

MECHANICAL/ELECTRICAL ADDENDUM

ME-02

Architect: GOW Hastings Architects

Date: 2024-10-24

Project: Scanlon Creek Nature Centre

Project No.: 23-088

This addendum forms part of the contract documents and amends the original bidding requirements, drawings and specifications noted below.

1 GENERAL

2 MECHANICAL

2.1 SPECIFICATIONS

- .1 Refer to Section 20 90 50 Mechanical-Electrical Equipment Schedule
 - .1 Refer to revised schedule included herewith.
- .2 Refer to Section 22 11 23 Plumbing Pumps
 - .1 Refer to article 2.2.1, revise model to Armstrong Astro 250SS
 - .2 Refer to article 2.2.2 revise capacity to 2USGPM and 1.5ft of head.
- .3 Refer to Section 23 81 26 Split Air Conditioning and Heat Pump Systems
 - .1 Refer to subsection 1.6 Quality Assurance.
 - .1 Refer to item 1.6.6. Revise to refrigerant type noted to "R-32 or R-454B".
 - .2 Refer to subsection 2.2 System Description.
 - .1 Refer to item 2.2.6. Revise to refrigerant type noted to "R-32 or R-454B".
 - .3 Add new subsection 2.7 Refrigerant Detection and Safeties.
 - .1 Manufacturer shall allow for provision of all shut off and refrigerant detection safety measures and equipment as required by ASHRAE 15 and CSA B52 for the installation of A2L equipment.
- .4 Refer to Section 23 73 00 Custom Air Handling Units
 - .1 Refer to subsection 2.2 Indoor Units, item 2.2.1.5. Revise to read: "Heat pipe for dehumidification by AHU manufacturer (or alternative DX coil for hot gas reheat by VRF manufacturer, installed by AHU manufacturer)"
 - .2 Add subsection 2.9 Controls and 2.10 Electrical to the specification as follows:

"2.9 CONTROLS

- .4 Controller
 - .1 Manufacturer shall supply unit complete with factory installed and tested controller. Controller shall be a microprocessor based control system with the ability to communicate with building BAS BACnet IP system. Controller shall permit starting or stopping the unit locally or remotely. Unit controller shall perform all unit control functions including scheduling, unit diagnostics and safeties.
- .5 Manufacturer Control Options:
 - .1 Airflow Control:
 - .1 Variable airflow demand control ventilation sequence to modulate airflow

- between minimum and maximum based on duct static pressure.
 - .2 Provide duct pressure sensor kit for field mounting by Controls contractor.
 - .3 Provide return air CO2 sensor.
- .2 Temperature Control:
 - .1 Supply air temperature to be maintained based on field installed temperature sensor in supply air duct. Setpoint adjustable from controller.
- .3 Energy Recovery Wheel Control:
 - .1 The wheel will be controlled to modulate speed to achieve most energy efficiency. When the outdoor air conditions allow for economizer mode, wheel shall stop. Wheel speed shall be controlled to provide defrost control.
- .4 Motorized Dampers:
 - .1 Field supplied and installed motorized dampers on outdoor air and exhaust to the DOAS shall be controlled to open when the unit is operating and close when the unit is shut down.
- .5 VRF Heating, Cooling and Dehumidification control:
 - .1 Control for VRF heating, cooling and dehumidification. Modulating signal to provide heating and or cooling after energy recovery wheel to achieve temperature setpoint.
 - .2 Heat recovery reheat control for dehumidification control, providing reheat with secondary DX VRF coil.
 - .3 Dew point sensor provided for field installation in the return/exhaust air duct.
 - .4 Electric back-up reheat controlled to run to maintain supply air temperature if temperature can't be maintained with ERW and VRF coil alone.
- .6 Filter Static Pressure Monitoring
 - .1 Supply and return air filter pressure transducer to monitor filter loading.
- .7 Humidifier Control
 - .1 VAV humidification control. Field installed humidity sensor. Provide a 0-10vdc signal from controller to humidifier to maintain relative humidity level in the return/exhaust air duct.
- .8 Time Schedule
 - .1 Provide signal from BAS to unit controller for schedule.
- .9 BAS Integration:
 - .1 DOAS Controller shall be provided with capability to integrate with the Siemens BACnet IP BAS system for control/adjustment of setpoints, schedule, and notification of alarms.

2.10 ELECTRICAL

- .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 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 shall also be provided with the unit.
- .3 Main unit disconnect supplied and installed by Electrical Contractor.
- .4 Back-up Electric heating coil shall be separately powered. Disconnect supplied and installed by Electrical Contractor.
- .5 Manufacturer shall supply transformer if 208v/3ph equipment is not available."
- .5 Refer to new Section 25 30 00 Controls and Instrumentation
 - .1 Add entire section included herewith.
 - .2 Division 25 Controls by Siemens.
- .6 Refer to Section 25 90 00 Sequence of Operations
 - .1 Refer to subsection 3.1 VRF Heating & Cooling System (FC, VRF & BC).
 - .1 Refer to item 3.1.2.4. Revise to read as follows: "On a drop in space temperature, heating is activated. When an auxiliary perimeter heating or back-up electric duct heater

- is in a fan coil zone, the electric heating shall act as a second stage of heating. Heating will operate to maintain space temperature setpoint.”
- .2 Refer to item 3.1.5. Revise “Perimeter Heating” to “Back-up Electric Heating”.
- .2 Refer to subsection 3.2 Electrical Room Cooling.
 - .1 Add item 3.2.1.2: Controls to provide a relay wired to the split AC refrigerant leak detection to shut off the electric heater in the electrical room on detection of refrigerant.

2.2 DRAWINGS

- .1 Refer to Drawing M001 Mechanical Drawing List, Legend and Notes
 - .1 As shown on the attached drawing M001.1 issued herewith,
 - .1 Refer to the Legend of Symbols.
 - .1 Revise the symbol for return/exhaust grille as shown.
 - .2 Revise “HP/LP GAS – High Pressure / Lower Pressure Gas” to read as “RG – Refrigerant Gas”
- .2 Refer to Drawing M002 Mechanical Schedules
 - .1 As shown on the attached drawing M002.1 issued herewith,
 - .1 Refer to VRF Branch Controller Schedule.
 - .1 Revise model numbers of VRF branch controller.
 - .2 Refer to VRF Condensing Unit Schedule.
 - .1 Add “Include drain pan heaters” in the Note No. 7.
 - .3 Refer to Dedicated Outside Air System Schedule.
 - .1 Revise “HGRH Capacity” to read as “HGRH Capacity or Heat Pipe”.
 - .2 Revise “Heating Coil, Electrical, In Casing ” to read as “ Heating Coil, Electrical”.
 - .3 Revise typo in the Notes.
- .3 Refer to Drawing M003 Mechanical Schedules
 - .1 As shown on the attached drawing M003.1 issued herewith,
 - .1 Refer to the Variable Volume Terminal Box Schedule.
 - .1 Delete Remark indicating “Constant Volume”. Variable volume terminal boxes shall be variable volume down to 0% open and controlled by CO2 sensor in space.
 - .2 Refer to the Electric Duct Heater Schedule.
 - .1 Add the following to the Notes:
 - .1 Temperature sensor to be included by manufacturer.
 - .2 Integrate the operation of the electric duct heater with the associated VRF fan coil unit.
- .4 Refer to Drawing M100 Floor Plan – Level 1 - Underground Plumbing
 - .1 As shown on the attached drawings M100.1 issued herewith,
 - .1 Revise drawing name to “Floor Plan Level 1 – Underground Plumbing and Lower Level Plumbing”
 - .2 Revise CW, HW, HWR, San, Vent and Condensate piping.
 - .3 Add heat tracing to piping.
 - .4 Revise and add plumbing notes.
 - .5 Add recirc pump and domestic expansion tank.
- .5 Refer to Drawing M101 Floor Plan Lower Level - Plumbing
 - .1 As shown on the attached drawings M101.1 issued herewith,
 - .1 Revise drawing name to “Floor Plan Level 1 – Plumbing”
 - .2 Add water heater detail.
 - .3 Revise CW, HW, HWR, San, Vent and Condensate piping.
 - .4 Revise pipe size.
 - .5 Revise and add plumbing notes
- .6 Refer To Drawing M200 Floor Plan Lower Level - Piping
 - .1 As shown on the attached drawings M200.1 issued herewith,

- .1 Revise the piping tag from "HP/LP GAS" to "RG" (refrigerant gas).
 - .2 Revise the location of back-up heat unit heater in the 003 Electrical.
 - .3 Add "Install c/w drain pan heaters" in the VRF outside unit note.
 - .4 Revise VRF-1 outside unit as a combination unit from two separate unit.
- .7 Refer To Drawing M201 Floor Plan Level 1 - Piping
- .1 As shown on the attached drawings M201.1 issued herewith,
 - .1 Revise the piping tag from "HP/LP GAS" to "RG" (refrigerant gas).
- .8 Refer To Drawing M300 Floor Plan Lower Level - Air Distribution
- .1 As shown on the attached drawings M300.1 issued herewith,
 - .1 Revise the location of back-up heat unit heater in the 003 Electrical.
 - .2 Revise VRF outside unit note, deleting " c/w board insulation, concrete pavers".
 - .3 Revise VRF-1 outside unit as a combination unit from two separate unit.
- .9 Refer To Drawing M301 Floor Plan Level 1 - Air Distribution
- .1 As shown on the attached drawings M301.1 issued herewith,
 - .1 Revise air transfer duct location between 101 Classroom 1 and 100 Corridor.
 - .2 Revise dryer venting note from 108 Jan, adding "c/w gooseneck".
- .10 Refer To Drawing M401 Mechanical Details
- .1 As shown on the attached drawings M401.1 issued herewith,
 - .1 Add a gooseneck exhaust detail.
 - .2 Revise note in the M-401 – 12 VRF Refrigerant Schematic, deleting "HP/LP".

3 ELECTRICAL

3.1 DRAWINGS

Refer to Drawing No. E400 Lower Level Floor Plan Power and Systems, E401 Level 1 Floor Plan Power and Systems, E500 Panel Schedules, E600 Single Line Diagram and Fire Alarm Riser Diagram and Fire Alarm Schedule.

- .1 As indicated in drawing E400.2 issued herewith:
 - a. Added Heat tracing and heat tracing notes.
 - b. Added BAS and VRF to Mechanical Room 002.
- .2 As indicated in drawing E401.2 issued herewith:
 - a. Added Heat tracing and heat tracing notes.
- .3 As indicated in drawing E500.2 issued herewith:
 - a. Added Heat tracing to Panel A.
 - b. Updated legend for Panel A.
 - c. Added Heat tracing to Panel D.
 - d. Updated legend for Panel D.
- .4 As indicated in drawing E600.1 issued herewith:
 - a. Added Breaker for SPD and note for Single Line Diagram.
 - b. Updated Fire Alarm Riser Diagram Notes - Sequence of Operation # 1.3, and 2.2.

END OF ADDENDUM ME-02

No.	Equipment				Controls			Responsibility		
	Item	Characteristics		Service / Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
1	Domestic Hot Water Heater (DHWH-1)	Amps	21.6	002 Mechanical	Disconnect	Receptacle	See elec spec	26	26	26
		Voltage	208 / 3 / 60		Other controls	In Unit	See mech spec	22	22	22
		Div. 26 to provide GFI protected outlet on a separate circuit and breaker.								
2	Domestic HW Re-circ Pump with Aquastat (RP-1)	FLA	0.98	002 Mechanical	Disconnect	Receptacle	See elec spec	26	26	26
		Voltage	120 / 1 / 60		Other controls	In Unit	See mech dwg	22	22	22
		Div. 26 to provide GFI protected outlet on a separate circuit and breaker.								
3	Electronic Trap Seal Primer (ETSP)	Watts	10	Refer to drawings	Receptacle	In Unit	See elec spec	26	26	26
		Voltage	120 / 1 / 60		Div. 26 to provide GFI protected outlet on a separate circuit and breaker for ETSP. Receptacle to be within 6 ft (1.8 m) of the solenoid valve.					
4	Exhaust Fan (EF-1)	HP	0.1	Roof	Disconnect (WP)	In Unit	See mech specs	23	23	26
		Voltage	120 / 1 / 60		Starter (HOA)	See Dwgs.	See mech specs	23	23	23
					Motorized Damper & Actuator	See Dwgs	See mech specs	23	23	23
					Wall Controller	See Dwgs.	See mech specs	23	23	25
					Div 26 to provide electrical service to the exhaust fan. Div 26 shall provide conduit c/w fish wire and dedicated electrical box for the controller.					
5	DOAS (Unit)	MCA	31.26	Refer to drawings	Disconnect	In Unit	See mech specs	26	26	26
		MOCP	35		Manufacturer Controls	See Dwgs.	See mech specs	23	23	25
		Voltage	208 / 3 / 60		Controls	See mech spec	See mech specs	25	25	25
					Div 26 to provide electrical service to the DOAS. Div 26 shall provide conduit c/w fish wire and dedicated electrical box for the control system. Div 25 shall provide all required transformers and control wire from DOAS to associated motorized dampers and humidifier, sensors or other controls devices.					
5	DOAS (Heating Coil, Electrical in Casing)	MCA	35	Refer to drawings	Disconnect	In Unit	See mech specs	26	26	26
		MOCP	35		Manufacturer Controls	See mech spec	See mech specs	23	23	25
		Voltage	208 / 3 / 60		Controls	See mech spec	See mech specs	25	25	25
					Div 26 to provide electrical service to the DOAS. Div 26 shall provide conduit c/w fish wire and dedicated electrical box for the control system. Div 25 shall provide all required transformers and control wire from DOAS to associated motorized dampers and humidifier, sensors or other controls devices.					

No.	Equipment				Controls			Responsibility		
	Item	Characteristics		Service / Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
6	Electric Duct Heater (EDH-1 through to EDH-5)	KW	Refer to schedule	Refer to drawings	Disconnect	In Unit	See mech specs	23	23	26
		Voltage	208 / 3 / 60		Manufacturer Controller	See Dwgs.	See mech specs	23	23	25
					Temp Sensor, Airflow Switch	See Mech Spec	See mech specs	23	23	25
7	Electric Humidifier (H-1)	Amps	33.3	002 Mechanical	Disconnect	In Unit	See mech specs	26	26	26
		Voltage	208 / 3 / 60		Manufacturer Controls	See Dwgs.	See mech specs	23	23	25
					Controls	See Mech Spec	See mech specs	25	25	25
8	Ceiling Fan (CF-1)	HP		Refer to drawings	Disconnect	In Unit	Hubbell HBL1379	26	26	26
		Voltage	120 / 1 / 60		Wall Controller	See Dwgs.	See mech specs	23	23	25
					Div 26 to provide electrical service to the fans. Div 26 shall provide conduit c/w fish wire and dedicated electrical box for the control system. Div 25 shall provide wire and control accessories from ceiling fan to the controller.					
9	Motorized Dampers MD	Voltage	24v	Refer to drawings	Damper	See Dwgs.	See mech spec	25	23	25
					Actuator	See Dwgs.	See mech spec	25	25	25
					Controls	T.B.D. on site	See mech spec	25	25	25
10	Variable Volume Terminal Box schedule VAV (1 - 4)	Voltage	24v	Refer to drawings	VAV Box Damper	See Dwgs.	See mech spec	23-25	23	25
					Controller Actuator	See spec Dwgs.	See mech spec	25	23-25	25
					Controls	T.B.D. on site	See mech spec	25	25	25
10	Ductless Split Air Conditioning Unit (Indoor Unit) (AC-1)	MCA	1.0	003 Electrical	Disconnect	In Unit	See elec spec	26	26	26
		Voltage	208 / 1 / 60		Starter	In unit	See mech specs	23	23	23
					Thermostat / Controller	Wall mounted	See mech spec.	23	23	25
					Manufacturer Controls	See Dwgs.	See mech spec.	23	23	25
					BMS Controls	See mech spec.	See mech spec.	25	25	25
	Ductless Split Air Conditioning Unit (Outdoor Unit) (CU-1)	MCA	14.23	Wall	Disconnect (WP)	At In Unit	See elec spec	26	26	26
		MOCP	20		Starter	In unit	See mech specs	23	23	23
		Voltage	208 / 1 / 60		Division 26 shall provide 1/2" conduit complete with pull wire between indoor units and controller, and between indoor units and outdoor unit.					

