiring shall be number coded per the electrical wiring diagrams. All electrical components shall be labeled according to the electrical diagram and be CSA recognized.
- 2.10.2 A terminal block shall be provided for the main power connection and a terminal board shall be provided for the low voltage control wiring. Knockouts shall be provided in the bottom of the main control panel for field wiring entrance. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, and a high temperature sensor shall also be provided with the unit.
- 2.10.3 Each compressor and condenser fan motor shall be furnished with contactors and internal thermal overload protection. Supply fan motors shall be supplied with external overload protection.
- 2.10.4 Unit shall include a 115V receptacle to be field wired and powered by separate connection.
- 2.10.5 Provide a disconnect switch to cut power to the entire unit before the control panel can be opened.
- 2.10.6 A single non-fused disconnect switch, with 50kA short circuit current rating, shall be provided for disconnecting electrical power at the unit. Disconnect switches shall be mounted internally to the control panel and operated by an externally mounted handle.

2.11 CONTROLS FOR APPLIED ROOFTOP

- 2.11.1 Each unit shall be equipped with a Daikin MicroTech® III microprocessor based control system. The unit control system shall include all required temperature and pressure sensors, input/output boards, main microprocessor and operator interface. The unit control system shall perform all unit control functions including scheduling, unit diagnostics and safeties.
- 2.11.2 The DDC control system shall permit starting and stopping of the unit locally or remotely. A set of contacts shall be provided for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/disable, heat indication, cool indication, and fan operation.
- 2.11.3 The unit control system shall have the ability to communicate with an independent Building Management System (BMS) via a direct *BACnet Ethernet* or *BACnet MSTP* communication connection. The independent BMS system shall have access to “read only” variables and “read & write” variables. Communications shall not require

field mounting of any additional sensors or devices at the unit. The BMS system shall be capable of interacting with the individual rooftop controllers in the following ways:

- Monitor controller inputs, outputs, set points, parameters and alarms

- Set controller set points and parameters

- Clear alarms

- Reset the cooling and heating discharge air temperature set point

- Set the heat/cool changeover temperature

- Set the representative zone temperature

It will be the responsibility of the Systems Integrating Contractor to integrate the rooftop data into the BMS control logic and interface stations.

- 2.11.4 The controller shall have a 4 line x 20 character display with all information and instructions shown in plain English. A keypad shall allow information and controls to

be accessed. The microprocessor shall have a programmable time clock, store current and past alarm conditions.

2.11.5 The display shall provide the following information:

Unit status including # of stages or % capacity for fans, heating, cooling and economizer.

Supply, return, outdoor, and space air temperature

Duct and building static pressure; the control contractor is responsible for providing and installing sensing tubes

Outside air damper position and economizer mode

Cooling and heating changeover status

Occupied, unoccupied, and dirty filter status

Date and time schedules

Alarm faults

2.11.6 The following set points shall be adjustable:

Control mode (Off / Auto / Cool Only / Fan Only / Heat Only)

Occupancy mode (Auto / Tenant Override / Occupied / Unoccupied)

Changeover mode (return air, space temperature or network signal)

Cooling and heating discharge air temperature control

Compressor lockouts and timers

Economizer changeover (enthalpy or dry bulb)

Scheduling

Building static pressure control

2.11.7 When heat recovery units are specified, the control of the energy recovery wheel shall form an integral part of the rooftop unit's DDC controller. The DDC controller shall have visibility of the outdoor air temperature, leaving wheel temperature, return air temperature, and exhaust air temperature. These temperatures shall be displayed on the rooftop units LCD display. All of these temperatures shall be made available through the BACnet interface.

2.11.8 The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of

the supply air fan designed airflow to maintain the adjustable building pressure set point.

2.11.9 Supply air reset options shall include; return air temperature, outdoor air temperature, space temperature, airflow (VAV), network signal, external signal (1-5 vdc or 0-20 mA)

2.11.10 The controller shall be complete with night setback control. The controller shall use its internal time clock for scheduling and have an adjustable override timer. (The unit shall be supplied with a wall mounted space sensor with an override button for field installation).

2.12 ROOF CURB

2.12.1 A prefabricated heavy gauge galvanized steel, mounting curb shall be provided for field assembly on the roof decking prior to unit shipment. The roof curb shall be a full perimeter type with complete perimeter support of the air handling section and condensing section. The curb shall be a minimum of 14" high and include a nominal 2"×4" wood nailing strip. Gasket shall be provided for field mounting between the unit base and roof curb. The roof curb shall be approved by the National Roofing Contractors Association.

2.13 STARTUP SERVICE AND WARRANTY

2.13.1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction to the owner's personnel on the operation and maintenance of the unit. Factory technician to provide copy of start-up log to owner and to demonstrate operation and maintenance to owners' representative. The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labour to install parts.

3. EXECUTION

3.1 INSTALLATION

3.1.1 Install unit flat and level on roof curb in accordance with manufacturers' installation literature.

3.1.2 Provide required rigging and hoisting/moving equipment required to move units to required locations. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.

- 3.1.3 Install and wire all control accessories and power wiring to the unit.
- 3.1.4 Hot water coil piping shall terminate in the vestibule. Install control valve in the vestibule.
- 3.1.5 Locate curbs on roof where required for installation and flashing into roof construction as part of roofing work of Division 07. Secure units in place, level, and plumb, on gasketing material.

END OF SECTION

SECTION 25 05 05 AUTOMATIC CONTROL SYSTEMS

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Submit shop drawings/product data sheets for following:
 - 1. all control system components;
 - 2. identified schematic control diagrams with component identification, catalogue numbers, and sequence of operation for all systems;
 - 3. certified wiring diagrams for all systems.
- B. Submit following samples for review:
 - 1. control damper section with linkage, operator, and certified flow and leakage data;
 - 2. wall mounting control system flow diagram as specified in Part 2 of this Section;
 - 3. each type of thermostat to be used, each identified as to intended use.
- C. Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- D. Submit written confirmation from control component manufacturer that site installation personnel are qualified and experienced in installation of components, and have parts and service availability on a 24/7 basis.

1.2 QUALITY ASSURANCE

- A. Control systems are to be installed by control component manufacturer or by licensed personnel authorized by control component manufacturer. Submit written confirmation from control component manufacturer.
- B. Control system installation company is to have local parts and service availability on 24/7 basis.
- C. Control wiring work is to be performed by licensed journeyman electricians, or under direct daily supervision of journeyman electricians.

PART 2 - PRODUCTS

2.1 CONTROL AIR PIPING AND TUBING

- A. High pressure piping mains are to be Type M hard drawn seamless copper with forged copper soldering type fittings and 95% tin / 5% Antimony solder joints.
- B. Low pressure tubing is to be:
 - 1. seamless hard drawn phosphorized copper tubing with proper soldering type copper fittings and 50% lead / 50% tin solder joints;
 - 2. annealed soft copper with Garlock compression fittings;
 - 3. type "FR" plenum rated flame retardant polyethylene control tubing, single, twin or bundled as required, and colour coded.

2.2 AUTOMATIC CONTROL VALVES AND OPERATORS

- A. Each control valve must be suitable in all respects for application, including system pressure, and have design output and flow rates with maximum pressure drops as follows:
 - 1. heating water valves for coils: ___ kPa (___ psi);
 - 2. heating water valves for radiation units: ___ kPa (___ psi);
- B. Unless otherwise indicated, control valves for proportional operation are to have equal percentage characteristics, and control valves for open/shut 2-position operation are to have straight line flow characteristics. Valves are to have position indicators. Valves for outdoor applications to be suitable in all respects for application.

- C. Heating valves are to be normally open, unless otherwise specified.
- D. Cooling valves are to be normally closed, unless otherwise specified.
- E. Unless otherwise specified, control valves in hydronic piping systems are to conform to requirements specified in Section entitled HVAC Piping and Pumps.
- F. Unless otherwise specified, valves in steam/condensate piping are to generally conform to requirements specified in Section entitled Steam and Condensate Piping and Pumps but must be equipped with stainless steel plugs and stems, removable screwed stainless steel seat rings, and spring loaded Teflon V-ring packing.
- G. Control valve operators are to be spring return type for fail safe operation, sized to tightly shut the control valves against differentials imposed by system, equipped with position indicators, and suitable in all respects for environment in which they are located.
- H. Electric valve operators are to be Belimo "EF Series" or approved equal, enclosed reversible gear type operators that can accept modulating control signals as required. Each is to be 1-phase AC, 120 or 24 volt as required or indicated, overload protected, and complete with enclosure to suit the mounting location.