No.	Equipment			Controls			Responsibility			
	Item	Characteristics		Service / Location	Type	Location	Manufacturer's Reference	Supplied by Div.	Installed By Div.	Wired & Connected by Div.
11	VRF Fan Coil Units (FC-1 though to FC-7)	MCA	Refer to schedule	See Dwgs.	Disconnect	At-In Unit	Hubbell HBL1379	26	26	26
		Voltage	208 / 1 / 60		Starter	In unit	See mech specs	23	23	23
					Integration with EDH	At unit	See mech specs	23	23	25
					Thermostat / Controller	Wall mounted	See mech specs	23	23	25
12	VRF Branch Controller (BC-1)	MCA	0.8	Refer to drawings	Disconnect	In Unit	SQD CH221NRB	26	26	26
		MOCP	15		Division 26 shall provide conduit complete with pull wire for both power and control between branch controller and indoor units and branch controller and outdoor unit.					
		Voltage	208 / 1 / 60							
13	VRF Branch Controller (BC-2)	MCA	0.4	002 Mechanical	Disconnect	In Unit	SQD CH221NRB	26	26	26
		MOCP	15		Division 26 shall provide conduit complete with pull wire for both power and control between branch controller and indoor units and branch controller and outdoor unit.					
		Voltage	208 / 1 / 60							
14	VRF Condensing Unit (VRF-1)	MCA	76.5 + 76.5	Ground	Disconnect (WP)	In Unit	SQD CH323NRB	26	26	26
		MOCP	80 + 80		Starter	In unit	See mech specs	23	23	23
		Voltage	208 / 3 / 60		VRF System Controller	Mezz Storage 201	See mech specs	23	23	23
					Division 26 shall provide conduit complete with pull wire between indoor units and controller, and between indoor units and outdoor unit. Division 26 shall provide data connection for VRF system.					
15	VRF Condensing Unit (VRF-2)	MCA	38.1	Ground	Disconnect (WP)	In Unit	SQD CH323NRB	26	26	26
		MOCP	45		Starter	In unit	See mech specs	23	23	23
		Voltage	208 / 3 / 60		VRF System Controller	Mezz Storage 201	See mech specs	23	23	23
					Division 26 shall provide conduit complete with pull wire between indoor units and controller, and between indoor units and outdoor unit. Division 26 shall provide data connection for VRF system.					
16	Controls Equipment	Voltage	120 / 1 / 60	As required for Controls	Controls	T.B.D. on site	See mech spec	25	25	25/26
					Division 26 shall provide junction box in ceiling with 120V power and circuit as required for building controls. All low voltage and line voltage control wiring shall be included by Division 25.					

1 GENERAL

1.1 RELATED SECTIONS

- .1 The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of this specification and shall be used in conjunction with this section as a part of the contract documents. Consult them for further instructions pertaining to this work.
- .2 The following sections but not limited constitute related work:
 - .1 Section 20 01 01 - General Requirements
 - .2 Section 23 34 00 – HVAC Fans
 - .3 Section 23 73 00 – Dedicated Outdoor Air Systems
 - .4 Section 23 81 26 – Ductless Split Air Conditioning System
 - .5 Section 23 81 29 – Variable Refrigerant Flow Systems
 - .6 Section 23 82 00 – Terminal Heat Transfer Units
 - .7 Section 25 90 00 - Sequence of Operations
- .3 Products furnished but not installed under this section:
 - .1 Temperature & Pressure Sensor Wells and Sockets
 - .2 Motorized dampers and valves

1.2 DESCRIPTION

- .1 General:
 - .1 This Section includes control equipment and installation for HVAC systems and components, including but not limited to control components that not supplied with factory-furnished controls.
 - .2 Provide all controls of equipment specified and required for a fully functioning system programmed to operate in accordance with the sequences of operation.
 - .3 Controls contractor shall coordinate with the mechanical contractor to ensure all equipment has been provided for a fully functioning system.

1.3 WORK INCLUDED

- .1 Building Management System (BMS) Contractor shall provide and install:
 - .1 A fully integrated Building Automation System (BAS), incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
 - .2 Provide refrigerant detection and control systems.
 - .3 All wiring, conduit, panels, and accessories for a complete operational system.
 - .4 BMS Contractor shall be responsible for all electrical work associated with the BMS.
 - .1 Perform all wiring in accordance with all local and national codes.
 - .2 Install all line (unless specifically covered under Division 26) and low voltage wiring, concealed or exposed, in conduit in accordance with the division 26 specifications, NEC and local building code.
 - .3 Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
 - .5 Provide open communications system. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, system shall be capable of utilizing standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols.
 - .1 System shall be capable of high speed Ethernet communication using TCP/IP protocol.
 - .2 The system shall be capable of supporting both standard and vendor specific protocols to integrate a wide variety of third-party devices and legacy systems.
 - .3 The system shall be capable of supporting wireless secondary level networks and sensor communications using a mesh topology and IEEE 802.15.4 network.
 - .4 The intent is to provide the capability to access the new Nature Centre BAS from the Main Building Siemens BAS.
 - .6 Provide system graphics for each controlled device and/or integrated systems as required by

- the owner. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
- .7 The BAS Contractor shall provide a complete and operational system that will perform the sequences of operation as described herein.
 - .8 Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:
 - .9 Provide a submittal that meets the requirements below for approval.
 - .10 Coordinate installation schedule with the mechanical contractor and general contractor.
 - .11 Provide installation of all panels and devices unless otherwise stated.
 - .12 Provide power for panels and control devices unless otherwise stated.
 - .13 Provide all low voltage control wiring for the DDC system.
 - .14 Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.
 - .15 Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
 - .16 Participate in commissioning for all equipment that is integrated into the BAS (Refer to Commissioning sections of the equipment or systems in other parts of this specification.)
 - .17 Provide testing, demonstration and training as specified below.
 - .18 The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.
 - .19 The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
 - .20 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.
 - .21 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.
 - .22 DDC Controllers shall be able to assign password access and control priorities to each point individually. The Logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable terminal. Passwords and priority levels for every point shall be fully programmable and adjustable.
 - .23 All DDC controllers shall be installed with 10% spare points (of each type) and 25% spare memory capacity for connection of floor work.
 - .24 Controls vendor must supply licensed copies of all software tools so customer can make all future Graphic and programming changes at no additional costs. i.e Siemens PPCL

1.4 RELATED SECTIONS

- .1 The General Conditions of the Contract, Supplementary Conditions, and General Requirements are part of this specification and shall be used in conjunction with this section as part of the contract documents.
- .2 The following sections constitute related work:
 - .1 Division 01
 - .2 Division 20; Section 20 01 01 General Mechanical Requirements
 - .3 Division 20; Section 20 05 00 Common Work Results
 - .4 Division 20; Section 20 90 50 Mechanical – Electrical Equipment Schedule
 - .5 Division 23; Section 23 05 14 Variable Frequency Drives

- .6 Division 23; Section 23 33 00 Air Duct Accessories
- .7 Division 23; Section 23 34 00 HVAC Fans
- .8 Division 23; Section 23 36 00 Air Terminal Units
- .9 Division 23; Section 23 73 00 Custom Air Handling Units
- .10 Division 23; Section 23 81 26 Split Air Conditioning and Heat Pump Systems
- .11 Division 23; Section 23 81 29 Variable Refrigerant Flow Systems
- .12 Division 23; Section 23 82 00 Terminal Heat Transfer Units
- .13 Division 23; Section 23 84 19 Humidifiers, Electronic
- .14 Division 25; Section 25 05 00 Common Work Results
- .15 Division 25; Section 25 90 00 Sequence of Operations
- .16 Division 26 - Electrical

1.5 APPROVED CONTROL SYSTEM CONTRACTORS

- .1 The following are the approved Control System Contractors and Manufacturers:
 - .1 Siemens Canada Ltd, Building Technologies Division.

1.6 QUALITY ASSURANCE

- .1 Codes
 - .1 Perform all wiring in accordance with Division 26, OBC, local codes and Owner's requirements.
 - .2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - .3 Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
 - .4 Comply with ASHRAE 135-2010 BACnet: A Data Communication Protocol for Building Automation and Control Networks.
 - .5 Comply with ASHRAE 90.1-2013 Energy Standard for Buildings Except Low-Rise Residential Buildings.
 - .6 All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAXX Energy Management Systems,
 - .7 Provide written approvals and certifications after installation has been completed.
 - .8 All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
 - .9 The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- .2 Qualifications
 - .1 The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel. BMS contractor shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. The BMS contractor shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the B.M.S. The Bidder shall be regularly engaged in the installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the installation and maintenance of B.M.S. systems similar in size and complexity to this project.
 - .2 The BMS contractor shall be the Manufacturer, NO Distributors are allowed.
 - .3 Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
 - .4 The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and

Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

- .5 This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.7 SUBMITTALS

- .1 Provide a complete submittal with all controls system information for approval before construction starts. Include the following:
 - .1 Sequence of Operations.
 - .1 Written sequence of operations for all equipment and/or systems.
 - .2 Schematic Flow Diagrams:
 - .1 Schematic flow diagrams showing fans, coils, dampers, valves, and control devices.
 - .3 Wiring Diagrams:
 - .1 Power, signal, and control wiring. Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.
 - .2 Starter and variable frequency drive wiring details of all automatically controlled motors.
 - .4 Control Panels:
 - .1 Details of control panel faces, including sizes, controls, instruments, and labeling.
 - .5 Schedule of Dampers & Actuators:
 - .1 Schedule of dampers and actuators including size, leakage, and flow characteristics. If dampers are furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule.
 - .6 Network Riser Diagram:
 - .1 Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and BACnet device instance numbers. Show all routers, switches, hubs and repeaters.
 - .7 Points List:
 - .1 Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device.
 - .8 Floor Plans:
 - .1 Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.
 - .9 Product Data:
 - .1 Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.
 - .10 PICS:
 - .1 Submit BACnet Protocol Implementation Conformance Statements (PICS) for all direct digital controllers, software and other system components that will communicate on the BAS utilizing BACnet.
 - .11 Testing / Commissioning Check-Lists:

- .1 Submit blank field check-out and commissioning test reports, customized for each panel or system, which will be filled out by the technician during start-up.
- .2 Sample Graphics:
 - .1 After the BAS system is approved for construction, submit sample graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters and issue manual commands. Programming shall not commence until typical graphics are approved.
- .3 Operation and Maintenance Data:
 - .1 In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - .1 Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
 - .2 Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - .3 Inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.
 - .4 Calibration records and list of set points.

1.8 PROJECT RECORD DOCUMENTS

- .1 Project Record Documents:
 - .1 Submit record copy (as-built) documents upon completion of installation. Submittal shall consist of:
- .2 Project Record Drawings.
 - .1 As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.
- .3 Testing and Commissioning Reports and Checklists.
 - .1 Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
- .4 Operation and Maintenance (O & M) Manual:
 - .1 As-built versions of the submittal product data.
 - .2 Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - .3 Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - .4 Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - .5 Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - .6 Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - .7 Graphic files, programs, and database on electronic media.
 - .8 List of recommended spare parts with part numbers and suppliers.
 - .9 Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
 - .10 Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - .11 Licenses, guarantees, and warranty documents for equipment and systems.
- .5 Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
 - .1 Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
 - .2 Description of manual override operation of all control points in system.

- .3 BMS system manufacturers complete operating manuals.
- .6 Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
 - .1 Complete as-built installation drawings for each building system.
 - .2 Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
 - .3 Photographs and/or drawings showing installation details and locations of equipment.
 - .4 Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
 - .5 Parts list with manufacturer's catalog numbers and ordering information.
 - .6 Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.
 - .7 Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
 - .8 Maintenance and repair instructions.
 - .9 Recommended spare parts.
- .7 Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
 - .1 Complete programming manuals, and reference guides.
 - .2 Details of any custom software packages and compilers supplied with system.
 - .3 Information and access required for independent programming of system.

1.9 WARRANTY

- .1 Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner. Respond during normal business hours within 24 hours of Owner's warranty service request.

1.10 DELIVERY, STORAGE, AND HANDLING

- .1 Factory-Mounted Components:
 - .1 Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.
 - .2 VAV controllers and damper actuators shall be shipped to the VAV manufacturer's factory for factory installation as specified in section 23 36 00 Air Terminal Units.
- .2 Deliver, store, protect, and handle products to site under provisions of the contract Documents. Coordinate all site delivers with Construction project Manager.
- .3 Protect products from construction operations, dust, and debris, by storing materials inside, protected from weather in a conditioned space.

1.11 COORDINATION

- .1 Coordinate IP drops, network connections, user interfaces, firewall, etc with Owner's IT representative.
- .2 Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.
- .3 Coordinate equipment with Division 28 "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.
- .4 Coordinate power for control units and operator workstation with electrical contractor and cover any costs (specific to BAS but unknown to other disciplines during design stage) not currently included under Division 26.
- .5 Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.
- .6 Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.
- .7 Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.

- .8 Products Furnished but Not Installed Under This Section
 - .1 Temperature Sensor Wells and Sockets
 - .2 Pressure Sensor Wells and Sockets
 - .3 Differential Pressure Transmitters
 - .4 Dampers where specified
 - .5 Airflow Stations
 - .6 Terminal Unit Controls
- .9 Products Installed but Not Furnished Under This Section
 - .1 Humidifier accessories such as humidistat and flow switch
 - .2 Electric duct heater temperature sensor and flow switch.

1.12 OWNERSHIP OF PROPRIETARY MATERIAL

- .1 Project specific software and documentation shall become Owner's property. This includes, but not limited to:
 - .1 Graphics
 - .2 Record drawings
 - .3 Database
 - .4 Application programming code

2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 The Building Automation System (BAS) contractor shall furnish and install a networked system of HVAC controls. The contractor shall incorporate direct digital control (DDC) for VRF system, DOAS, humidifier, VAV terminal boxes, heaters, fans, domestic hot water system, fire water tank, and lighting control system.
- .2 Provide networking to DDC equipment using industry accepted communication standards. System shall utilize BACnet communication according to ANSI/ASHRAE standard 135-2010 for interoperability with smart equipment, for the main IP communication trunk to the BAS Server and for peer-to-peer communication between DDC panels and devices. The system shall not be limited to only standard protocols but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.
- .3 Provide standalone controls where called for on the drawings or Sequences.
- .4 The BAS shall be the Siemens APOGEE system as manufactured by Siemens

2.2 BUILDING AUTOMATION SYSTEM NETWORK

- .1 All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication involving control components (i.e. all types of controllers and operator interfaces) shall conform to ASHRAE 135-2010 BACnet standard. Networks and protocols proprietary to one company or distributed by one company are prohibited.
- .2 Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.
 - .1 Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.
- .3 Provide at a minimum 1 operator interface to be designated as the BAS Server with server application software. Additional operator interfaces shall use operator workstation licenses or connect via a thick or thin-client application.
- .4 BAS Server shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.
- .5 Any break in Ethernet communication from the server to the controllers on the Primary Network shall result in a notification at the server.
- .6 Any break in Ethernet communication between the server and standard client workstations on the Primary Network shall result in a notification at each workstation.
- .7 The network architecture shall consist of three levels of networks:
 - .1 The Management Level Network (MLN) shall utilize BACnet/IP over Ethernet along with other

- standardized protocol, such as web services, html, JAVA, SOAP, XML, etc., to transmit data to non-BAS software applications and databases. The BAS Server and Operator Workstations shall reside on this level of the network architecture.
- .2 The Automation Level Network (ALN) shall utilize BACnet/IP over Ethernet. It shall connect BACnet Building Controllers to the BAS Server and Operator Workstations. Controllers for central plant equipment and large infrastructure air handlers shall reside on the ALN backbone BACnet/IP network. Provide network media converters, routers and switches as necessary for a complete network.
- .3 The Floor Level Network shall utilize BACnet/IP over Ethernet or BACnet MS/TP over RS-485 to connect all of the DDC-controlled terminal heating and cooling equipment on a floor or in a system that are controlled with BACnet Advanced Application Controllers or BACnet Application Specific Controllers. FLN devices are networked to a router that connects to the Automaton Level Network backbone. Provide hard wired points where specified.
- .8 The primary backbone network between the building level controllers, BAS Server and Operator Workstations shall be based upon BACnet/IP. Ethernet Network switches shall be strategically placed through the building to cover several floors or several mechanical rooms that are within 300 ft wiring-feet of each other.
- .9 Use fiber optic cabling for all Ethernet runs longer than 300 ft.
- .10 Provide a router for each RS-485 subnetwork to connect them to the base building backbone level network. The router shall connect BACnet MS/TP subnetworks to BACnet over Ethernet. Routers shall be capable of handling all of the BACnet BIBBs that are listed for the controller that reside on the subnetwork.
- .11 The Building Level Controllers shall be able to support subnetwork protocols that may be needed depending on the type of equipment or application. Subnetworks shall be limited to:
- .1 BACnet MS/TP
- .2 Apogee FLN
- .3 Modbus
- .12 BACnet MSTP Setup rules
- .1 Addressing for the MSTP devices shall start at 00 and continue sequentially for the number of devices on the subnetwork.
- .2 No gaps shall be allowed in the addresses.
- .3 Set the MaxMaster property to the highest address of the connected device.
- .4 MaxMaster property shall be adjusted when devices are added to the subnetwork.
- .13 Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.
- .14 Controllers and software shall be BTL listed at the time of installation.
- .15 The system shall meet 8peer-to-peer communication services such that the values in any one BACnet Building Controller or BACnet Advanced Application Controller can be read or changed from all other controllers without the need for intermediary devices. The software shall provide transparent transfer of all data, control programs, schedules, trends, and alarms from any one controller through the internetwork to any other controller, regardless of subnetwork routers.
- .16 Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges or networks that are not peer-to-peer are not allowed.
- .17 Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.
- .18 The system shall be installed with a 10% spare capacity on each subnetwork for the addition of future controllers.
- .19 Distributed Control Requirements:
- .1 The loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
- .2 The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
- .3 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection.

The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

- .4 DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller on the network without dependence upon a central processing device. DDC Controllers shall also be able to send alarms to multiple operator workstations without dependence upon a central or intermediate processing device.
- .5 Operators shall have the ability to make database changes at the central system server while operator workstations are on-line without disrupting other system operations.
- .6 The DDC control panel shall be mounted in the same mechanical room as the equipment being controlled, or an adjacent utility room.
- .7 Multiple systems can be programmed on the same controller as long as they are in the same room. Systems on separate floors shall have separate controllers.
- .8 Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.
- .9 Signals to remote motor control centers shall be hard wired to the control panel, not across the network.

2.3 MATERIALS

- .1 All products used in this project installation shall be new and currently manufactured and shall have been applied in similar installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner or Owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.4 OPERATOR WORKSTATION

- .1 Provide a PC-based workstation with all required software, hardware, and server for use in accessing all the information on the BAS system.
- .2 The system shall be capable of supporting an unlimited number of clients using a standard web browser such as Internet Explorer, Chrome or Firefox.

2.5 DIRECT DIGITAL CONTROLLER SOFTWARE

- .1 Provide a full capability user license to the owner for the operator to be able to see, modify, create, upload, download and save control programs to the DDC controllers.
- .2 The software program shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer or another controller for execution.
- .3 The software application shall be accessible from a PC using the Windows environment but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems-based viruses.
- .4 The software shall be provided with an interactive HELP function to assist operators with syntax, abbreviations, commands and saving programs.
- .5 Point naming and communication format:
 - .1 All points, panels, and programs shall be identified by a 30-character name. All points shall also be identified by a 16-character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.
 - .2 All digital points shall have a consistent, user-defined, two-state status indication with 8 characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).
 - .3 The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004, Annex L.
- .6 System Security
 - .1 User access shall be secured using individual security passwords and usernames.
 - .2 Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.

- .3 Building Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.
- .4 User Log On/Log Off attempts shall be recorded.
- .5 The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user definable.
- .6 Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.
- .7 User Defined Control Applications: The applications software shall program DDC routines to meet the sequences of operations.
 - .1 Building Controllers shall have the ability to perform energy management routines including but not limited to time-of-day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding, and power failure restart.
 - .2 The Building Controllers shall have the ability to perform the following pretested control algorithms:
 - .1 Two position with differential control and time delays
 - .2 Floating control
 - .3 Proportional control
 - .4 Proportional plus integral control
 - .5 Proportional, integral, plus derivative control
 - .6 Automatic tuning of control loops
 - .7 Model-free adaptive control
 - .8 Start Stop Time Optimization
 - .3 Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 - .4 Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
- .8 Peer-to-peer access to other DDC controllers
 - .1 It shall be possible to use any actual or virtual point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.
 - .2 Any process shall be able to issue commands to points in any and all other controllers in the system.
 - .3 Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of an advanced annunciation feature, such as:
 - .1 Generate a report
 - .2 Annunciate an alarm
 - .3 Issue a text message or email
- .9 Alarm Management
 - .1 Alarm management shall be provided within the controller software to monitor and direct alarm information to operator devices.
 - .2 Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
 - .3 Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
 - .4 An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
 - .5 Binary Alarms. Each binary alarm object shall be set to alarm based on the operator-specified

- state. Provide the capability to automatically and manually disable alarming.
- .6 Analog Alarms. Each analog alarm object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
- .7 All alarm shall include the point's user-defined language description and the time and date of occurrence.
- .8 Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print reports, be logged in the event log, generate custom messages, and display graphics.
- .9 The user shall be able to add a 200-character alarm message to each alarm point to more fully describe the alarm condition or direct operator response. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assigned to any number of points in the Controller.
- .10 Operator-selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.
- .11 An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.
- .10 Scheduling:
 - .1 Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
 - .2 Schedules shall reside in the building controller and shall not rely on external processing or network.
 - .3 It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
 - .4 For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.
 - .5 The operator shall be able to define the following information:
 - .1 Time, day
 - .2 Commands such as on, off, auto, etc.
 - .3 Time delays between successive commands.
 - .4 There shall be provisions for manual overriding of each schedule by an authorized operator.
 - .6 It shall be possible to schedule calendar-based events up to one year in advance based on the following:
 - .1 Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.
 - .2 Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
- .11 Peak Demand Limiting (PDL):
 - .1 The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
 - .2 PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
 - .3 PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
 - .4 If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
 - .5 Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
- .12 Temperature-compensated duty cycling
 - .1 User defined conditions shall be able to initiate a Duty Cycle Control Program.
 - .2 The Duty Cycle Control Program (DCCP) shall be configured to periodically stop and start

- loads according to various patterns.
- .3 The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
- .13 Automatic Daylight Savings Time Switchover. The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- .14 Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.
- .15 Enthalpy switchover (economizer). The Building Controller Software (BCS) shall control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover setpoint the BCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly change over to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
- .16 Control Loop Algorithm
 - .1 Provide a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and weighting parameters shall be accessible from the operator workstation.
- .17 Adaptive Loop Tuning
 - .1 Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a monthly, seasonal, quarterly, annual period.
 - .2 For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).
 - .3 For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
 - .1 In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
 - .2 Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- .18 Logic programming: Provide a software routine that can build ladder logic to control using many conditional statements.
 - .1 The logic programming syntax shall be able to combine ladder logic with other software features, such as combining status, scheduling, PDL and alarm conditions into one conditional decision.
 - .2 Logic programming shall be able to reference conditions in any other controller in the system.
- .19 Staggered Start:
 - .1 This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable in an application and shall not require written scripts or ladder logic.
 - .2 Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
- .20 Totalization Features:
 - .1 Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
 - .2 Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input

- type points.
- .3 Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.
- .21 Data Collection:
 - .1 A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.
 - .2 Building Controllers shall store point history data for selected analog and digital inputs and outputs:
 - .3 Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.
 - .4 Two methods of collection shall be allowed: either by up to four pre-defined time intervals or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided.
 - .5 Each Building Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.
 - .6 Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in third-party personal computer applications.

2.6 BACnet BUILDING CONTROLLERS

- .1 Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.
- .2 Basis of design is Siemens PX Modular and Compact Controllers (PXC).
- .3 This controller shall have the BTL listing and meet the BACnet device profile of a Building Controller (B-BC) and shall support the following BACnet BIBBs:
 - .1 Data Sharing
 - .1 Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - .2 Data Sharing-Read Property Multiple- Initiate, Execute (DS-RPM-A,B)
 - .3 Data Sharing-Write Property- Initiate, Execute (DS-WP-A,B)
 - .4 Data Sharing-Write Property Multiple- Execute (DS-WPM-B)
 - .5 Data Sharing-COV- Initiate, Execute (DS-COV-A,B)
 - .6 Data Sharing-COV-Unsolicited- Initiate, Execute (DS-COVU-A,B)
 - .2 Scheduling
 - .1 Scheduling-Internal- Execute (SCHED-I-B)
 - .2 Scheduling-External- Execute (SCHED-E-B)
 - .3 Trending
 - .1 Trending-Viewing and Modifying Trends - Initiate (T-VMT-A)
 - .2 Trending-Viewing and Modifying Trends Internal- Execute (T-VMT-I-B)
 - .3 Trending-Viewing and Modifying Trends-External- Execute (T-VMT-E-B)
 - .4 Trending-Automated Trend Retrieval- Execute (T-ATR-B)
 - .4 Network Management
 - .1 Network Management-Connection Establishment- Initiate (NM-CE-A)
 - .5 Alarming
 - .1 Alarm and Event-Notification- Initiate (AE-N-A)
 - .2 Alarm and Event-Notification Internal- Execute (AE-N-E-B)
 - .3 Alarm and Event-Notification External- Execute (AE-N-E-B)
 - .4 Alarm and Event-ACK- Initiate, Execute (AE-ACK-A,B)
 - .5 Alarm and Event –Alarm Summary- Execute (AE-ASUM-B)
 - .6 Alarm and Event –Enrollment Summary- Execute (AE-ESUM-A,B)
 - .7 Alarm and Event –Information- Initiate, Execute (AE-ESUM-A,B)
 - .6 Device Management
 - .1 Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A,B)

- .2 Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
- .3 Device Management-Device Communication Control- Execute (DM-DCC-B)
- .4 Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)
- .5 Device Management-Text Message- Initiate, Execute (DM-TM-A,B)
- .6 Device Management-Time Synchronization- Execute (DM-TS-B)
- .7 Device Management-Reinitialize Device- Execute (DM-RD-B)
- .8 Device Management-Backup and Restore- Execute (DM-RD-B)
- .9 Device Management-List Manipulation- Execute (DM-RD-B)
- .10 Device Management-Object Creation and Deletion- Execute (DM-OCD-B)
- .7 The Building Level Controller shall support the following Data Link Layers:
 - .1 BACnet IP Annex J
 - .2 BACnet IP Annex J Foreign Device
 - .3 MS/TP Master (Claus 9)
- .8 The Building Level Controller shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
 - .1 Calendar – Creatable, Deletable
 - .2 Command – Creatable, Deletable
 - .3 Event Enrollment – Creatable, Deletable
 - .4 Notification Class – Creatable, Deletable
 - .5 Schedule - Creatable, Deletable
- .9 The Building Level Controller shall support transmitting and receiving segmented messages.
 - .1 The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.
 - .2 The Building Level Controller shall have the capability to act as a BACnet router between MS/TP subnetworks and BACnet/IP.
- .4 This level of controller shall be used for the following types of systems:
 - .1 Systems with over 24 input/output points
- .5 Computing power and memory minimum:
 - .1 A 32 bit, stand alone, multi tasking, multi user, real-time 100MHz digital control microprocessor module.
 - .2 Inputs shall be 16-bit minimum analog-to-digital resolution
 - .3 Outputs shall be 10-bit minimum digital-to-analog resolution
 - .4 Memory module (24 Megabyte, minimum) to accommodate all Primary Control Panel software requirements, including but not limited to, its own operating system and databases (see Controllers Software section), including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial up communications.
 - .5 Real time clock and battery
 - .6 Data collection/ Data Trend module sized for 10,000 data samples.
 - .7 Flash Memory Firmware: Each Building Level Control Panel shall support firmware upgrades without the need to replace hardware.
- .6 Onboard or Modular hardware and connections:
 - .1 Primary Network communication module, if needed for primary network communications.
 - .2 Secondary Network communication module, if needed for secondary network communications.
 - .3 RJ45 port 10/100Mbaud
 - .4 RS485 ports for subnetworks and point expansion
 - .5 Man to Machine Interface port (MMI)
 - .6 USB Port
- .7 Input and Output Points Hardware
 - .1 Input/output point modules as required including spare capacity.
 - .2 Input/output point modules shall have removable terminal blocks.
 - .3 Monitoring of the status of all hand off auto switches.
 - .4 Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
 - .5 Local status indication for each digital input and output for constant, up to date verification of

- all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
- .6 Graduated intensity LEDs or analog indication of value for each analog output.
 - .7 Optional HOA (hand-off-auto module) with software configurability and LED status indicators.
 - .8 Code compliance
 - .1 Approvals and standards: UL916; CE; FCC
 - .2 Provide UL864-UUKL where called for in the sequences of operations.
 - .9 Accessories:
 - .1 Appropriate NEMA rated metal enclosure.
 - .2 Power supplies as required for all associated modules, sensors, actuators, etc.
 - .10 The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.
 - .11 Each Building Level Control Panel shall continuously perform self diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.
 - .12 Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.
 - .13 Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.
 - .14 Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.
 - .15 Building Level Controllers shall have the capability to serve as a gateway between Modbus subnetworks and BACnet objects. Provide software, drives and programming.
 - .16 Isolation shall be provided at all primary control panel terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standards 587 1980.
 - .17 Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.
 - .18 Environment.
 - .1 Controller hardware shall be suitable for the anticipated ambient conditions.
 - .2 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 - .3 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 - .4 Controller hardware shall be optionally suitable for rooftop environments.
 - .19 Immunity to power and noise.
 - .1 Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
 - .2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 - .3 Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - .1 RF-Conducted Immunity (RFCl) per ENV 50141 (IEC 1000-4-6) at 3V.
 - .2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - .3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV

- power.
- .4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
- .4 Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
 - .1 IEEE Standard 587 1980
 - .2 UL 864 Supply Line Transients
 - .3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.7 BACnet APPLICATION SPECIFIC CONTROLLERS (DXR)