2.3 CONTROL DAMPERS AND OPERATORS

- A. T. A. Morrison & Co. Inc. "TAMCO" 100 mm (4") deep, flanged, AMCA low leakage certified aluminium dampers. Dampers for modulating and mixing applications are to be opposed blade type. Dampers for open-shut service are to be parallel blade type. Maximum blade length is to be 1 m (4'). Dampers greater than 2 sections wide are to be complete with jackshaft. Each damper is to be complete with:
 - 1. extruded 6063T5 aluminum frame and airfoil blades, each with an integral slot to receive a gasket;
 - 2. extruded TPE frame gaskets and extruded EPDM blade gaskets;
 - 3. slip-proof aluminium and corrosion resistant plated steel linkage of metal thickness to prevent warping or bending during damper operation, concealed in frame, equipped with self-sealing and self-lubricating bearings consisting of Celcon inner bearing fixed on hexagonal blade pin and rotating in polycarbonate outer bearing inserted in frame.
- B. For standard damper(s), Series 1000 as above.
- C. For insulated damper(s), Series 9000 as above but with all 4 sides of frame insulated with polystyrene, and blades thermally broken and insulated with expanded polyurethane foam.
- D. Each damper motor is to be shaft mounted, spring return, fail safe in the normally open or normally closed position, sized to control damper against maximum pressure or dynamic closing pressure, whichever is greater, to suit sizes of dampers involved, and to provide sufficient force to maintain damper rated leakage characteristics. Each operator is to be complete with a damper position indicator, and external adjustable stops to limit length of stroke in either direction, and is to be mounted on a corrosion resistant adjustable bracket. Operating arms are to have double yoke linkages and double set screws for fastening to damper shaft. Operators for dampers to be connected to building fire alarm system or to freeze protection devices are to be equipped with additional relays to permit dampers to respond and go to required position in less than 15 seconds upon receipt of a signal. Operator enclosures are to be suitable in all respects for environment in which they are located.
- E. Electric damper operators are to be Belimo EF Series or approved equal, 24 volt or 120 volt AC spring return, direct coupled electric motor operators for either modulating or 2-position control as required. Each operator is to be overload protected and complete with an enclosure to suit the mounting location.

2.4 LOCAL CONTROL PANELS

- A. NEMA 1 (NEMA 2 in sprinklered areas) wall mounting, enamelled steel barriered enclosures sized to suit the application with 20% spare capacity, perforated sub-panel, numbered terminal strips for all low and line voltage wiring, hinged door, and slotted flush latch.

2.5 CONTROL SYSTEM COMPONENTS

- A. Components specified below are required for control of equipment and systems in accordance with drawing control diagrams and sequences of operation. Not all required components may be specified.

- B. Sensor/transmitter input devices to be suitable in all respects for application and mounting location. Devices are as follows:
1. unless otherwise specified, temperature sensors are to be resistance type, either 2-wire 1000 ohm nickel RTD or 2-wire 1000 ohm platinum RTD with accuracy (includes errors associated with sensor, lead wire, and A to D conversion), equipped with type 316 stainless steel thermowells for pipe mounting applications, as follows:
 - a. chilled water, room temperature, and duct temperature points, $\pm 1^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$);
 - b. all other points, $\pm 0.75^{\circ}\text{C}$ ($\pm 1.3^{\circ}\text{F}$).
 2. room temperature sensors constructed for surface or recessed wall box mounting, complete with an adjustable set-point reset slide switch with a $\pm 1.66^{\circ}\text{C}$ ($\pm 3^{\circ}\text{F}$) range, individual heating/cooling set-point slide switches as required, momentary override request pushbutton for activation of after-hours operation, an analogue thermometer;
 3. outside air sensors designed and constructed for ambient temperatures and to withstand environmental conditions to which they are exposed, complete with NEMA 3R enclosure, solar shield, and a perforated plate surrounding sensor element where exposed to wind velocity pressure;
 4. insertion duct mounting sensors type with lock nut and mounting plate, designed to mount in an electrical box (weather-proof with gasket and cover where outside) through a hole in duct;
 5. for ducts greater than 1.2 m (4') or for ducts where air temperature stratification occurs, averaging type sensors with multiple sensing points, and for plenums for applications such as mixed air temperature measurement to account for air turbulence and/or stratification, averaging string of sensors with capillary supports on sides of duct/plenum;
 6. factory solid-state relative humidity sensors with element that resists contamination, weather-proof with NEMA 3R enclosure for outside air applications, supplied with type 304 stainless steel probe with mounting bracket and hardware for duct mounting, each complete with factory calibrated humidity transmitter which is accurate (including lead loss and analog to digital conversion) to 3% between 20% to 80% RH at 25°C (77°F) and equipped with non-interactive span and zero adjustments, and 2-wire isolated loop powered, 4-20 mA, 0 to 100% linear proportional output;
 7. carbon dioxide sensors for air quality control purposes having a maximum 20 second response time, suitable for operating conditions from 0°C to 50°C (32°F to 122°F) and 0 to 100% RH non-condensing, complete with a calibration kit (to be handed to Owner) and characteristics as follows:
 - a. measurement range: 0 to 2000 ppm;
 - b. accuracy: ± 100 ppm;
 - c. repeatability: ± 20 ppm;
 - d. drift: ± 100 ppm per year;
 - e. output signal: 0 to 10 VDC proportional over the 0 to 2000 ppm range.
- C. Pressure transmitters are to be constructed to withstand 100% pressure over-range without damage and to hold calibrated accuracy when subject to a momentary 40% over-range input. Pressure transmitters are to transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal. Differential pressure transmitters used for flow measurement are to be sized to the flow sensing device and supplied with a tee fitting and shut-off valves in the high and low sensing pick-up lines to allow permanent ease of use connection for balancing, etc. Transmitter housing is to suit mounting location. Standalone pressure transmitters are to be mounted in a minimum NEMA 1 (NEMA 2 in sprinklered area) by-pass valve assembly panel with high and low connections piped and valved, air bleed units, by-pass valves, and compression fittings. Transmitters are to be as follows:
1. low differential water pressure, 0 to 5 kPa (0 to 20" wc): equal to Setra or Mamac industrial quality transmitter capable of transmitting a linear 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - a. maintain accuracy up to 20 to 1 ratio turndown;
 - b. reference accuracy: $+0.2\%$ of full scale.
 2. medium to high differential water pressure, over 5 kPa (20" wc): Setra or Mamac or approved equal, transmitters as specified above for low pressure transmitters but with a pressure range of from 2.5 kPa (10" wc) to 2070 kPa (300 psi), a reference accuracy of $\pm 1\%$ of full span (includes non-linearity, hysteresis, and repeatability);