- .1 Each Application Specific Controller shall operate as a stand alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each Application Specific Controller shall provide standard applications and programmability to provide both reliability and flexibility. Each application specific controller shall be a microprocessor based, multi tasking, digital control processor.
- .2 Basis of design is the programmable Siemens DXR controller.
- .3 Configurable control applications. Each Application Specific Controller model must have a set of pre-loaded, selectable and field-adjustable control applications appropriate for the secondary HVAC equipment that the controller model is intended to control. Specific applications must be configurable to meet the user's control strategy requirements, allowing for additional system flexibility.
- .4 Programmability: Application Specific Controllers shall be programmable. Program language shall be graphical.
- .5 The Application Specific Controller shall include all point inputs and outputs necessary to perform the specified HVAC control sequences. The controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control output signals shall not be acceptable. Controllers shall provide outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.
 - .1 Analog inputs shall be software configurable to accept sensors using 0-10v (such as RH or CO2 sensors), NTC3k, NTC10k, NTC100k, Ni1000, PT1K 385, and resistance sensors of 1000Ω, 2500 Ω, 10K Ω, and 100k Ω . 24vDC power to drive active sensors shall be an option available from the controller.
 - .2 Digital input
 - .3 Analog Outputs shall support 0-10v HVAC control signals.
 - .4 Digital outputs shall be AC 24V high-side switching triacs, able to switch loads of 250 mA / 6 VA per output.
 - .5 Every installed Application Specific Controller shall be prepared for the addition of occupancy, CO2 and humidity sensors
 - .6 Additional sensors and output modules for occupancy, lighting and shade control within the same space as the HVAC control shall be connected as needed via a sub-network connection on each Application Specific Controller
 - .7 The Application Specific Controller shall be compatible with a Siemens Room Unit which combines a display with CO2, temperature and humidity sensing in 1 wall device.
 - .8 The Application Specific Controller shall be compatible with a Siemens Room Unit which combines a display with temperature sensing and configurable switches for lighting, shade and scene control in 1 wall device.
- .6 Application Specific Controller communication
 - .1 Communication over floor level network shall be BACnet over MS/TP.
 - .2 A maximum of 96 controllers may be configured on individual BACnet MS/TP networks.
 - .3 Each controller that uses BACnet IP shall provide at least two Ethernet ports allowing the controllers to be wired in a daisy-chain configuration of up to at least 20 controllers per chain, utilizing standard Ethernet cables of up to 300ft in length between each controller.
- .7 The Application Specific Controller shall have the BTL listing and meet the BACnet device profile of an Application Specific Controller (B-ASC) as specified in ANSI/ASHRAE 135-2012. The controller shall support the following BACnet BIBBs:
 - .1 Data Sharing
 - .1 DS-RP-A: Data Sharing – Read Property-A
 - .2 DS-RP-B: Data Sharing – Read Property-B

- .3 DS-RPM-A: Data Sharing – Read Property Multiple-A
- .4 DS-RPM-B: Data Sharing – Read Property Multiple-B
- .5 DS-WP-A: Data Sharing – Write Property-A
- .6 DS-WP-B: Data Sharing – Write Property-B
- .7 DS-WPM-A: Data Sharing – Write Property Multiple-A
- .8 DS-WPM-B: Data Sharing – Write Property Multiple-B
- .9 DS-COV-A: Data Sharing – Change of Value -A
- .10 DS-COV-B: Data Sharing – Change of Value -B
- .11 DS-COVP-A: Data Sharing – Change of Value Property -A
- .12 DS-COVP-B: Data Sharing – Change of Value Property -B
- .2 Alarm and Event
 - .1 AE-N-I-B: Alarm and Event – Notification Internal-B
 - .2 AE-ACK-B: Alarm and Event – ACK-B
 - .3 AE-ASUM-B: Alarm and Event – Alarm Summary-B
 - .4 AE-ESUM-B: Alarm and Event – Enrollment Summary-B
 - .5 AE-INFO-B: Alarm and Event – Information-B
 - .6 AE-EL-I-B: Alarm and Event – Event Log Internal-B
- .3 Trending
 - .1 T-VMT-I-B: Trending – Viewing and Modifying Internal-B
 - .2 T-ATR-B: Trending – Automated Trend Retrieval-B
- .4 Device Management
 - .1 DM-DDB-A: Device Management – Dynamic Device Binding-A
 - .2 DM-DDB-B: Device Management – Dynamic Device Binding-B
 - .3 DM-DOB-B: Device Management – Dynamic Object Binding-B
 - .4 DM-DCC-B : Device Management – Device Communication Control-B
 - .5 DM-TS-B: Device Management – Time Synchronization-B
 - .6 DM-UTC-B: Device Management – UTC Time Synchronization-B
 - .7 DM-RD-B: Device Management – Reinitialize Device-B
 - .8 DM-BR-B: Device Management – Backup and Restore-B
 - .9 DM-R-B: Device Management – Restart-B
 - .10 DM-LM-B : Device Management – List Manipulation-B
- .8 The Application Specific Controller shall support the following Data Link Layers:
 - .1 BACnet MS/TP Master (Clause 9)
 - .2 BACnet IP, Foreign Device
- .9 The Application Specific Controller shall provide for control of each piece of equipment, including, but not limited to the following:
 - .1 Variable Air volume (VAV)
 - .2 Electric reheat Coils (RH)
 - .3 Fan Coil Units
 - .4 Air Conditioners
 - .5 Heaters
 - .6 DX cooling and chilled water coils
- .10 All VAV applications must support the following options (where appropriate):
 - .1 Demand Control Ventilation using CO2 measurement
 - .2 Minimum ventilation control and flow set points configurable for each application operating mode
 - .3 Auxiliary/Base-board/Radiator heating, valve, two position or modulating and electric.
 - .4 Fault Detection for automatic change to pressure dependent control.
 - .5 Built in air balancing support.
 - .6 User initiated rapid ventilation to assist in purging the space for a configurable time with a separate flow set point
 - .7 Occupancy sensor

2.8 CONTROL PANELS

- .1 Controllers in mechanical rooms shall be mounted in NEMA 12 enclosures.
- .2 Controllers in areas where moisture is a concern shall be mounted in NEMA 12 enclosures.

- .3 Controllers installed outdoors shall be mounted in NEMA 4X enclosures. Provide heaters where freezing temperatures are normally experienced.
- .4 Mount on walls at an approved location or provide a free-standing rack.
- .5 Panels shall be constructed of 16-gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 gray polyester-powder painted finish, UL listed. Provide common keying for all panels.
- .6 Provide power supplies for control voltage power.
- .7 Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply unless the power for the control device is derived from the controller terminations.
- .8 Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.
- .9 All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.
- .10 Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
- .11 All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.
- .12 Provide a pocket to hold documentation.

2.9 SENSORS

- .1 General
 - .1 For terminal unit sensors refer to the BACnet Application Specific Controller (DXR) section.
 - .2 Provide mounting hardware for all devices, including actuator linkages, wells, installation kits for insertion devices, wall boxes and fudge plates, brackets, etc.
 - .3 If a special tool is required to mount a device, provide that tool.
- .2 Temperature Sensors
 - .1 All temperature sensors shall meet the following specifications:
 - .1 Accuracy: Plus or minus 0.2 percent at calibration point.
 - .2 Wire: Twisted, shielded-pair cable.
 - .3 Vibration and corrosion resistant
 - .2 Space temperature sensors shall meet the following specifications:
 - .1 1k ohm Pt RTD.
 - .3 Insertion Elements in Ducts shall meet the following specifications:
 - .1 Single point 1k ohm Pt RTD.
 - .2 Use where not affected by temperature stratification
 - .3 The sensor shall reach more that 1/3 the distance from the duct wall
 - .4 Junction box for wire splices
 - .4 Averaging Elements in Ducts shall meet the following specifications:
 - .1 72 inches (183 cm) long
 - .2 Flexible
 - .3 Use where prone to temperature stratification, in front of coils, or where ducts are larger than 9 sq. ft.
 - .4 Junction box for wire splices
 - .5 Insertion Elements for Liquids shall meet the following specifications:
 - .1 1k ohm Pt RTD.
 - .2 Threaded mounting with matching well
 - .3 Brass well with minimum insertion length of 2-1/2 inches for pipes up to 4" diameter
 - .4 Brass well with insertion length of 6 inches for pipes up to 10" diameter
 - .5 Junction box for wire splices
 - .6 Outside-Air Sensors 1k ohm Pt RTD
 - .1 Watertight enclosure, shielded from direct sunlight
 - .2 Circulation fan
 - .3 Watertight conduit fitting
- .3 Where called for in the sequences of operations, provide the following feature on space sensors and

- thermostats:
- .1 Security Sensors: Stainless-steel cover plate with insulated back and security screws
 - .2 Space sensors with setpoint adjust: Plain white plastic cover with slide potentiometer to signal a setpoint adjustment to the DDC
 - .3 Space Sensors with LCD display:
 - .1 Operator buttons for adjusting setpoints, setting fans speeds and overriding unit to on/off
 - .2 Graphical LCD icons for signaling heating/cooling mode, fans speed, schedule mode, actual temperature and current setpoint
 - .4 Humidity Sensors shall meet the following specifications:
 - .1 Bulk polymer sensor element
 - .2 Accuracy: 2 percent full range with linear output
 - .3 Room Sensors: With locking cover matching room thermostats, span of 0 to 100 percent relative humidity
 - .4 Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity
 - .5 Air Static Pressure Transmitter shall meet the following specifications:
 - .1 Non-directional sensor with suitable range for expected input, and temperature compensated.
 - .2 Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - .3 Output: 4 to 20 mA.
 - .4 Building Static-Pressure Range: 0 to 60 Pa
 - .5 Duct Static-Pressure Range: 0 to 1200 Pa
 - .6 Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.
 - .7 Equipment operation sensors as follows:
 - .1 Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 inches wg.
 - .2 Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 55 to 400 kPa.
 - .3 Status Inputs for direct drive electric motors: Current-sensing relay with current transformers, adjustable and sized for 175 percent of rated motor current.
 - .4 Status inputs for belt drive electric motors: Current sensing transmitter with linear 4-20mA output
 - .8 Electronic Valve/Damper Position indication: Visual scale indicating percent of travel and 0 to 10 V dc, feedback signal.
 - .9 Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5 amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.
 - .10 Leak detectors: Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall used a microchip controlled energized probes. The detector shall operate on 24V or less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

2.10 ELECTRO-MECHANICAL THERMOSTATS

- .1 Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point. Setpoint shall be adjustable.
 - .1 Bulb Length: Minimum 20 feet.
 - .2 Quantity: One thermostat for every 20 sq. ft. of coil surface.
- .2 Electric space thermostats: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.
- .3 Aquastat: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.

2.11 ELECTRONIC ACTUATOR SPECIFICATION

.1 ELECTRONIC VALVE ACTUATORS

- .1 Actuator shall be fully modulating, floating (tri-state), two-position, and/or spring return as indicated in the control sequences. Specified fail safe actuators shall require mechanical spring return.
- .2 Modulating valves shall be positive positioning, responding to a 2-10VDC or 4-20mA signal. There shall be a visual valve position indicator.
- .3 The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.
- .4 Actuator shall provide minimum torque required for proper valve close-off. The actuator shall be designed with a current limiting motor protection. A release button (clutch) or handle on the actuator shall be provided to allow for manual override (except when actuator is spring return type).
- .5 Actuators shall be UL listed.

.2 ELECTRONIC DAMPER ACTUATORS

- .1 Actuator shall be direct coupled (over the shaft), enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator-to-shaft clamp shall use a "V" bolt and "V" shaped, toothed cradle to attach to the damper shaft for maximum holding strength. Single bolt or set screw type fasteners are not acceptable.
- .2 Actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator. End switches to deactivate the actuator at the end of rotation or magnetic clutch are not acceptable.
- .3 For power-failure/safety applications, a mechanical, spring return mechanism shall be used.
- .4 Actuators with spring return mechanisms shall be capable of either clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
- .5 Proportional actuators shall accept a 2-10VDC, 4-20mA signal, or be of the 2 point floating type and provide a 2-10VDC actuator position feedback signal.
- .6 All actuators shall have an external manual gear release (clutch) or manual crank to aid in installation and for allowing manual positioning when the actuator is not powered.
- .7 All actuators shall have an external direction of rotation switch to aid in installation and to allow proper control response.
- .8 Actuators shall be provided with a factory-mounted 3-foot electrical cable and conduit fitting to provide easy hook-up to an electrical junction box.
- .9 Actuators shall be listed under Underwriters Laboratories Standard 873 and Canadian Standards Association. They must be manufactured under ISO 9001.

2.12 COMMUNICATION AND CONTROL WIRING

.1 General:

- .1 Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 26 unless otherwise noted herein.
- .2 All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

.2 Wire Sizing and Insulation

- .1 Wiring shall comply with minimum wire size and insulation based on services listed below:

.1 Service	Minimum Gage/Type	Insulation Class
.2 AC 24V Power	12 Ga Solid	600 Volt
.3 DC 24V Power	10 Ga Solid	600 Volt
.4 Class 1	14 Ga Stranded	600 Volt
.5 Class 2	18 Ga Stranded	300 Volt
.6 Class 3	18 Ga Stranded	300 Volt

- .2 Provide plenum-rated cable when open cable is permitted in supply or return air plenum where allowed per execution specifications defined in Paragraph 3.07

.3 Power Wiring:

- .1 115V power circuit wiring above 100 feet distance shall use minimum 10 gage.
- .2 24V control power wiring above 200 feet distance shall use minimum 12 gage.

.4 Control Wiring:

- .1 Digital Input/Output wiring shall use Class 2 twisted pair, insulated.
- .2 Analog inputs shall use Class 2 twisted shielded pair, insulated and jacketed and require a

- grounded shield.
- .3 Actuators with tri-state control shall use 3 conductor with same characteristics
- .5 Communication Wiring
 - .1 Ethernet Cable shall be minimum CAT5
 - .2 Secondary level network shall be 24 gage, TSP, low capacitance cable
- .6 Approved Cable Manufacturers:
 - .1 Wiring from the following manufacturers which meet the above criteria shall be acceptable:
 - .1 Anixter
 - .2 Belden
 - .3 Cerco

3 EXECUTION

3.1 EXAMINATION

- .1 The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.
- .2 The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.
- .3 The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others-the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.2 PROTECTION:

- .1 The contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.
- .2 The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.3 INSTALLATION

- .1 Provide all relays, switches, and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.
- .2 Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.
 - .1 Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.
 - .2 Install equipment level and plumb.
 - .3 Install control valves horizontally with the power unit up.
 - .4 Unless otherwise noted, install wall mounted thermostats and humidistat 60" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.
 - .5 Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.
 - .6 Install outdoor sensors in perforated tube and sunshield.
 - .7 Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.
 - .8 Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.
 - .9 Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.

3.4 GRAPHIC DISPLAY GENERATION

- .1 All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and control environment and definition and construction of dynamic color graphic displays.
- .2 Provide a main default screen showing the basic layout of the building. Each color graphic screen shall have transfer links to allow the building operator to transfer between system associated screens (both forward and backward), as well as a transfer link back to the main default screen.
- .3 Basic CAD floor plans with layers for walls, windows, low pressure ductwork only, supply diffusers and room numbers shall be provided for all terminal units. Floor plans shall show the location of each space temperature sensor with a dashed line to the associated terminal unit. Display in real time the difference between the space temperature and the current setpoint.
 - .1 Display the
 - .1 cooling %,
 - .2 heating % (if applicable)
 - .3 current CFM of each terminal unit.
 - .2 Provide a transfer link for each terminal unit to allow the operator to access the flow graphic for each individual terminal unit. Use a different color to shade the background area for each part of a floor plan graphic served by a different air handling unit.
- .4 All control set points shall be easily adjustable from the system's color graphic screen by operators with the proper access level. Each controlled point on the BAS operator workstation color graphic screens shall have the set point indicated along with the actual controlled variable reading (preferred set point on top and actual reading on bottom). All points shall indicate the associated engineering unit. All analog outputs points shall indicate engineering units such as "%-open" or "%-closed" as required by the application. All normally-closed or normally-open points shall indicate the normal position (such as "N.C." or "N.O." next to the controlled device).
- .5 Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service, and system data as required.
- .6 Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems and hot water systems to optimize system performance analysis and speed alarm recognition.
- .7 The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
- .8 Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
- .9 The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - .1 Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays via an off the shelf graphics package similar to MicroGraphix Designer.
 - .2 Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.
 - .3 Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.
- .10 Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers, PC workstation(s) and networks.
- .11 Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical, and/or plumbing system connected to the BMS.
- .12 Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.
- .13 Provide an additional (10) separate dynamic, graphic display pages at each workstation as required by the operating staff to further assist in daily system operations.
- .14 Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be

- controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
- .15 Each graphic shall have a "BACK" button and a "HOME" or "MAIN" button located in the same location on all graphics.
- .16 The operator shall be able to clearly distinguish the difference between the following types of points on a graphic either by color, shape, icon or text label:
 - .1 Real-time sensor reading
 - .2 Setpoint
 - .3 Manually set vs. program set Setpoint
 - .4 Real-time output reading
 - .5 Manually Overridden or commanded output vs program set output
 - .6 Status feedback from a piece of equipment vs the output command
- .17 When the operator selects a graphic from a menu or a hyperlink, the system shall also make the following adjustments for the operator:
 - .1 Highlight the system name on the system tree
 - .2 Highlight the controller name on the network tree
 - .3 Make appear links to additional information associated with the data on the graphic, such as:
 - .1 Adjustable modes of operation
 - .2 Setpoints
 - .3 Alarm statuses
 - .4 Trend logs
 - .4 Make appear links to additional information associated with the system on the graphic, such as:
 - .1 Controls as-built schematics and wiring diagrams
 - .2 As-built Sequence of Operation
 - .3 Mechanical drawings
 - .4 Electrical drawings
- .18 For control loops that have a 4-point setpoint reset schedule, the operator shall have access to adjust the 4 points in the graphics. Provide a separate graphic with the 4 adjustable data points and a line graph with labels vertices showing the scale of the reset ramp. Display the current calculated output setpoint.
- .19 Integration graphics shall be representative of personnel standing in front of equipment. The graphics for equipment specified in the Building Systems Integration paragraph shall be representative of the manufacturers' local display panel and each shall be completely operable from the computer workstation.

3.5 ELECTRICAL WIRING SCOPE

- .1 This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.
 - .1 Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.
 - .2 This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.
 - .3 Refer to Coordination section for what devices this contractor is responsible to mount and which are turned over to others to mount.
 - .4 This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.
 - .5 Interlock wiring shall be run in separate conduits from BAS associated wiring.
 - .6 Provide network wiring for equipment that is called to be integrated to the BAS.

3.6 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- .1 All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.

- .2 Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.
- .3 Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."
- .4 Install building wire and cable according to Division 26 Section "Conductors and Cables."
- .5 Installation shall meet the following requirements:
 - .1 Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
 - .2 Install exposed cable in raceway or conduit.
 - .3 Install concealed cable using plenum rated cable which need not be in conduit.
 - .4 Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 - .5 Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - .6 Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - .7 All wiring in lab areas shall be in conduit.
 - .8 All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.
- .6 Rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.
- .7 Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90-degree angles.
- .8 Install conduit adjacent to machine to allow service and maintenance.
- .9 Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- .10 Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- .11 Ground equipment.

3.7 COMMUNICATION WIRING

- .1 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- .2 Do not install communication wiring in raceway and enclosures containing Class 1 wiring.
- .3 Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- .4 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- .5 Cable bundling:
 - .4 RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
 - .5 RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
 - .6 RS485 cabling run between floors shall be in a communication only conduit.
 - .7 RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
 - .8 Ethernet cabling shall be in a communication only conduit.
 - .9 Ethernet and RS485 can be run together.
 - .10 Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.
- .6 RS485 Cabling
 - .1 RS485 cabling shall be used for BACnet MS/TP networks.
 - .2 RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
 - .3 The shields shall be tied together at each device.
 - .4 The shield shall be grounded at one end only and capped at the other end.

- .5 Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.
- .7 Ethernet Cabling
 - .1 Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
 - .2 CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
 - .3 Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
 - .4 When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.
- .8 Fiber-Optic Cabling
 - .1 Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.
 - .2 All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable andunjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.
 - .3 All terminations shall be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.
- .9 When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lightning arrestor shall be installed according to the manufacturer's instructions.
- .10 All runs of communication wiring shall be unspliced length when that length is commercially available.
- .11 All communication wiring shall be labeled to indicate origination and destination data.
- .12 Grounding of coaxial cable shall be in accordance with OBC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 IDENTIFICATION

- .1 Permanent warning labels shall be affixed to all equipment that can be automatically started by the DDC system.
 - .1 Labels shall use white lettering (12-point type or larger) on a red background.
 - .2 Warning labels shall read as follows: C A U T I O N This equipment is operating under automatic control and may start or stop at any time without warning. Switch disconnect to "Off" position before servicing.
- .2 Permanent warning labels shall be affixed to all motor starters and all control panels that are connected to multiple power sources utilizing separate disconnects.
 - .1 Labels shall use white lettering (12-point type or larger) on a red background.
 - .2 Warning labels shall read as follows: C A U T I O N This equipment is fed from more than one power source with separate disconnects. Disconnect all power sources before servicing.
- .3 Control Equipment and Device labeling:
 - .1 Labels and tags shall match the unique identifiers shown on the as-built drawings.
 - .2 All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
 - .3 All sensors and actuators not in occupied areas shall be tagged.
 - .4 Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
 - .5 Duct static pressure taps shall be tagged at the location of the pressure tap.
 - .6 Each device inside enclosures shall be tagged.
 - .7 Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:
 - .1 First, the design drawings, or
 - .2 Second, the control as-builts, or
 - .3 Third, the DDC addressing scheme
 - .2 Tags on the terminal units shall be displayed on the Operator Workstation Graphics.
- .4 Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12 point height minimum.

- .5 Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- .6 Identification of Wires
 - .1 Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination.
 - .2 Tag each network wire with a common identifier on each end.
 - .3 Tag each 120V power source with the panel and breaker number it is fed by.
- .7 Identification of Conduits:
 - .1 Identify the low voltage conduit runs as BAS conduit, power feeds not included.
 - .2 Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.
 - .3 For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.
 - .4 Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.
 - .5 Identify all BAS communication conduits the same as above.

3.9 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
 - .1 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
 - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
 - .3 Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- .2 Engage a factory-authorized service representative to perform startup service.
- .3 Replace damaged or malfunctioning controls and equipment.
 - .1 Start, test, and adjust control systems.
 - .2 Demonstrate compliance with requirements, including calibration and testing, and control sequences.
 - .3 Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.10 SYSTEM CHECKOUT AND STARTUP

- .1 Inspect each termination in the MER control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.
- .2 After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following:
 - .1 Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.
 - .2 Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.
 - .3 Inspect the reading on each CO2 sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.
 - .4 Inspect the reading of each status switch to verify the DDC reads the open and close correctly.
 - .5 Command each relay to open and close to verify its operation.
 - .6 Command each 2-position damper actuator to open and close to verify operation.
 - .7 Command each 2-position valve to open and close to verify operation.
 - .8 Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.
 - .9 Ramp each modulating output signal, such as a VFD speed, to verify its operation.
 - .10 Test each safety device with a real-life simulation, for instance check freezestats with ice water, water detectors with water, etc.

- .3 Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.
- .4 Verify that each DDC controller communicates on its respective network correctly.
- .5 After all of the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:
 - .1 Start systems from DDC.
 - .2 Verify that each setpoint can be met by the system.
 - .3 Change setpoints and verify system response.
 - .4 Change sensor readings to verify system response.
 - .5 Test safety shutdowns.
 - .6 Verify time delays.
 - .7 Verify mode changes.
 - .8 Adjust filter switches and current switches for proper reactions.
 - .9 Adjust proportional bands and integration times to stabilize control loops.
- .6 Perform all program changes and debugging of the system for a fully operational system.
- .7 Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.
- .8 After the sequence of operation is verified, setup the trends that are listed in the sequence of operations for logging and archiving for the commissioning procedure.

3.11 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

- .1 The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, inter-locks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.
- .2 After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).
- .3 The BAS contractor shall fix punch list items within 30 days of acceptance.
- .4 When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

3.12 TRAINING

- .1 During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide 16 hours of on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

END OF SECTION

DOMESTIC HOT WATER HEATER

DESCRIPTION	LOCATION	SERVICE	TYPE	TOTAL VOLUME		RECOVERY	WATER TEMP RISE		EFFICIENCY	REFRIGERANT TYPE	ELECTRICAL			SHIPPING WEIGHT	MODEL	SPECIFICATION REFERENCE	REMARKS
DESIGNATION				GAL	LITRE	GPH	°F	°C	UEF		V / PH / HZ	WATTS	MOCP	LBS			
DHWH-1	MECHANICAL ROOM	DOMESTIC HOT WATER	HYBRID ELECTRIC HEAT PUMP	66	250	79	100	56.0	3.45	R134A	208 / 3 / 60	4500 UPPER & LOWER	30	289.00	AO SMITH PROLINE XE HPTLJ56N	22 30 00	-

VARIABLE VOLUME TERMINAL BOX SCHEDULE

DESCRIPTION	MAX AIR FLOW		INLET SIZE DIAMETER		CASING						MANUFACTURER AND MODEL	SPECIFICATION REFERENCE	REMARKS
					LENGTH		WIDTH		HEIGHT				
DESIGNATION	CFM	l/s	INCHES	mm	INCHES	mm	INCHES	mm					
VV-1, 2, 3, 4	450	212	8	203	20.125	511	12	305	10	254	PRICE - SDV 07	23 36 00	
NOTES: 1. CONTROLLER AND WALL MOUNT CO2 SENSOR BY DIVISION 25.													

ELECTRIC DUCT HEATER SCHEDULE

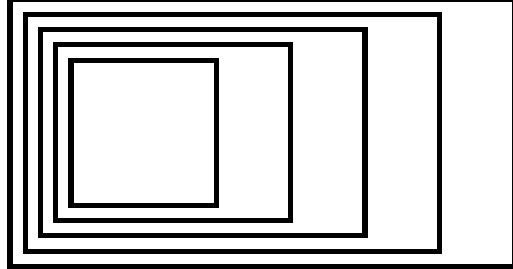
DESCRIPTION	HEATING CAPACITY		AIR FLOW		LEAVING AIR TEMP.		FACE VELOCITY		STAGE	SIGNAL	ELECTRICAL	DUCT HEIGHT		DUCT WIDTH		DUCT DIAMETER		MANUFACTURER MODEL	SPECIFICATION REFERENCE
DESIGNATION	MBH	KW	CFM	L/S	°F	°C	FPM	M/S			V / PH / HZ	INCH	MM	INCH	MM	INCH	MM		
EDH-1	13.6	4	1130	533	90	32	678	3.44	SCR	0 -10 V	208 / 3 / 60	12	300	20	500	-	-	NAILER - DHRS	23 82 00
EDH-2	13.6	4	1130	533	90	32	678	3.44	SCR	0 -10 V	208 / 3 / 60	12	300	20	500	-	-	NAILER - DHRS	23 82 00
EDH-3	13.6	4	1377	650	90	32	986	5.00	SCR	0 -10 V	208 / 3 / 60	-	-	-	-	16	400	NAILER - DHRR	23 82 00
EDH-4	13.6	4	1377	650	90	32	986	5.00	SCR	0 -10 V	208 / 3 / 60	-	-	-	-	16	400	NAILER - DHRR	23 82 00
EDH-5	10.2	3	742	350	90	32	742	3.77	SCR	0 -10 V	208 / 3 / 60	8	200	18	450	-	-	NAILER - DHRS	23 82 00
EDH-6	10.2	3	1080	509	90	32	648	3.29	SCR	0 -10 V	208 / 3 / 60	10	250	24	600	-	-	NAILER - DHRS	23 82 00
NOTES: ALL ELECTRIC DUCT HEATERS SHALL INCLUDE THE FOLLOWING: 1. AUTOMATIC AND MANUAL THERMAL CUTOUT; 2. HEC CONTROLLER; 3. MAGNATIC CONTACTOR; 4. CONTROL FUSE; 5. MEMA 1 CONTROL PANEL; 6. AIR FLOW SENSOR; 7. TEMPERATURE SENSOR; 8. INTEGRATE THE OPERATION OF THE ELECTRIC DUCT HEATER WITH THE ASSOCIATED VRF FAN COIL UNIT.																			

DUCTLESS SPLIT AIR CONDITONING SYSTEMS

DESCRIPTION	LOCATION	TOTAL COOLING CAPACITY		ELECTRICAL			MANUFACTURER AND MODEL	DESCRIPTION	TOTAL COOLING CAPACITY		ELECTRICAL			EFFICIENCY EER2	REFRIGERANT	MANUFACTURER AND MODEL	SPECIFICATION REFERENCE
				VOLTAGE	AMPS	EMERGENCY POWER					VOLTAGE	AMPS	EMERGENCY POWER				
INDOOR UNIT		MBH	KW	V/PH/Hz	MCA	Y/N		OUTDOOR UNIT	MBH	KW	V/PH/Hz	MCA	Y/N				
AC-1	ELEC. RM 003	22.4	6.56	208 / 1 / 60	1.0 A	N	DAIKIN FTKF24AXVJU	CU-1	22.4	6.56	208 / 1 / 60	14.23	N	12.00	R32	DAIKIN RKF24AXVJU	23 81 26
NOTES: 1. RATED COOLING CAPACITIES BASED ON: INDOOR ENTERING AIR TEMPERATURE: 80°F (26°C) DB & 67°F (19°C) WB, OUTDOOR AIR TEMPERATURE: 95°F (35°C) DB. 2. INCLUDE CONDENSATE PUMP, WIRED CONTROLLER. 3. INCLUDE PUMP KIT FOR CONDENSATION.																	

DEDICATED OUTDOOR AIR SYSTEM ENERGY RECOVERY WHEEL

SUPPLY	SUMMER	DESCRIPTION	DOAS-1 ERW
		AIRFLOW: CFM	2200
		ENTERING AIR TEMPERATURE:	86.0 °F DB / °F WB
		LEAVING AIR TEMPERATURE:	67.4 °F DB / °F WB
		AIR PRESSURE DROP:	0.61 IN.WG.
	WINTER	TOTAL CAPACITY RECOVERED:	90.5 MBH
		AHRI SENSIBLE EFFECTIVENESS: (%)	81.8%
		AHRI LATENT EFFECTIVENESS: (%)	71.7%
		AIRFLOW: CFM	2200
		ENTERING AIR TEMPERATURE:	-13.0 °F DB
EXHAUST	SUMMER	LEAVING AIR TEMPERATURE:	58.9 °F DB
		AIR PRESSURE DROP:	0.61 IN.WG.
		TOTAL COIL CAPACITY:	171 MBH
		AHRI SENSIBLE EFFECTIVENESS: (%)	84.30%
		AHRI LATENT EFFECTIVENESS: (%)	84.60%
	WINTER	AIRFLOW: CFM	2200
		ENTERING AIR TEMPERATURE:	63.2 °F DB
		LEAVING AIR TEMPERATURE:	82.2 °F DB
		AIR PRESSURE DROP:	0.64 IN.WG.
		AIRFLOW: CFM	2200
NOTES	WINTER	ENTERING AIR TEMPERATURE:	72.3 °F DB
		LEAVING AIR TEMPERATURE:	-1 °F DB
		AIR PRESSURE DROP:	0.64 IN.WG.
		1. ENERGY RECOVERY WHEEL EFFICIENCY INCLUDES THE EFFECT OF DEFOST CONTROLS (WHEEL SPEED ROTATION MODULATION)	



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6	ADDENDUM ME-02	2024-10-24
4	ISSUED FOR TENDER	2024-09-24
3	ISSUED FOR 100%	2024-08-29
2	ISSUED FOR PERMIT	2024-08-16
1	ISSUED FOR 60% PROGRESS	2024-07-12

No.	ISSUED/REVISED	DATE
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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