3. building differential air pressure: Setra or Johnson Controls Inc. or approved equal, industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - a. maintain accuracy up to 20 to 1 ratio turndown;
 - b. reference accuracy: +0.2% of full span.
 4. low differential air pressure, 0 to 1.25 kPa (0" to 5" wc): Setra or Johnson Controls Inc. or approved equal, industrial quality transmitter with a range suitable for the application, capable of transmitting a linear 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points, each complete with non-interactive zero and span adjustments adjustable from outside the cover, and performance as follows:
 - a. maintain accuracy up to 20 to 1 ratio turndown;
 - b. reference accuracy: +0.2% of full span.
 5. medium differential air pressure, over 1.5 kPa (5" wc): Setra or Johnson Controls Inc. or approved equal, transmitters as specified above for low pressure air transmitters, but performance requirements as follows:
 - a. zero and span: (c/o F.S./Deg. F); .04% including linearity, hysteresis, and repeatability;
 - b. accuracy: 1% F.S. (best straight line); static pressure effect: 0.5% F. S.;
 - c. thermal effects: <+0.33 F.S./°F over 40°F to 100°F (calibrated at 70°F).
- D. Air and water flow monitoring stations and probes are to be Air Monitor Corp., Tek-Air Systems Inc., Ebtron, or Dietrich Standard products as follows:
1. Fan Inlet Air Flow Measuring Station: At fan inlet and near exit of inlet sound trap, air flow traverse probes are to continuously monitor fan air volume and system velocity pressure, and traverse probes are to be as follows:
 - a. each probe is to be of a dual manifold, cylindrical, anodized type 3003 extruded aluminium construction probe with sensors located along the stagnation plane of approaching air flow, and the static pressure manifold is to incorporate dual offset static tops on opposing sides of averaging manifold so as to be insensitive to flow angle variations for as much as $\pm 20^\circ$ in approaching air stream;
 - b. each probe is not to introduce a measurable pressure drop, nor is sound level within duct to be amplified by its singular or multiple presence in air stream, and each probe is to contain multiple static and total pressure sensors places at equal distances along its length in accordance with ASHRAE Standards for duct traversing.
 2. Single Probe Air Flow Measuring Sensor: Duct mounting hot wire anemometer type which utilizes 2 temperature sensors, one is a heater element temperature sensor and the other is to measure downstream temperature, with temperature differential related directly to air flow velocity. Sensor insertion length is to be adjustable up to 200 mm (8"), and transmitter is to produce a 4 to 20 mA or 0 to 10 VDC signal linear to air velocity.
 3. Duct Flow Measuring Stations: #14 gauge galvanized steel casing with duct connection flanges of a size to mate with connecting ductwork, and complete with an air directionalizer and a 98% free area parallel cell 20 mm ($\frac{3}{4}$ ") honeycomb profile suppressor across entering air stream to equalize velocity profile and eliminate turbulent and rotational flow from the air stream prior to measuring point, mechanically fastened to casing so as to withstand velocities of up to 1828 m (6000') per minute. Additional requirements as follows:
 - a. total pressure measurement side (high side) is to be designed and spaced to requirements of Industrial Ventilation Manual, 16th Edition, page 9-5, and self-averaging manifolding is to be constructed of brass and copper components;
 - b. static pressure sensing probes (low side) is to be bullet-nose shaped, per detailed radius, as illustrated in Industrial Ventilation Manual referred to above, page 9-5;
 - c. main take-off point from both total pressure and static pressure manifolds is to be symmetrical, and manifolds are to terminate with external ports for connection to control tubing;
 - d. each station is to be equipped with a label on casing indicating unit model number, size, area, and specified air flow capacity;

- e. each station is to have a self-generated sound rating of less than NC 40, and sound level within duct is not to be amplified nor is additional sound to be generated.
 4. Static Pressure Traverse Probe: Duct mounting, complete with multiple static pressure sensors located along exterior surface of cylindrical probe.
 5. Shielded Static Air Probe: Indoor type or outdoor type as required, each with multiple sensing ports, an impulse suppression chamber, and air flow shielding.
 6. Water Flow Monitoring: Equal to Onicon microprocessor-based electromagnetic water flow meters with an accuracy of 0.25%.
- E. Power (amps) monitoring is to be performed by a combination of a current transformer and a current transducer with transformer sized to reduce full amperage of monitored circuit to a maximum 5 ampere signal which will be converted to a 4 to 20 mA DDC compatible circuit for use by building automation system. Current transformer and current transducer are as follows:
1. equal to Veris Industries split core current transformer with an operating frequency of from 50 to 400 Hz, 0.6 Kv class, 10 Kv BIL insulation, and 5 ampere secondary;
 2. equal to Veris Industries current to voltage or current to mA transducer with an accuracy of $\pm 5\%$, a minimum load resistance of 30 kOhm, an input of 0 to 20 amperes and an output of 4 to 20 mA, and a 24 VDC regulated power supply.
- F. Duct mounting smoke detectors supplied as part of electrical work for mounting as part of control system work.
- a. 3 internal DPDT relays rated at 5 amperes at 30 VDC, at fully programmable alarm levels and within programmable time delays, and capable of activating multiple relay modules of 8 external relays each at programmable alarm set-points and time delays;
 - b. alphanumeric display indicating concentration and type of gas detected as well as location of sensor/transmitter, and 2 alarm levels for each sensing point;
 - c. identified LED's to indicate Power, Alarm Levels A, B and C, and/or Fault;
 - d. audible alarm rated at minimum 65 dBA at 1 m (3') that will fully activate at programmable levels;
 - e. 3 levels of continuous diagnostics to verify reading of each sensor/transmitter for abnormal sensing behaviour, loss of communication between control panel and sensor/transmitter, and program corruption analysis;
 - f. capability of long term data logging to determine trends;
 - g. capability of output communication through BACnet/IP to building automation system to monitor system status and to view logged historical data.
 - h.
 - i. 2 internal DPDT relays rated at 5 amperes at 30 VDC, at fully programmable alarm levels and within programmable time delays, and capable of activating remote devices such as fan starters;
 - j. alphanumeric display indicating exact concentration and type of gas detected, and 2 alarm levels for each sensing point;
 - k. identified LED's to indicate Power (green), and Alarm Levels A and B (amber);
 - l. audible alarm rated at minimum 65 dBA at 1 m (3') that will fully activate at programmable levels;
 - m. continuous monitoring electro-chemical sensors, one for carbon monoxide, one for nitrogen dioxide.
2. Digital to Analog Output Convertor: Model 4201 24 volt AC, 500 mA convertor to communicate digitally with up to 8 sensor/transmitter units and control panel within a daisy-chain network to convert digital signal from transmitters to analog outputs to permit each transmitter to produce up to 8 dedicated 4-20 mA signals to a building automation system or variable frequency drive from one central location which can be a maximum of 600 m (2000') from control panel.
 3. Acceptable manufacturers are:
 - a. Honeywell Analytics/Vulcain Inc.;
 - b. Mine Safety Appliance Co. (MSA);
 - c. Armstrong Monitoring Co.;
 - d. Quatrosense Environmental Ltd. (QEL).
- G. Double contact switches to monitor equipment status and safety conditions, and generate alarms when a failure or abnormal condition occurs. Status and safety switches are to be as follows:

1. current sensing switches: Veris Industries or approved equal, self-powered dry contact output switches for sensing run status of motor loads, each calibrated to indicate a positive run status only when motor is operating under load, and each consisting of a current transformer, a solid-state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and a LED to indicate on or off status;
 2. air filter status switches: Johnson Controls Inc. or Cleveland Controls or approved equal, automatic reset type differential pressure switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC, a scale range and differential pressure adjustment appropriate for the service, and an installation kit which includes static pressure taps, tubing, fittings, and air filters;
 3. air flow switches: Johnson Controls Inc. or Cleveland Controls or approved equal, pressure flow switches, bellows actuated mercury switch or snap-acting micro-switch type with an appropriate scale range and pressure adjustment;
 4. air pressure safety switches: Johnson Controls Inc. or Cleveland Controls or approved equal, manual reset switches, each complete with SPDT contacts rated for 2 amperes at 120 VAC and an appropriate scale range and pressure adjustment;
 5. water flow switches: Johnson Controls Inc. Model P74 or approved equal;
 6. low temperature limit switches: manual reset type, Johnson Controls Inc. Model A70 or approved equal, each complete with DPST snap acting contacts rated for 16 amperes at 120 VAC, a minimum 4.5 m (15") sensing element for mounting horizontally across duct/plenum with sensing reaction from coldest 450 mm (18") section of element, and where sensing element does not provide full coverage of air stream, additional switches are to be supplied as required.
- H. Control relays as follows:
1. control pilot relays: Johnson Controls Inc. or Lectro or approved equal, modular plug-in design with snap-mount mounting bases, retaining springs or clips, DPDT, 3 PDT or 4 PDT as required for the application, with contacts rated for 10 amperes at 120 VAC;
 2. lighting control relays: latching type with integral status contacts rated for 20 amperes at 120 VAC, each complete with a split low voltage coil that moves the voltage contact armature to On or Off latched position, each controlled by a pulsed tri-state output (preferred) or pulsed paired binary outputs, and each designed so power outages will not result in a change-of-state and so multiple same state commands will simply maintain commanded state.
- I. Electronic signal isolation transducers, Advanced Control Technologies or approved equal, for installation whenever analog output signal from building automation system is to be connected to an external control system as an input (i.e. equipment control panel) or is to receive as an input signal from a remote system, and to provide ground plane isolation between systems.
- J. Each manual override station is to be complete with contacts rated minimum 1 ampere at 24 VAC and is to provide following:
1. integral H-O-A switch to override controlled device pilot relay;
 2. status input to building automation system to indicate whenever switch is not in the Auto position;
 3. status LED to illuminate whenever output is On;
 4. override LED to illuminate whenever H-O-A switch is in either the Hand or Off position.
- K. Electronic/pneumatic transducers, Johnson Controls Inc. or approved equal, transducers with output of from 3 to 15 psig, an input of from 4 to 20 mA or 10 VDC, manual output adjustment, a pressure gauge, and an external replaceable supply air filter.
- L. Thermostats:
1. Wall mounting adjustable set-point thermostats, each suitable in all respects for equipment (and operating sequence) they are provided for, equipped with a thermometer, cover and any required mounting and connection accessories.
 2. Pneumatic thermostats are to be of bimetal element construction, double valve type, operating without constant waste of air.
 3. Line voltage thermostats are to be 115 volt.
 4. Low voltage thermostats are to be 24 volt electronic type.
 5. Set-point adjustment for thermostats in public spaces is to be concealed behind cover. Set-point adjustment for other thermostats is to be accessible through cover.