MECHANICAL SCHEDULES

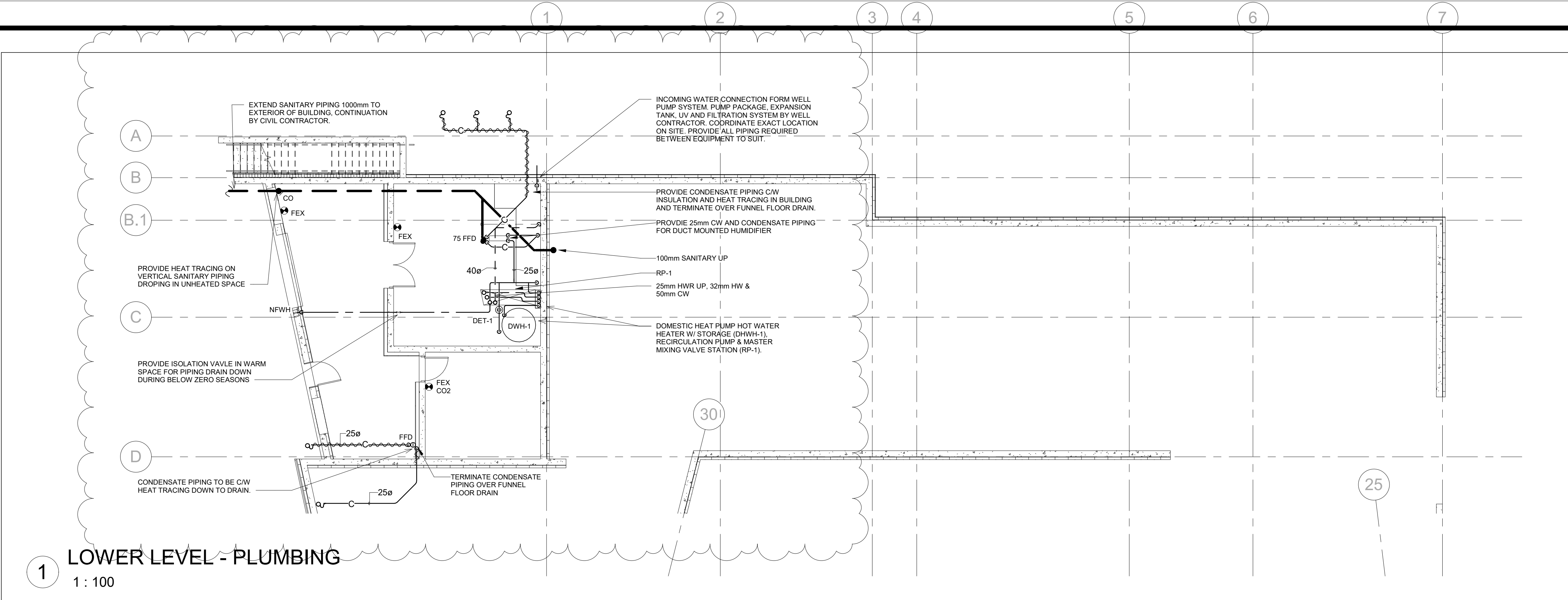
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Project Number:
23-088

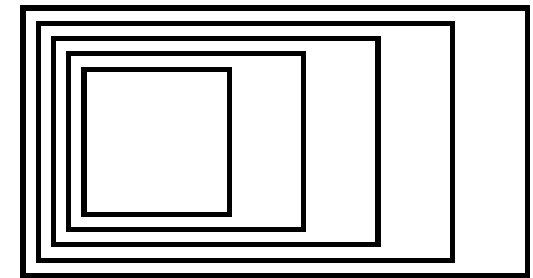
Drawn By:
CYS

Checked By:
NL

M003.1



PLUMBING FIXTURE SCHEDULE						
REFER	DESCRIPTION	SAN	VENT	HOT	COLD	
W1	WATER CLOSET - W.H. F.T.	75	40	--	15	
W2H	WATER CLOSET - W.H. F.T. B.F.	75	40	--	15	
L1	LAVATORY - W.H.	40	32	15	15	
L2H	LAVATORY - W.H. B.F.	40	32	15	15	
S1	S.S. SINK - 1 COMP. C.M.	40	40	15	15	
S2	S.S. SINK - 1 COMP. C.M. DEEP	40	40	15	15	
DW	DISHWASHER	40	--	20	--	
LT	LAUNDRY TUB	40	40	15	15	
MS	MOP SINK	50	40	20	20	
WMV	WASHING MACHINE VALVE BOX	75	40	20	20	
BF	BOTTLE FILL W.H.	40	32	--	15	
W.H. - WALL HUNG F.M. - FLOOR MOUNT F.T. - FLUSH TANK						
B.F. - BARRIER FREE ELEC - ELECTRONIC C.M. - COUNTER MOUNT						

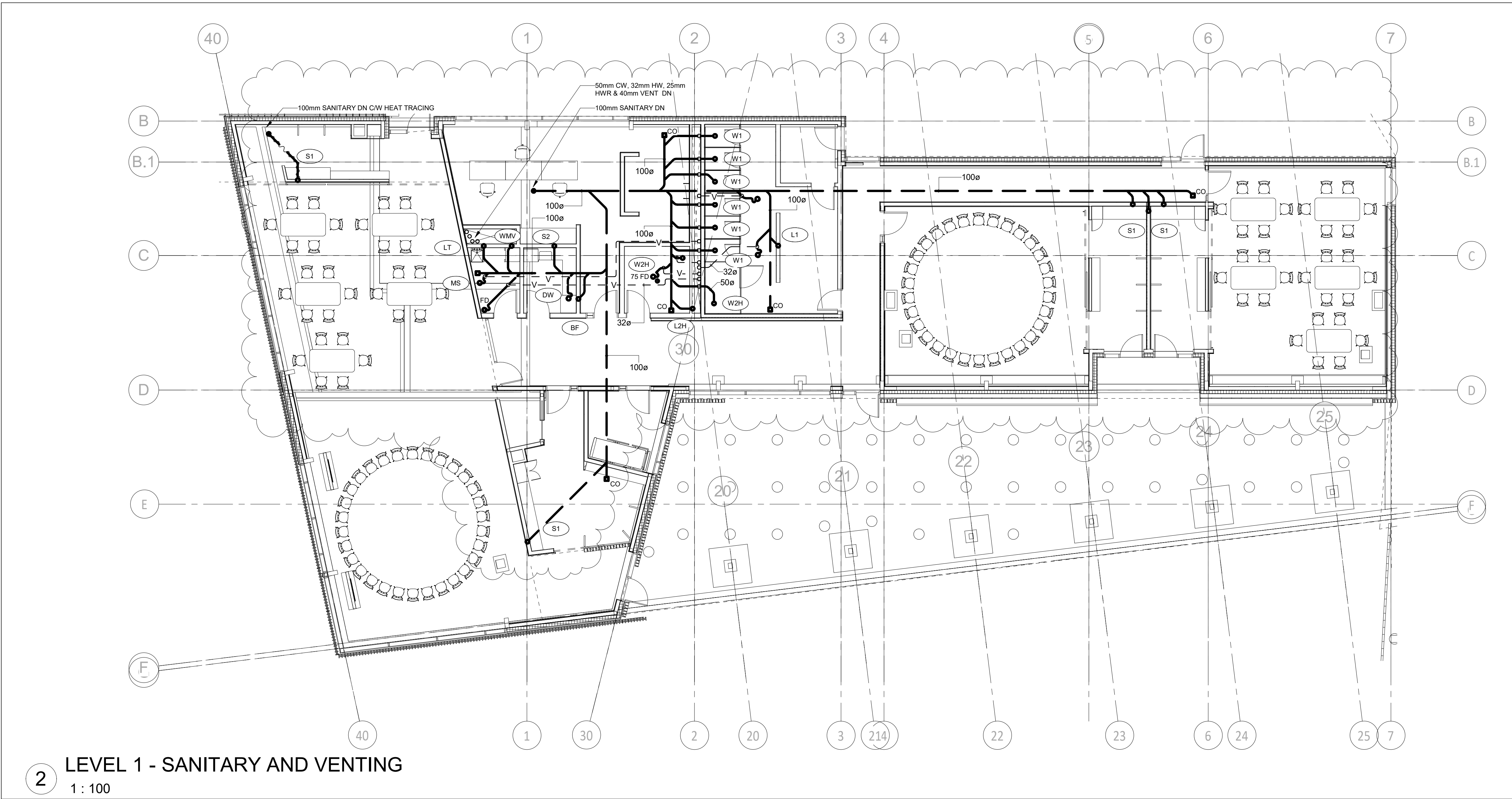


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6	ADDENDUM ME-02	2024-10-24
4	ISSUED FOR TENDER	2024-09-24
3	ISSUED FOR 100%	2024-08-29
2	ISSUED FOR PERMIT	2024-08-16
1	ISSUED FOR 60% PROGRESS	2024-07-12

No.	ISSUED/REVISED	DATE
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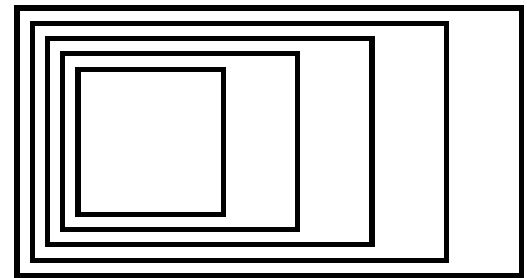
SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

FLOOR PLAN LEVEL 1 -
UNDERGROUND
PLUMBING AND LOWER
LEVEL PLUMBING

Scale: As indicated	
Project Number: 23-088	Drawn By: RR Checked By: NL
Drawn By: RR	
Checked By: NL	

M100.1

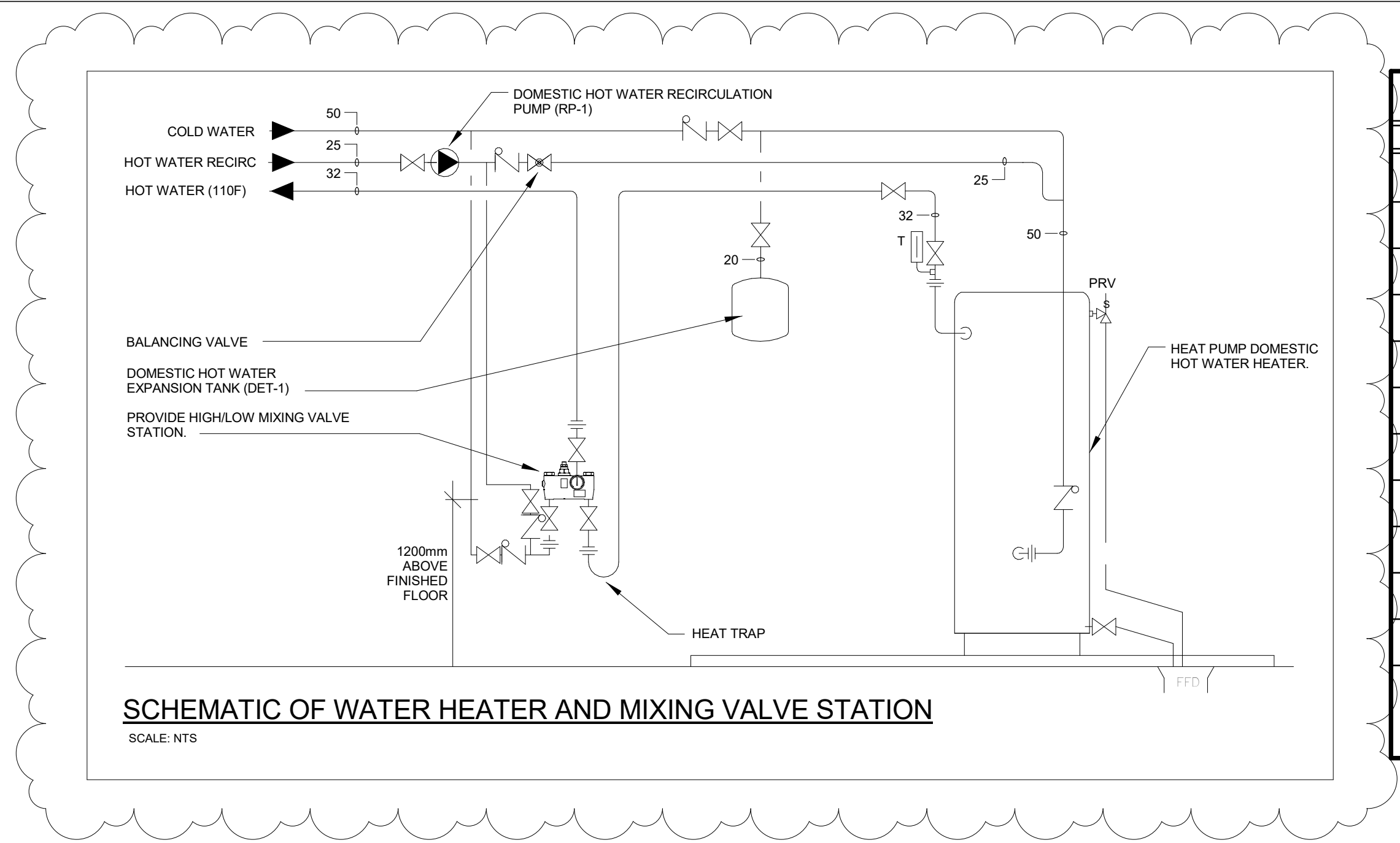
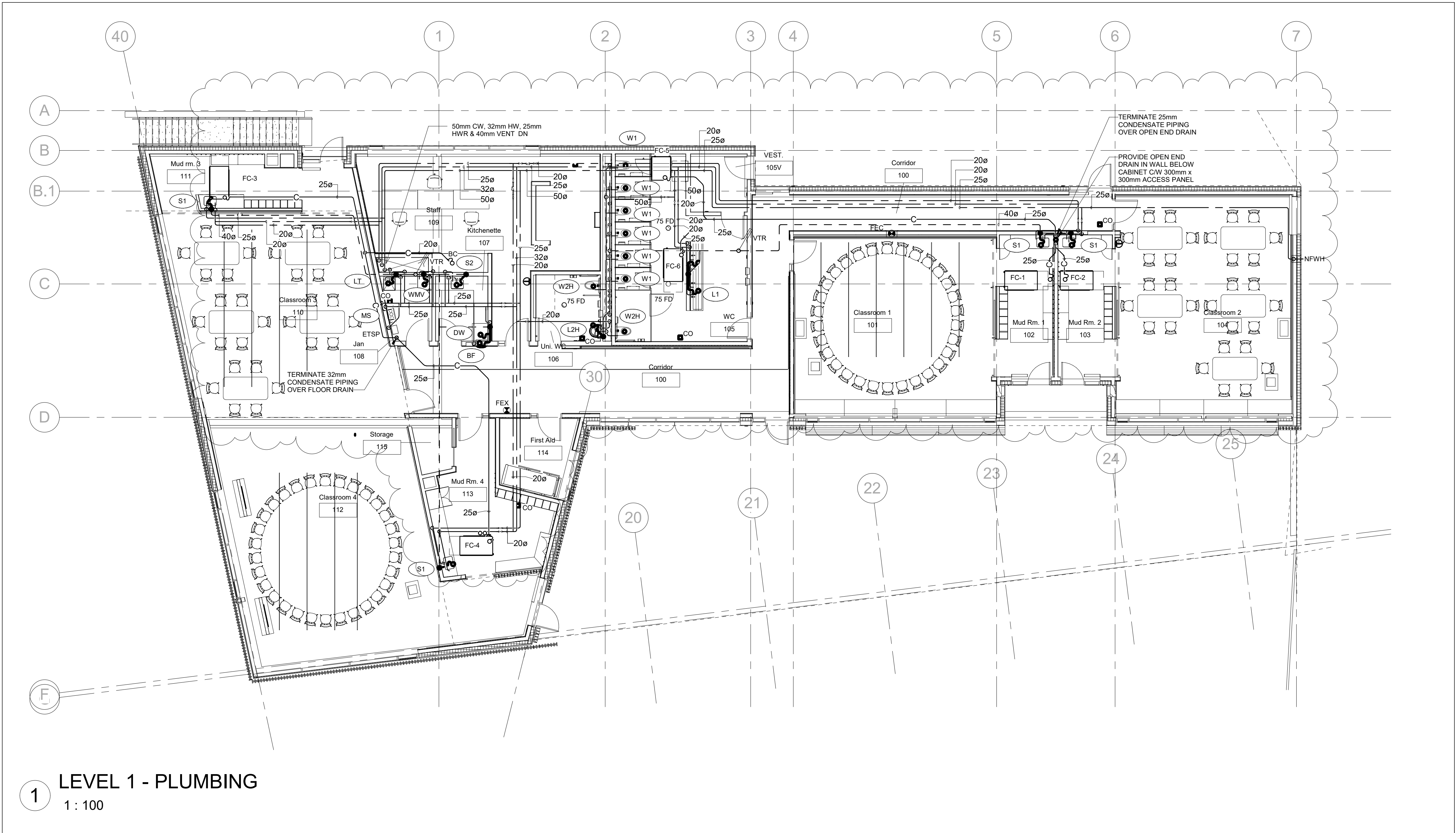


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PLUMBING FIXTURE SCHEDULE				
REFER	DESCRIPTION	SAN	VENT	HOT COLD
W1	WATER CLOSET - W.H. F.T.	75	40	-- 15
W2H	WATER CLOSET - W.H. F.T. B.F.	75	40	-- 15
L1	LAVATORY - W.H.	40	32	15 15
L2H	LAVATORY - W.H. B.F.	40	32	15 15
S1	S.S. SINK - 1 COMP. C.M.	40	40	15 15
S2	S.S. SINK - 1 COMP. C.M. DEEP	40	40	15 15
DW	DISHWASHER	40	--	20 --
LT	LAUNDRY TUB	40	40	15 15
MS	MOP SINK	50	40	20 20
WMV	WASHING MACHINE VALVE BOX	75	40	20 20
BF	BOTTLE FILL W.H.	40	32	-- 15
W.H. - WALL HUNG F.M. - FLOOR MOUNT F.T. - FLUSH TANK B.F. - BARRIER FREE ELEC - ELECTRONIC C.M. - COUNTER MOUNT				

6	ADDENDUM ME-02	2024-10-24
4	ISSUED FOR TENDER	2024-09-24
3	ISSUED FOR 100%	2024-08-29
2	ISSUED FOR PERMIT	2024-08-16
1	ISSUED FOR 60% PROGRESS	2024-07-12

No.	ISSUED/REVISED	DATE
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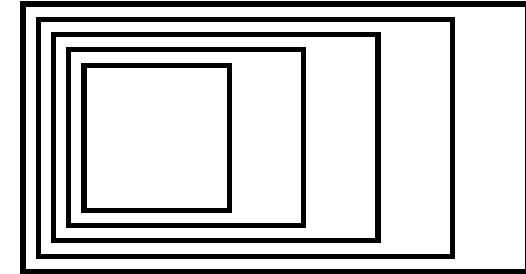
SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

FLOOR PLAN LEVEL 1 -
PLUMBING

Scale: As indicated
Project Number:
23-088
Drawn By:
RR
Checked By:
NL

M101.1



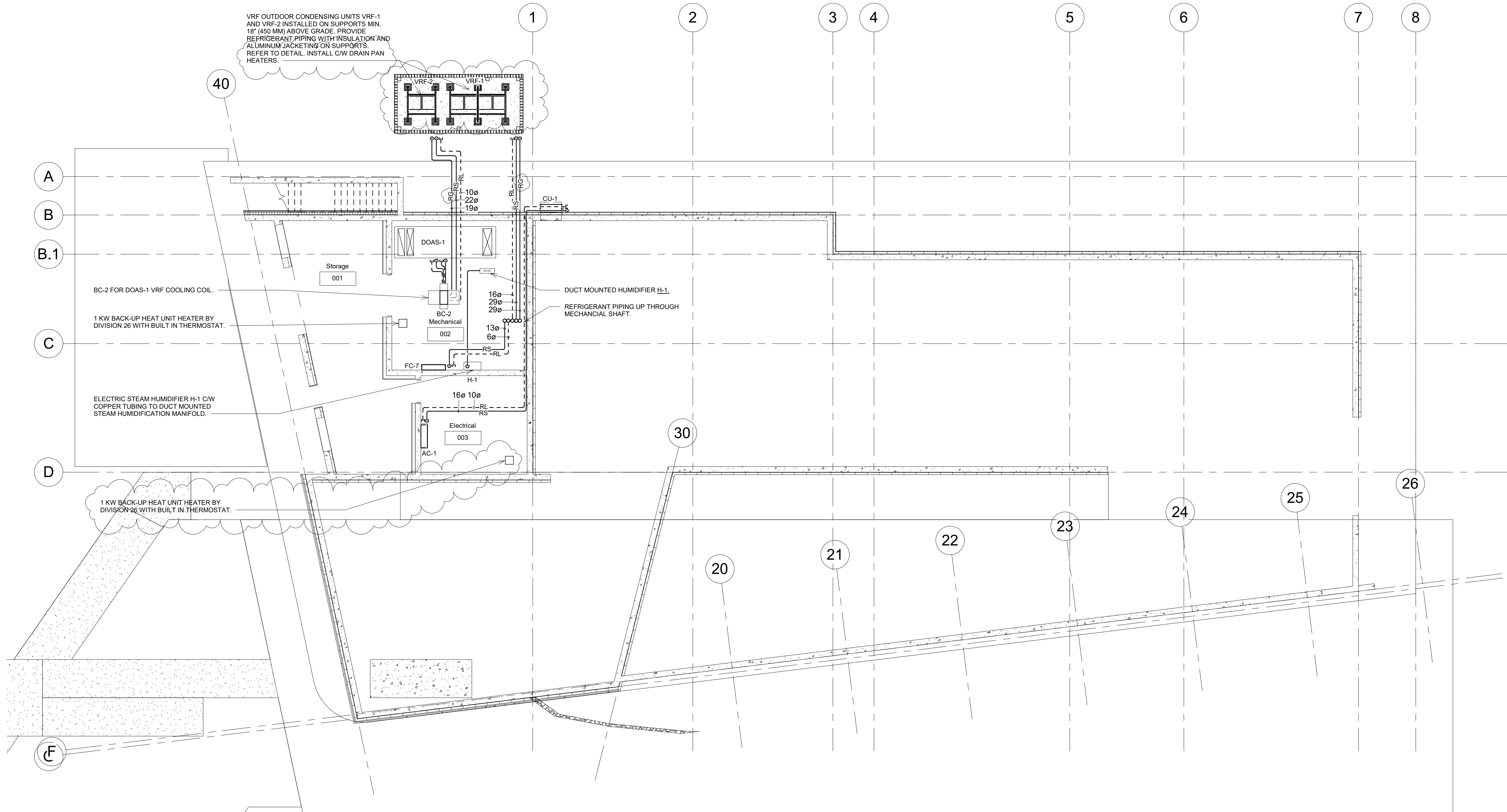
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NOTES - PIPING:

- REFER TO DRAWING M-001 FOR LEGEND OF SYMBOLS AND NOTES.
- REFER TO DRAWINGS M-400s FOR MECHANICAL DETAILS.
- SIZES AND QUANTITY OF REFRIGERANT PIPING SHALL BE CONFIRMED BASED ON VRF SYSTEM MANUFACTURER SHOP DRAWINGS. WHERE A MANUFACTURER WHICH IS NOT THE BASIS OF DESIGN IS PROVIDED, THE MECHANICAL CONTRACTOR SHALL PROVIDE FOR ANY ADDITIONAL COSTS RELATED TO DIFFERENCES IN ELECTRICAL REQUIREMENTS, PIPING, EQUIPMENT, AND CONTROLS.

6	ADDENDUM ME-02	2024-10-24
4	ISSUED FOR TENDER	2024-09-24
3	ISSUED FOR 100%	2024-08-29
2	ISSUED FOR PERMIT	2024-08-16
1	ISSUED FOR 60% PROGRESS	2024-07-12

No.	ISSUED/REVISED	DATE
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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

FLOOR PLAN LOWER LEVEL - PIPING

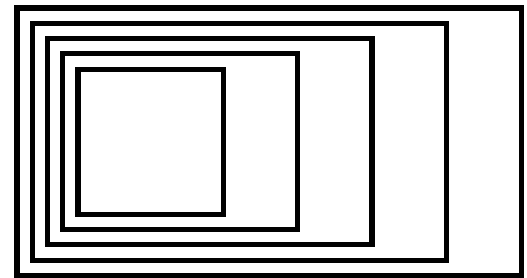
Scale: As indicated

Project Number:
23-088

Drawn By:
CYS

Checked By:
NL

M200.1



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No.	ISSUED/REVISED	DATE
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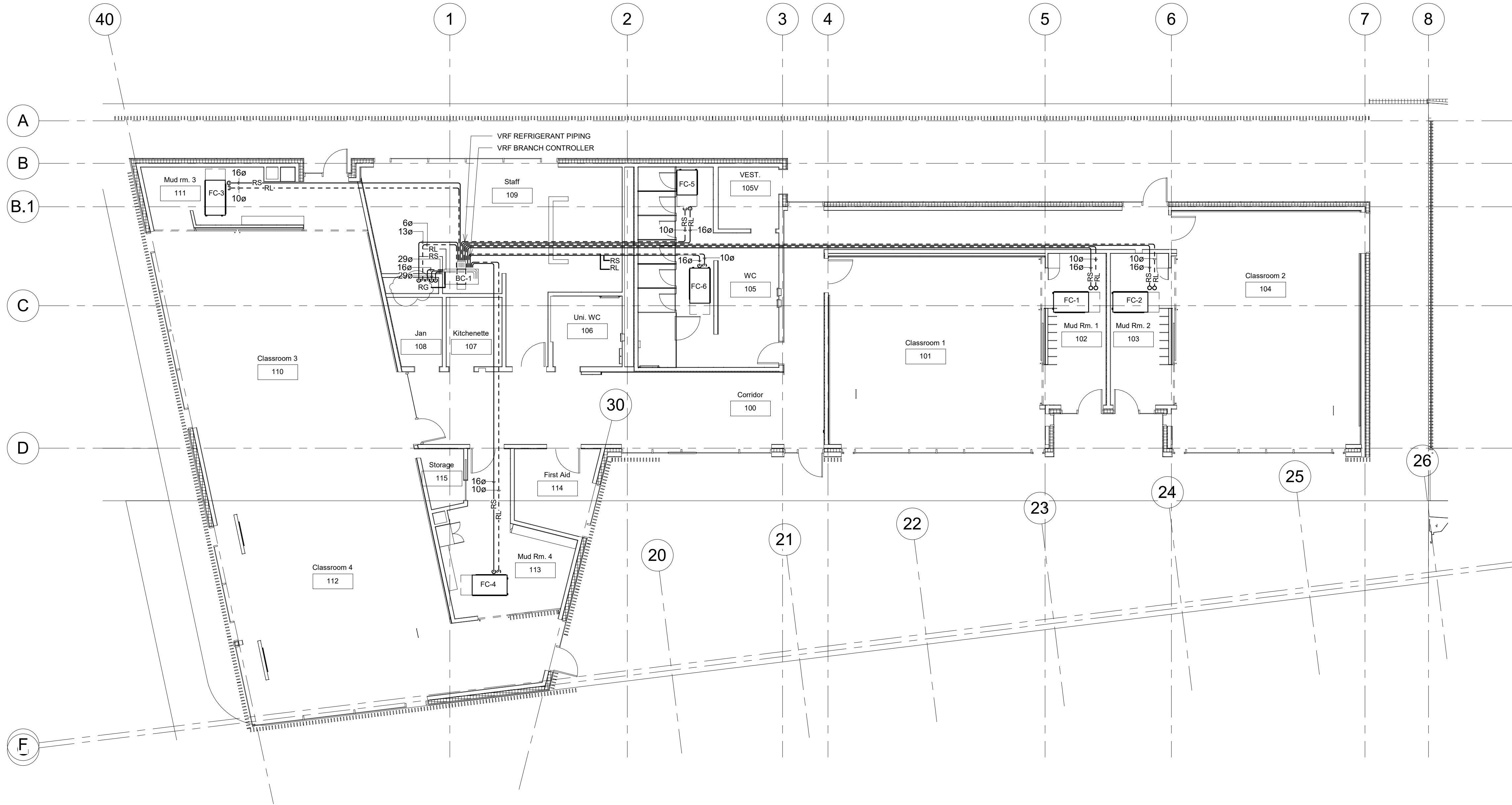
SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

FLOOR PLAN LEVEL 1 -
PIPING

Scale: As indicated	
Project Number: 23-088	
Drawn By: CYS	
Checked By: NL	

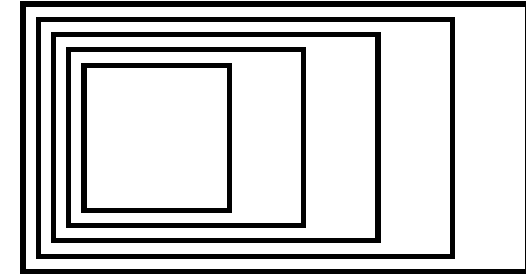
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1 LEVEL 1 - PROPOSED PLAN - PIPING
1 : 100

NOTES - PIPING:

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- PROVIDE FULL SIZE ACCESS DOORS IN CEILINGS FOR SERVICING VRF FAN COILS.



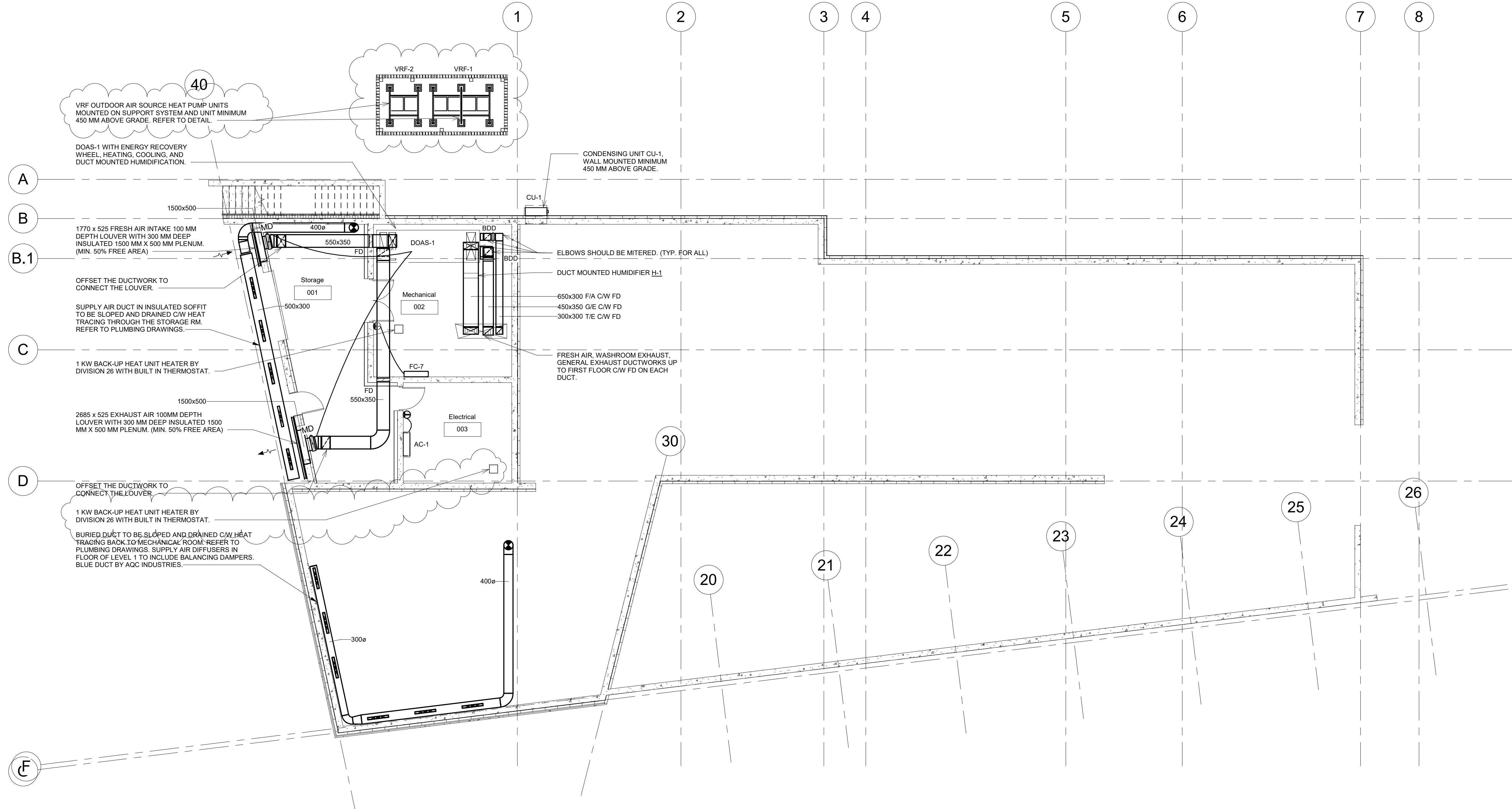
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1 LOWER LEVEL - PROPOSED PLAN - AIR DISTRIBUTION
1 : 100