6. Covers are to be removable, tamper-proof covers with temperature set-point and thermometer displays.
7. Guards for thermostats are to be clear, ventilated polycarbonate covers with allen key locking hardware.

M. Humidistats:

1. Direct or reverse acting (to suit system), proportional type, adjustable humidity controllers, each corrosion resistant, suitable in all respects for application and complete with nylon element, replaceable cartridge type air filter, internally adjustable limit stops for maximum and minimum settings, a cover, and required mounting and connection accessories.
2. Pneumatic humidistats are to be 2 pipe type and complete with plug-in air connections.
3. Electric humidistats are to be line voltage (115 volt), or 24 volt electronic type.
4. Wall mounting humidistats are to be complete with a tamper-proof display type cover.
5. Duct mounting humidistats are to be complete with a display type cover, duct sampling chamber with 300 mm (12") long extruded pick-up tube for duct mounting, a moulded mounting base, and ventilated cover.

N. Hardware to permit building automation system control and monitoring of input/output points in accordance with Section entitled Building Automation System, points schedule, and drawing control diagrams and operation sequences. Such hardware is to be suitable in all respects for interface with BAS.

O. Honeywell Analytics microprocessor-based gas detection system, programmable monitoring and alarm equipment as indicated on drawings, CSA certified, in accordance with ANSI/UL 2017, General-Purpose Signaling Devices and Systems, ANSI/UL 2034, Single and Multiple Station Carbon Monoxide Alarms, and CAN/CSA C22.2 No. 61010, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use-Part 1: General Requirements, and as follows:

1. Mechanical room CO and NO₂ Sensors: Model E3SA-E3SCO with E3SRMNO2 remote sensor, 24 volt AC/DC wall mounting enclosure, capable of communicating with a building automation system to monitor exhaust fan status (primary or secondary), zone concentration and alarms through required protocol, and complete with:
 - a. factory programmed software to enable required sequence of operation;
 - b. 2 internal DPDT relays rated at 5 amperes at 30 VDC, at fully programmable alarm levels and within programmable time delays, and capable of activating remote devices such as fan starters;
 - c. alphanumeric display indicating exact concentration and type of gas detected, and 2 alarm levels for each sensing point;
 - d. identified LED's to indicate Power (green), and Alarm Levels A and B (amber);
 - e. audible alarm rated at minimum 65 dBA at 1 m (3') that will fully activate at programmable levels;
 - f. continuous monitoring electro-chemical sensors, one for carbon monoxide, one for nitrogen dioxide;

2.6 SYSTEM WIRING MATERIALS

- A. System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in appropriate Section(s) of Electrical Work specification.

PART 3 - EXECUTION

3.1 DEMOLITION

- A. Perform required control system demolition work.

- B. Refer to demolition requirements specified in Section entitled Demolition and Revision Work.

3.2 GENERAL RE: INSTALLATION OF CONTROLS

- A. Provide complete systems of control and instrumentation to control and supervise building equipment and systems in accordance with this Section and drawings.
- B. Control systems are to generally be as indicated on drawing control diagrams and are to have elements therein indicated or implied.
- C. Control diagrams show only principal components controlling equipment and systems. Supplement each control system with relays, transformers, sensors, etc., as required to enable each system to perform as specified and to permit proper operation and supervision.

3.3 INSTALLATION OF CONTROL AIR COMPRESSOR SET AND DRYER

- A. Provide a duplex air compressor set. Secure set in place on vibration isolation on a concrete housekeeping pad. Install flexible piping connections supplied with set and connect with required piping, including drain piping extended and terminated at nearest drain.
- B. Wall mount power and control panel(s) adjacent to equipment. Connect compressor set panel pressure switch with copper tubing to compressor set.

3.4 INSTALLATION OF CONTROL AIR PIPING AND TUBING

- A. Provide required control air piping and tubing.
- B. Piping/tubing is to be as follows:
 1. for piping mains and branches, type "M" seamless copper;
 2. for exposed connections to control components, hard or soft copper tubing;
 3. for tubing in accessible ceiling spaces, plenum rated polyethylene, neatly bundled with plastic ties and properly supported;
 4. for connections to control components within control cabinets, soft copper or plenum rated polyethylene tubing.
- C. Properly install and support piping and tubing. Provide suitably sized trap legs with drain valves at all low points to prevent condensation pockets.
- D. Solder all copper joints except at instruments or panels where compression fittings are to be used.

3.5 SUPPLY OF CONTROL AIR DAMPERS AND OPERATORS

- A. Unless otherwise specified, supply required control dampers. Hand dampers to sheet metal trade at site in location where they are required for installation as part of sheet metal work. Ensure each damper is correctly located and mounted.
- B. Provide linkage and operators for dampers. Wherever possible locate damper operators so they are accessible from outside duct, plenum, and equipment casings. Bracket mount operators on ducts or plenums clear of insulation where applicable.
- C. Where sequence operation is indicated, or where multiple operators drive a series of dampers, provide pilot positioners to couple their action.
- D. Ensure dampers located in ductwork other than galvanized steel are constructed of type 316 stainless steel.

3.6 SUPPLY OF AUTOMATIC CONTROL VALVES AND OPERATORS

- A. Unless otherwise specified, supply required automatic control valves. Hand valves to appropriate piping trades at site in locations they are required for installation as part of piping work. Ensure each valve is properly located and installed.
- B. Provide operator for each valve.

3.7 SUPPLY OF ACTUATORS, CONTROLLERS, AND TRANSFORMERS FOR TERMINAL UNITS

- A. Supply required 24 volt actuators, controllers, and transformers for terminal units.

- B. Deliver actuators and controllers to successful terminal unit manufacturer's factory.
- C. Coordinate delivery of product with General Contractor and successful terminal unit manufacturer.

3.8 INSTALLATION OF THERMOSTATS

- A. Unless otherwise noted, provide required thermostats.
- B. Provide a ventilated clear polycarbonate cover for each thermostat located in finished areas, and a wire type guard for each thermostat located in unfinished areas and in areas such as mechanical rooms where thermostat is subject to damage.
- C. Unless otherwise indicated, mount room thermostats in accordance with requirements of local governing authority and, where applicable, barrier-free requirements. Review exact location of thermostats with Consultant prior to roughing-in.
- D. Provide stand-off mounting and an insulated sub-base for thermostats on outside walls.
- E. Perform control wiring associated with installation of electric or electric-electronic thermostats.

3.9 INSTALLATION OF CONTROL SYSTEM COMPONENTS

- A. Provide required control system components and related hardware. Refer to drawing control diagrams and sequences.
- B. Where components are pipe, duct, or equipment mounted supply components at proper time, coordinate installation with appropriate trade, and ensure components are properly located and mounted.

3.10 INSTALLATION OF GAS DETECTION SYSTEM

- A. Provide gas detection system sensor/transmitter and control panel equipment for areas where indicated and/or specified on drawings.
- B. Review exact locations of equipment with Consultant prior to installation.
- C. Perform required 24 volt wiring in conduit to control panel(s) and from each panel to associated sensor/transmitter units as required and in accordance with wiring requirement specified in the electrical work specification and system manufacturer's certified wiring schematics. Provide 24 volt interlock wiring to exhaust fan starters in accordance with drawing control requirements.

3.11 CONTROL WIRING

- A. Perform required control wiring work for control systems except:
 - 1. power wiring connections to equipment and panels, except as noted below;
 - 2. control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
 - 3. starter interlock wiring.
- B. Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2') connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- C. Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.
- D. Wiring work is to be in accordance with certified wiring schematics and instructions, and wiring standards specified in appropriate Sections of Electrical Work Specification.

3.12 IDENTIFICATION AND LABELLING OF EQUIPMENT AND CIRCUITS

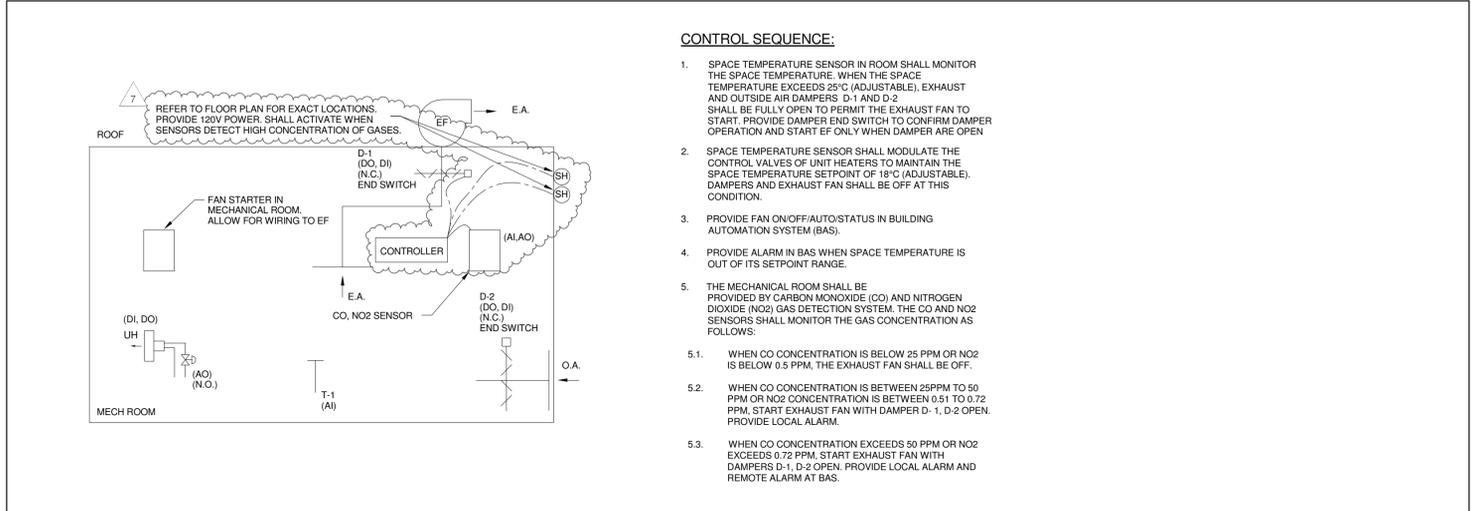
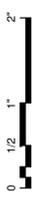
- A. Refer to identification requirements specified in Section entitled Basic Mechanical Materials and Methods.
- B. Identify equipment as follows:
 - 1. enclosures and components: engraved laminated nameplates with wording listed and approved prior to manufacture of nameplates;

2. wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings.

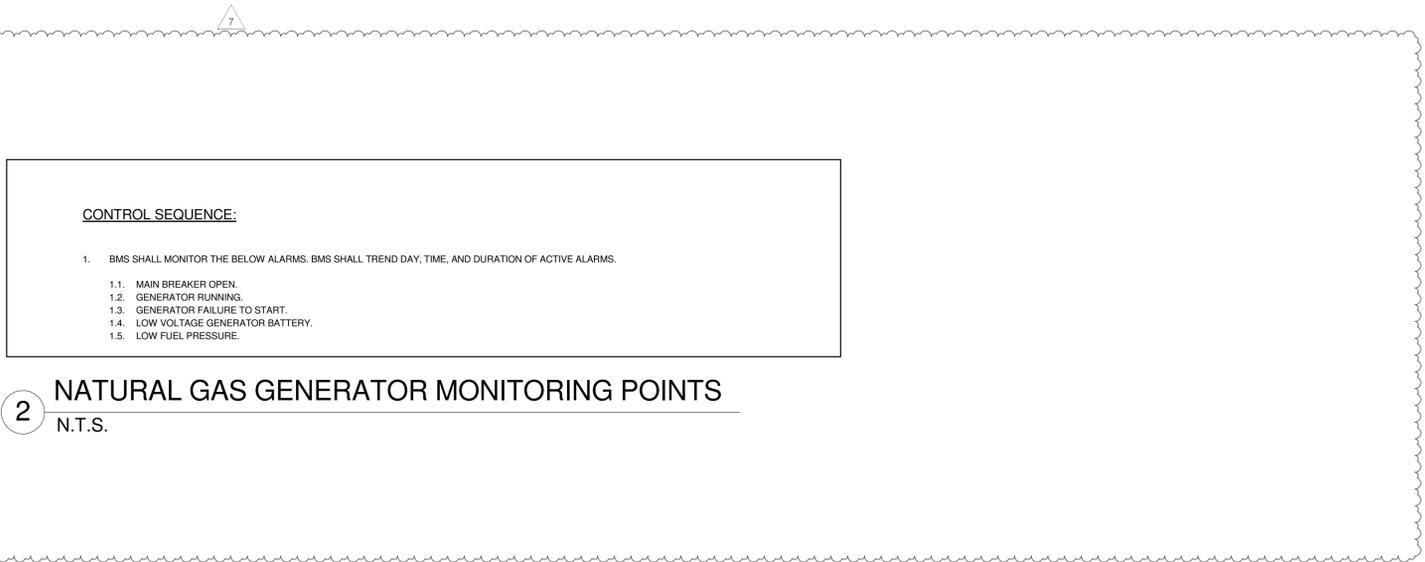
3.13 TESTING, ADJUSTING, CERTIFICATION, START-UP, AND TRAINING

- A. When control work is complete, check installation of components and wiring connections, make any required adjustments, and coordinate adjustments with personnel doing HVAC testing, adjusting and balancing work.
- B. Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- C. Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- D. Include for 2 full, 8 hour days on-site operation demonstration and training sessions. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.
- E. Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full, 8 hour day to provide additional system training as required, and to demonstrate troubleshooting procedures.

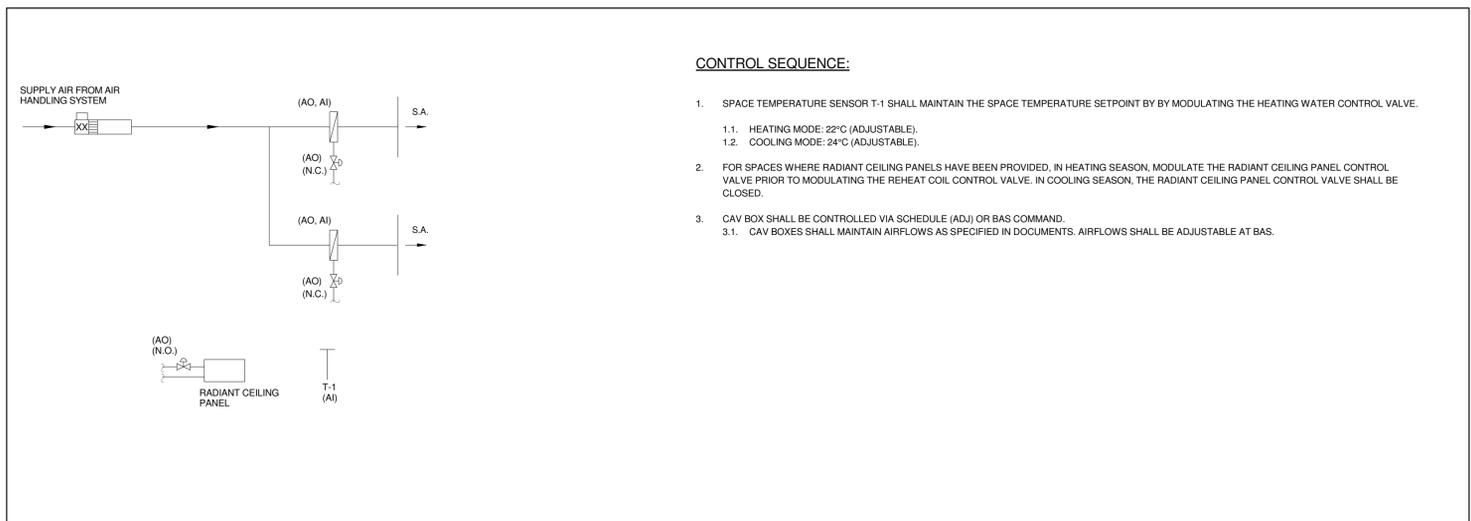
END OF SECTION



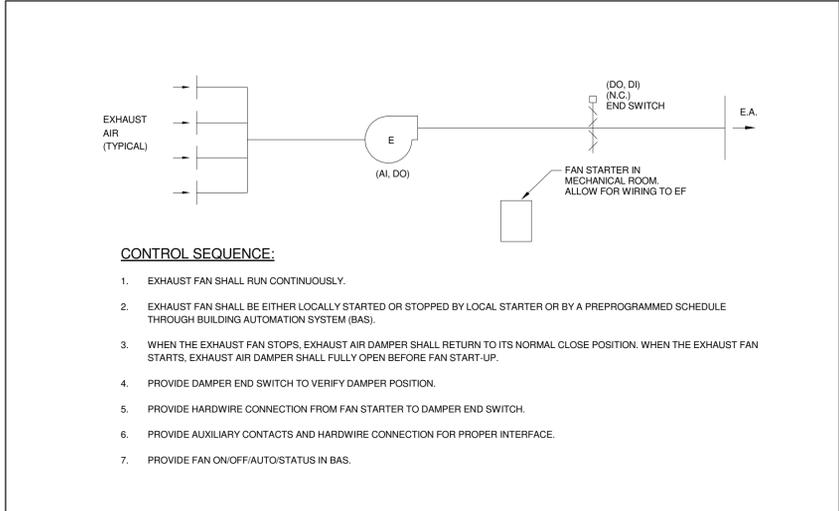
1 MECHANICAL ROOM VENTILATION CONTROL DIAGRAM
N.T.S.



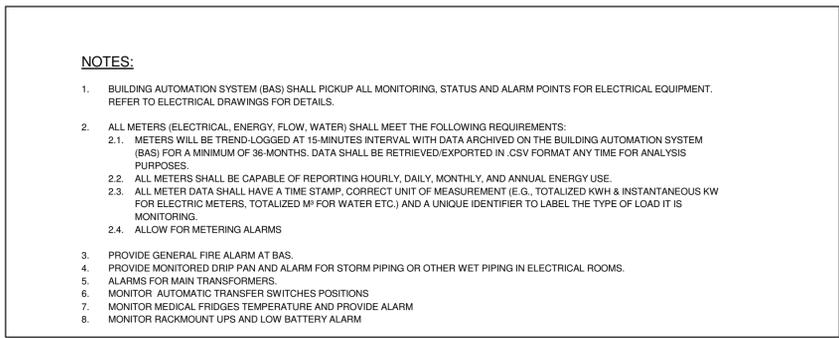
2 NATURAL GAS GENERATOR MONITORING POINTS
N.T.S.



5 REHEAT COIL & RADIANT CEILING PANEL CONTROL DIAGRAM
N.T.S.



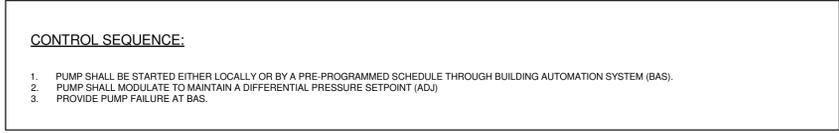
6 TYPICAL EXHAUST CONTROL DIAGRAM
N.T.S.



7 MISCELLANEOUS CONTROL POINTS
N.T.S.



8 DCW RECIRC. PUMP DHWR-1 CONTROL DIAGRAM
N.T.S.



8 DOMESTIC COLD WATER BOOSTER PUMP CONTROL
N.T.S.

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Project Manager	Approver
Project Designer	Author
Project Architect	HDR
Landscape Architect	
Civil Engineer	WSP
Structural Engineer	WSP
Mechanical Engineer	WSP
Plumbing Engineer	WSP
Interior Designer	Interior Designer
Equipment Planner	Equipment Planner
Wayfinding	

Sheet Reviewer	Checker
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MARK	DATE	DESCRIPTION
1	2023-07-05	ISSUED FOR MOH STAGE 3.2
2	2023-11-24	ISSUED FOR STAGE 3.3 COSTING
3	2024-02-12	ISSUED FOR MOH STAGE 3.3
4	2024-03-22	ISSUED FOR BUILDING PERMIT
5	2024-09-18	ISSUED FOR TENDER
6	2024-10-07	ISSUED FOR ADDENDUM M01
7	2024-10-21	ISSUED FOR ADDENDUM M03

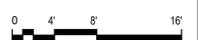
Project Number 221-11662-00
Original Issue 02/23/21

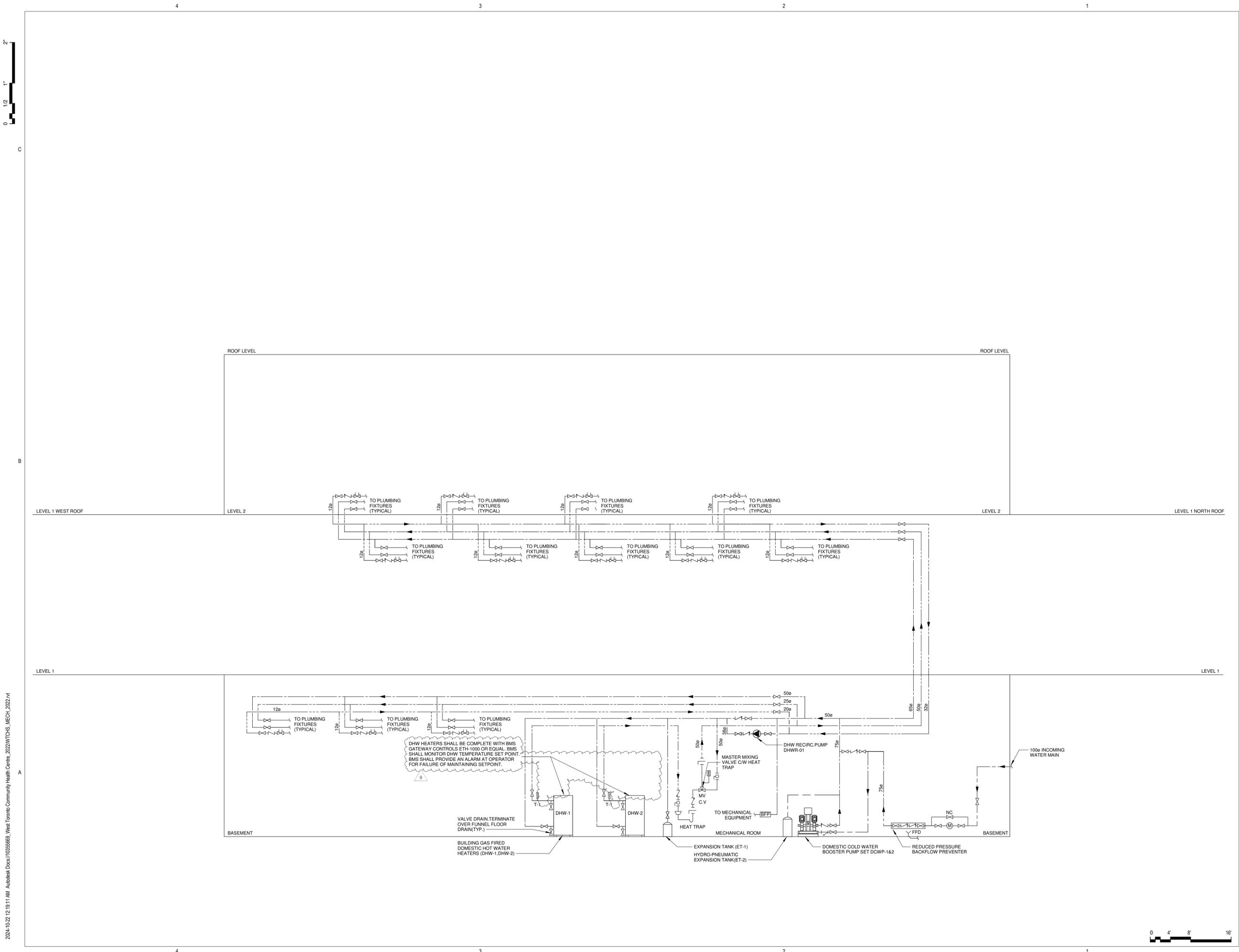
Sheet Name
MECHANICAL CONTROLS I

Scale
N.T.S.
Sheet Number

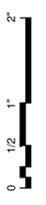
M-501

Project Status
ISSUED FOR TENDER





2024-10-22 12:58:11 AM Autodesk Docs://10355669_West Toronto Community Health Centre_2022/WTCHS_MECH_2022.rvt



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Mechanical Engineer	WSP
Plumbing Engineer	WSP
Interior Designer	Interior Designer
Equipment Planner	Equipment Planner
Wayfinding	

Sheet Reviewer	Checker
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MARK	DATE	DESCRIPTION
1	2022-12-16	ISSUED FOR MOH STAGE 3.1
2	2023-05-05	ISSUED FOR STAGE 3.2 COSTING
3	2023-07-05	ISSUED FOR MOH STAGE 3.2
4	2023-11-24	ISSUED FOR STAGE 3.3 COSTING
5	2024-02-12	ISSUED FOR MOH STAGE 3.3
6	2024-03-22	ISSUED FOR BUILDING PERMIT
7	2024-09-18	ISSUED FOR TENDER
8	2024-10-07	ISSUED FOR ADDENDUM M01
9	2024-10-21	ISSUED FOR ADDENDUM M03

Project Number	221-11662-00
Original Issue	12/08/22

Sheet Name DOMESTIC WATER SCHEMATIC

Scale
N.T.S.

Sheet Number
M-601

Project Status
ISSUED FOR TENDER



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SCHEDULE OF ROOFTOP UNITS (DAIKIN)

TAG NO.	LOCATION	AREA SERVED	MANUFACTURER	MODEL NUMBER	FANS													HEATING							ELECTRICAL													
					FAN TAG	FUNCTION	QTY	TYPE	FAN WHEEL DIAM (mm)	SERIES	AIR FLOW (L/S)	O/A %	E.S.P. (Pa)	T.S.P. (Pa)	FAN RPM	MOTOR (HP)	VFD / ECM	EMERG. POWER	HEATING CAPACITY (kW)	AIR SIDE				GAS			CONDENSING SECTION	QTY.	DX COOLING CAPACITY TOTAL-SENSE (kW)	AIRIDE (°C) COOLING	POWER (V/PH/Hz)	FLA (A)	MCA (A)	MROPD (A)	SCCR (kAIC)	WEIGHT (kg)	CURB WEIGHT (kg)	
																				EAT (°C)	LAT (°C)	A.P.D. (Pa)	MIN PRESSURE (kPa)	MAX PRESSURE (kPa)	TURNDOWN	DB												WB
RTU-1	ROOF	BASEMENT	DAIKIN	DPS12B	ACS-1	S/A	1	DIRECT DRIVE SWSI AF	457	SERIES II	1,652	40	374	774	1930	4.3	ECM	NO	46.9	5.6	-	18.3	-	7.50	1.24	3.48	MODULATING 10:1	INVERTER SCROLL	1	42.4-27.8	12.8	575/3/60	29.0	34.2	50	10	1071	308 HORIZONTAL DISCHARGE CURB
					ACE-1	E/A	1	DIRECT DRIVE SWSI AF	406	SERIES II	1,652		125	-	1651	1.5	ECM	NO																				
RTU-2	ROOF	LEVEL 1	DAIKIN	DPS12B	ACS-2	S/A	1	DIRECT DRIVE SWSI AF	457	SERIES II	1,558	40	274	672	1796	4.3	ECM	NO	46.9	5.6	-	18.3	-	7.50	1.24	3.48	MODULATING 10:1	INVERTER SCROLL	1	41.9-27.0	12.8	575/3/60	29.0	34.2	50	10	1071	308 HORIZONTAL DISCHARGE CURB
					ACE-2	E/A	1	DIRECT DRIVE SWSI AF	406	SERIES II	1,558		125	-	1574	1.5	ECM	NO																				
RTU-3	ROOF	LEVEL 1	DAIKIN	DPS12B	ACS-3	S/A	1	DIRECT DRIVE SWSI AF	457	SERIES II	1,558	40	374	771	1891	4.3	ECM	NO	46.9	5.6	-	18.3	-	7.50	1.24	3.48	MODULATING 10:1	INVERTER SCROLL	1	41.9-27.0	12.8	575/3/60	29.0	34.2	50	10	1071	308 HORIZONTAL DISCHARGE CURB
					ACE-3	E/A	1	DIRECT DRIVE SWSI AF	406	SERIES II	1,558		125	-	1574	1.5	ECM	NO																				
RTU-4	ROOF	LEVEL 1	DAIKIN	DPSA020	ACS-4	S/A	2	DIRECT DRIVE SWSI AF	450	SERIES II	2,880	40	249	672	1746	2.2	ECM	NO	47.5	5.6	-	18.3	-	4.98	1.74	3.48	-	STAGED	3	75.8-53.9	12.8	575/3/60	-	94.2	125	10.0	4157	308
					ACR-4	R/A	2	DIRECT DRIVE SWSI AF	450	SERIES I	2,880		125	-	1112	2.3	ECM	NO																				
RTU-5	ROOF	LEVEL 2	DAIKIN	DPSA020	ACS-5	S/A	2	DIRECT DRIVE SWSI AF	450	SERIES II	2,975	40	249	672	1769	3.7	ECM	NO	47.5	5.6	-	18.3	-	4.98	1.74	3.48	-	STAGED	3	76.2-57.0	12.8	575/3/60	-	97.0	125	10.0	4166	308
					ACR-5	R/A	2	DIRECT DRIVE SWSI AF	450	SERIES I	2,975		125	-	1137	2.3	ECM	NO																				

- NOTES:
- UNIT CONTROL PANEL PACKAGED INTEGRAL TO UNIT INTEGRATED TO BAS.
 - DX COIL AND CONDENSER REFRIGERANT SHALL BE R32.
 - RTU-4,5 SHALL BE C/W PACKAGED HUMIDIFIERS BY MANUFACTURER. REFER TO SCHEDULE OF HUMIDIFIERS FOR SIZING.
 - ROOFTOP UNITS SHALL BE INSTALLED COMPLETE WITH 120V MAINTENANCE RECEPTACLE. WIRING BY ELECTRICAL CONTRACTOR.
 - RTU-1, 2 AND 3 SHALL BE SUPPLIED WITH A 914MM TALL HORIZONTAL DISCHARGE CURB IN ORDER TO ACCOMMODATE DUCT CONNECTIONS.
 - RTU-1,2,3 ARE SUPPLIED WITH EXHAUST FANS. RTU-4,5 ARE SUPPLIED WITH RETURN FANS.

SCHEDULE OF ELECTRIC STEAM GENERATORS AND ELECTRIC HUMIDIFIERS (DRISTEEM)

TAG	LOCATION	MODEL NO.	STEAM CAPACITY (kg/hr)		POWER			REMARKS
			REQUIRED	CAPACITY	V/PH/Hz	FLA	KW	
STG-1-HUM-1	MECHANICAL ROOM	RX-36-1	15.7	16.3	575/3/60	11.6	12	REFER TO NOTE 1, 2, 3, 6.
STG-2-HUM-2	MECHANICAL ROOM	RX-36-1	14.8	16.3	575/3/60	11.6	12	REFER TO NOTE 1, 2, 3, 6.
STG-3-HUM-3	LEVEL 1 ROOF	RX-36-1	14.8	16.3	575/3/60	11.6	12	REFER TO NOTE 1, 2, 3, 5, 6.
STG-HUM-4	RTU-4	RX-75-1	28.70	34.02	575/3/60	26	25	REFER TO NOTE 1, 2, 4.
STG-HUM-5	RTU-5	RX-75-1	29.65	34.02	575/3/60	26	25	REFER TO NOTE 1, 2, 4.

- NOTES:
- HUMIDIFIERS SHALL BE COMPLETE WITH GENERATION DRAIN COOLER, HIGH-LIMIT HUMIDISTAT (ELECTRIC, MODULATING), AIRFLOW PROVING SWITCH (ELECTRIC), HUMIDITY TRANSMITTER.
 - REFER TO RECOMMEND FUSE SIZE AS PER MANUFACTURERS INFORMATION.
 - STEAM GENERATORS (STG-1, 2 AND 3) ARE COMPLETE WITH ASSOCIATED DUCT-MOUNTED HUMIDIFIERS.
 - HUMIDIFIERS (HUM-4 AND 5) ARE LOCATED WITHIN THE ASSOCIATED PACKAGED ROOFTOP UNITS (RTU-4 AND RTU-5).
 - STG-3 SHALL BE COMPLETE WITH OUTDOOR ENCLOSURE, CURB AND APPROPRIATE WEATHER COVERS FOR WIND, SUN AND RAIN. THE OUTDOOR ENCLOSURE SHALL BE COMPLETE WITH WATER TEMPERING DEVICE. INSTALLED WITHIN THE ENCLOSURE.
 - PROVIDE ARMSTRONG CC-5 DRAIN COOLER.

SCHEDULE OF RTU NOISE DATA

TAG	MAXIMUM SOUND LEVEL PER FREQUENCY (HZ) BAND								REMARKS
	(INLET / OUTLET / RADIATED)								
	63	125	250	500	1000	2000	4000	8000	
RTU-1	82/82	80/83	83/88	88/91	85/91	79/85	74/82	68/76	
	/85	/85	/78	/81	/77	/73	/70	/60	
RTU-2	80/80	78/81	86/89	81/86	83/89	77/83	72/80	66/74	
	/85	/85	/81	/78	/77	/73	/70	/60	
RTU-3	82/82	80/83	83/88	88/91	85/91	79/85	74/82	68/76	
	/85	/85	/78	/81	/77	/73	/70	/60	
RTU-4	70/70	60/78	57/71	55/75	56/76	53/71	52/66	70/63	
	/39	/78	/83	/87	/88	/86	/85	/82	
RTU-5	70/70	60/79	57/72	56/75	57/77	53/71	52/67	70/63	
	/39	/78	/83	/87	/88	/86	/85	/82	

NOTES:

SCHEDULE OF IN-DUCT UV (UVDI)

SERVICE	MODEL	TAG	DUCT SIZE W (mm) x H (mm)	LAMP MODEL LENGTH (mm)	LAMP ARC LENGTH (mm)	AIRFLOW (L/S)	LAMP QTY	IRRADIATION DOSE DELIVERED			POWER			REMARKS
								URV	TOTAL AVG. IRR (mW/cm2)	TOTAL UV EXPOSURE DOSE (uJ/cm2)	V / PH / HZ	INPUT	AMPS	
RTU-1 - SUPPLY AIR MAIN	V-MAX-33	UV-L1	700 x 400	838	762	1,652	5	13	13946	2195	120 / 1 / 60	75.6 W	-	REFER TO NOTE 1, 2, 3.
RTU-2 - SUPPLY AIR MAIN	V-MAX-33	UV-L2	700 x 400	838	762	1,558	5	13	13931	2327	120 / 1 / 60	75.6 W	-	REFER TO NOTE 1, 2, 3.
RTU-3 - SUPPLY AIR MAIN	V-MAX-33	UV-L3	700 x 400	838	762	1,558	5	13	13946	2325	120 / 1 / 60	75.6 W	-	REFER TO NOTE 1, 2, 3.
RTU-4 - SUPPLY AIR MAIN	V-MAX-33	UV-L4	850 x 500	838	762	2,880	8	13	14622	2007	120 / 1 / 60	103.88 W	-	REFER TO NOTE 1, 2, 3.
RTU-5 - SUPPLY AIR MAIN	V-MAX-33	UV-L5	850 x 500	838	762	2,975	8	12	14750	1957	120 / 1 / 60	103.88 W	-	REFER TO NOTE 1, 2, 3.

- NOTES:
- THE UNIT SHALL BE C/W SAFETY CUT-OFF SWITCH, SANUVOX MODEL MSCSWC14 OR EQUAL.
 - THE UNIT SHALL HAVE CAPABILITY TO CONNECT TO BUILDING AUTOMATION SYSTEM (BAS).
 - ALLOW FOR 914MM OF STRAIGHT AIRSTREAM FOR THE INSTALLATION OF THE UNITS.

SCHEDULE OF HEAT TRACING

TAG	MATERIAL OF PIPE	INSULATION (THICKNESS IN mm)	OPERATING TEMPERATURE (°C)	SIZE		REMARKS
				DIAMETER(mm)	LENGTH (FL)	
LPS	CARBON STEEL, SCH 40	MINERAL FIBRE (65)	100	75	46	REFER TO NOTE 1.
LPS	CARBON STEEL, SCH 40	MINERAL FIBRE (50)	100	100	8	REFER TO NOTE 1.
LPS	CARBON STEEL, SCH 40	MINERAL FIBRE (50)	100	38	6	REFER TO NOTE 1.
COND. DRAIN	CARBON STEEL, SCH 80	MINERAL FIBRE (50)	83	20	13	REFER TO NOTE 1.
COND. DRAIN	CARBON STEEL, SCH 80	MINERAL FIBRE (50)	83	25	5.5	REFER TO NOTE 1.
DCW	COPPER PRESSURE, TYPE L	MINERAL FIBRE (50)	-	20	5.5	REFER TO NOTE 1.
DCW	COPPER PRESSURE, TYPE L	MINERAL FIBRE (50)	-	25	5.5	REFER TO NOTE 1.

- NOTES:
- THE PIPING SHALL BE HEATED WHEN THE TEMPERATURE DROPS TO OR BELOW 4°C.



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Electrical Engineer	WSP
Plumbing Engineer	WSP
Interior Designer	Interior Designer
Equipment Planner	Equipment Planner
Wayfinding	

Sheet Reviewer: _____
Checker: _____

MARK	DATE	DESCRIPTION
1	2023-05-05	ISSUED FOR STAGE 3.2 COSTING
2	2023-05-19	ISSUED FOR STAGE 3.2 COSTING-R1
3	2023-07-05	ISSUED FOR MOH STAGE 3.2
4	2023-11-24	ISSUED FOR STAGE 3.3 COSTING
5	2024-02-12	ISSUED FOR MOH STAGE 3.3
6	2024-03-22	ISSUED FOR BUILDING PERMIT
7	2024-09-18	ISSUED FOR TENDER
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9	2024-10-21	ISSUED FOR ADDENDUM M03

Project Number: 221-11662-00
Original Issue: 02/23/21

Sheet Name
MECHANICAL SCHEDULES 1

Sheet Number
M-701

Project Status
ISSUED FOR TENDER