NOTES - AIR DISTRIBUTION:

- REFER TO DRAWING M-001 FOR LEGEND OF SYMBOLS AND NOTES.
- REFER TO DRAWINGS M-400's FOR MECHANICAL DETAILS.
- LOCATION OF THERMOSTAT TO BE COORDINATED WITH FINAL LOCATION OF FURNITURE AND EQUIPMENT, AND ACCEPTED BY CONSULTANT. TYPICAL FOR ALL INDICATED.
- LOCATION OF CO2 MONITORS TO BE COORDINATED WITH FINAL LOCATION OF FURNITURE AND EQUIPMENT, AND ACCEPTED BY CONSULTANT. TYPICAL FOR ALL INDICATED.
- AIR OUTLETS (DIFFUSERS / GRILLES):
TAG DESIGNATION
AIRFLOW-L/S

S
L/S
- DUCT MOUNTED STEAM DISTRIBUTOR. PROVIDE S.S. WELDED DUCT COMPLETE WITH DRAIN AT STEAM HUMIDIFICATION MANIFOLD. REFER TO MECHANICAL DETAILS DRAWINGS.
- ALL SUPPLY AIR DUCTWORK SHALL BE EXTERNALLY INSULATED UNLESS SHOWN HATCHED TO INDICATE INTERNAL LINING IN LIEU OF EXTERNAL INSULATION.
- PROVIDE PROTECTION AND REPLACE FILTERS ON AIR INTAKES THAT MAY BECOME CONTAMINATED DUE TO DUST AND DEBRIS GENERATED DURING CONSTRUCTION.
- MECHANICAL CONTRACTOR SHALL ALLOW FOR OFFSETS IN DUCTWORK AS REQUIRED TO AVOID STRUCTURE.

6	ADDENDUM ME-02	2024-10-24
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No.	ISSUED/REVISED	DATE
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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

FLOOR PLAN LOWER LEVEL - AIR DISTRIBUTION

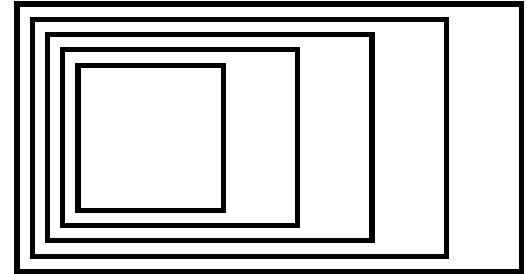
Scale: As indicated

Project Number:
23-088

Drawn By:
CYS

Checked By:
NL

M300.1

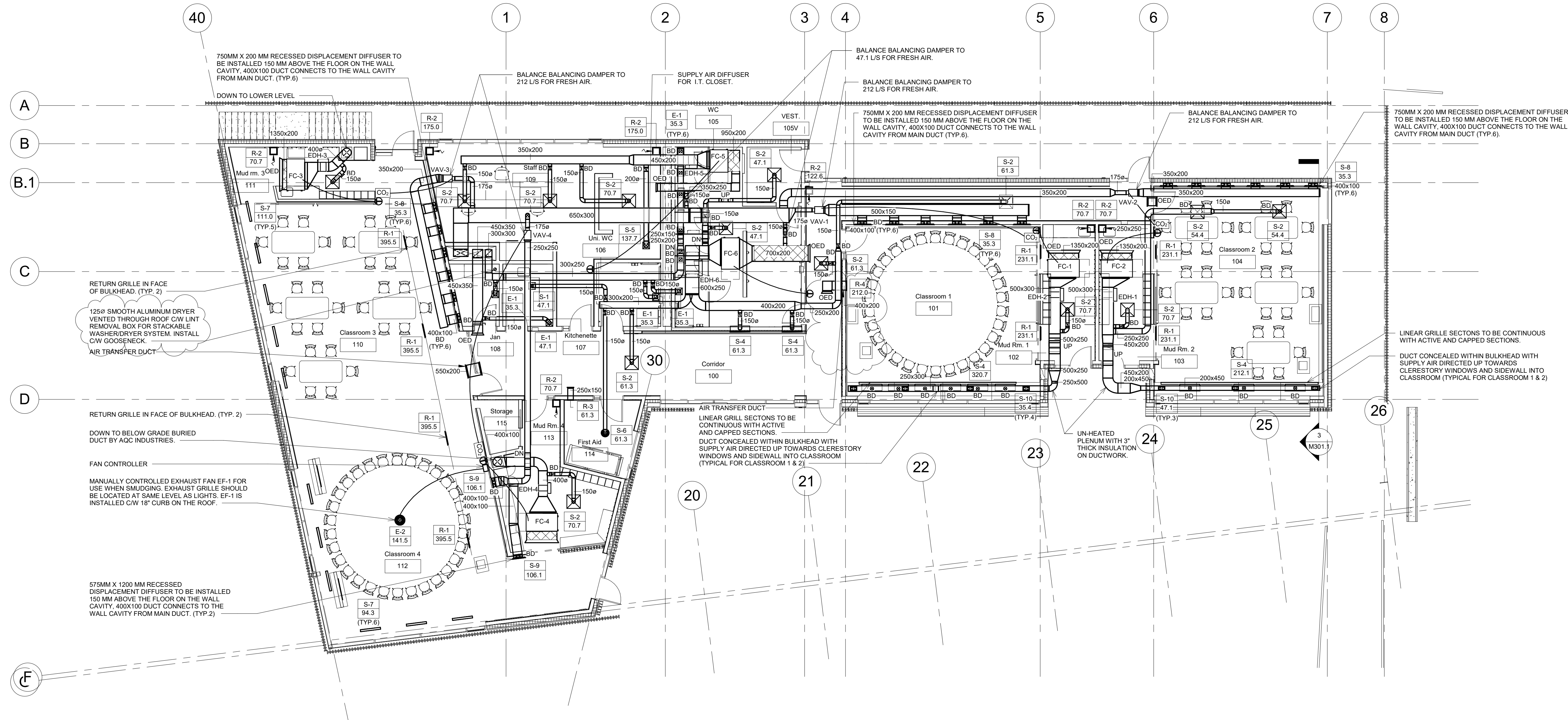


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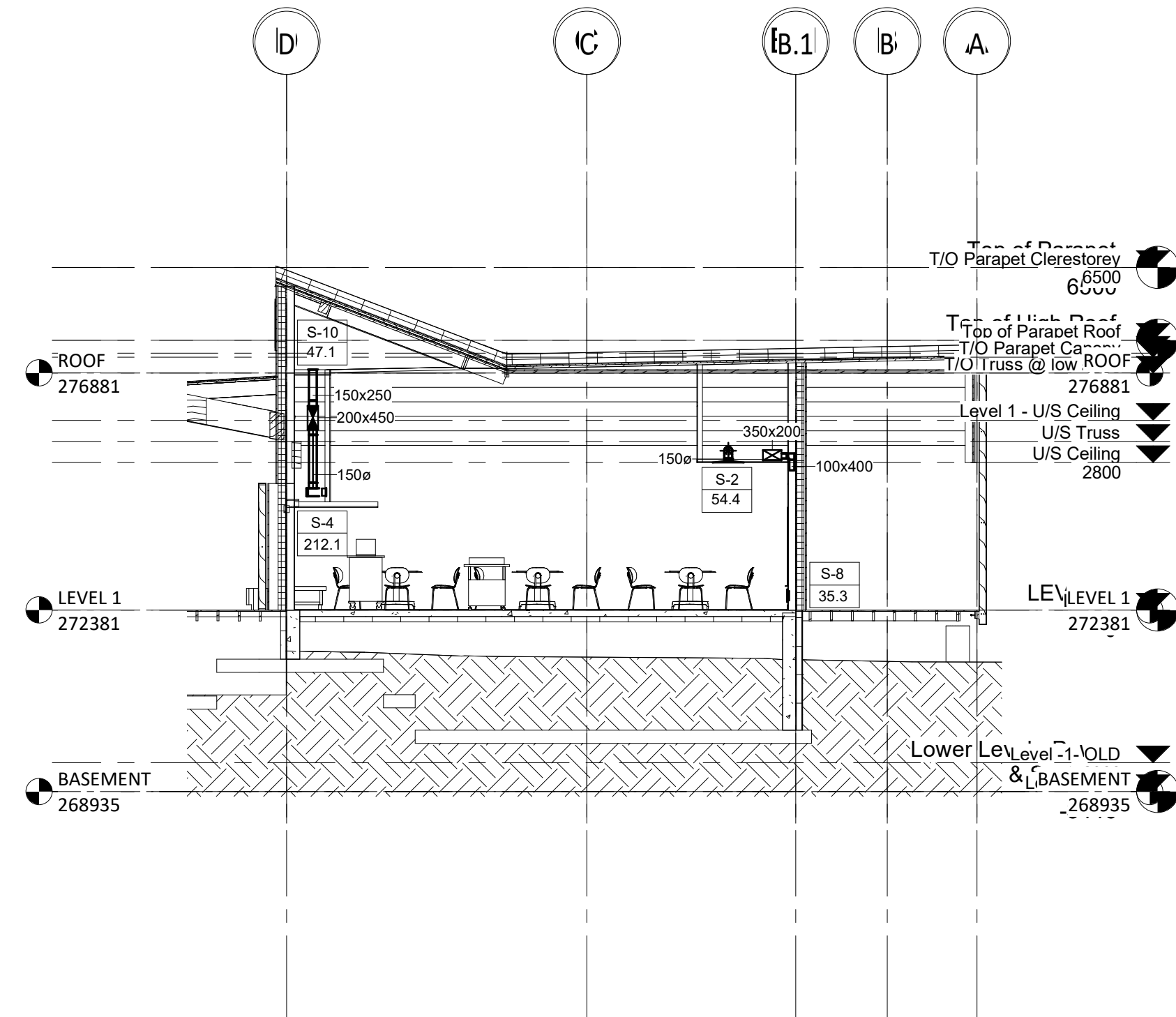
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1 LEVEL 1 - PROPOSED PLAN - AIR DISTRIBUTION
1 : 100



3 CLASSROOM 2 SECTION
1 : 100

NOTES - AIR DISTRIBUTION:

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- AIR OUTLETS (DIFFUSERS / GRILLES):
TAG DESIGNATION
AIRFLOW-L/S

S-	L/S
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No.	ISSUED/REVISED	DATE
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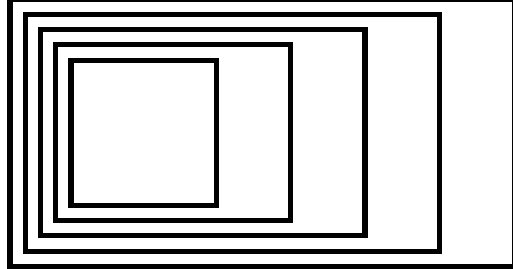
SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

FLOOR PLAN LEVEL 1 -
AIR DISTRIBUTION

Scale: As indicated	
Project Number: 23-088	
Drawn By: CYS	
Checked By: NL	

M301.1

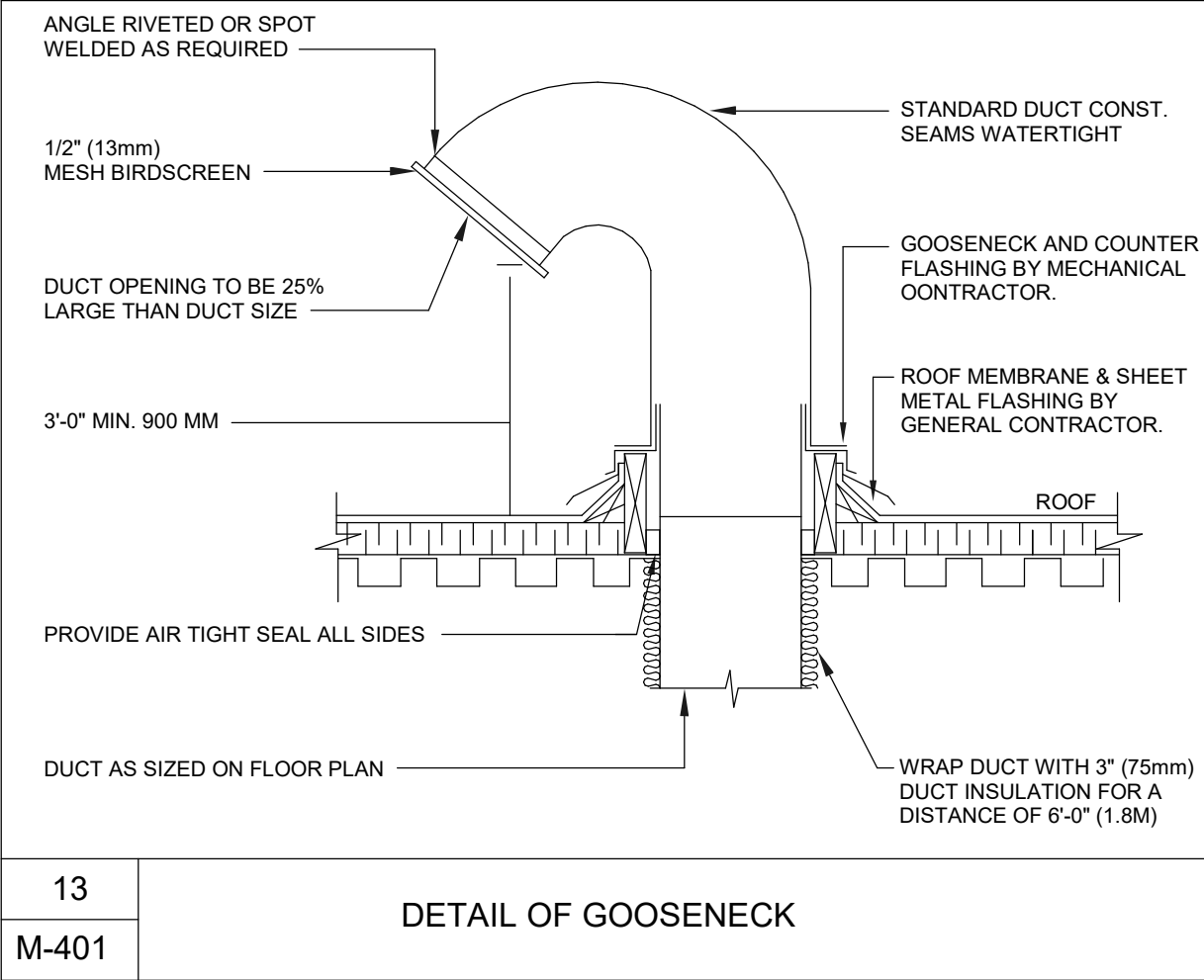
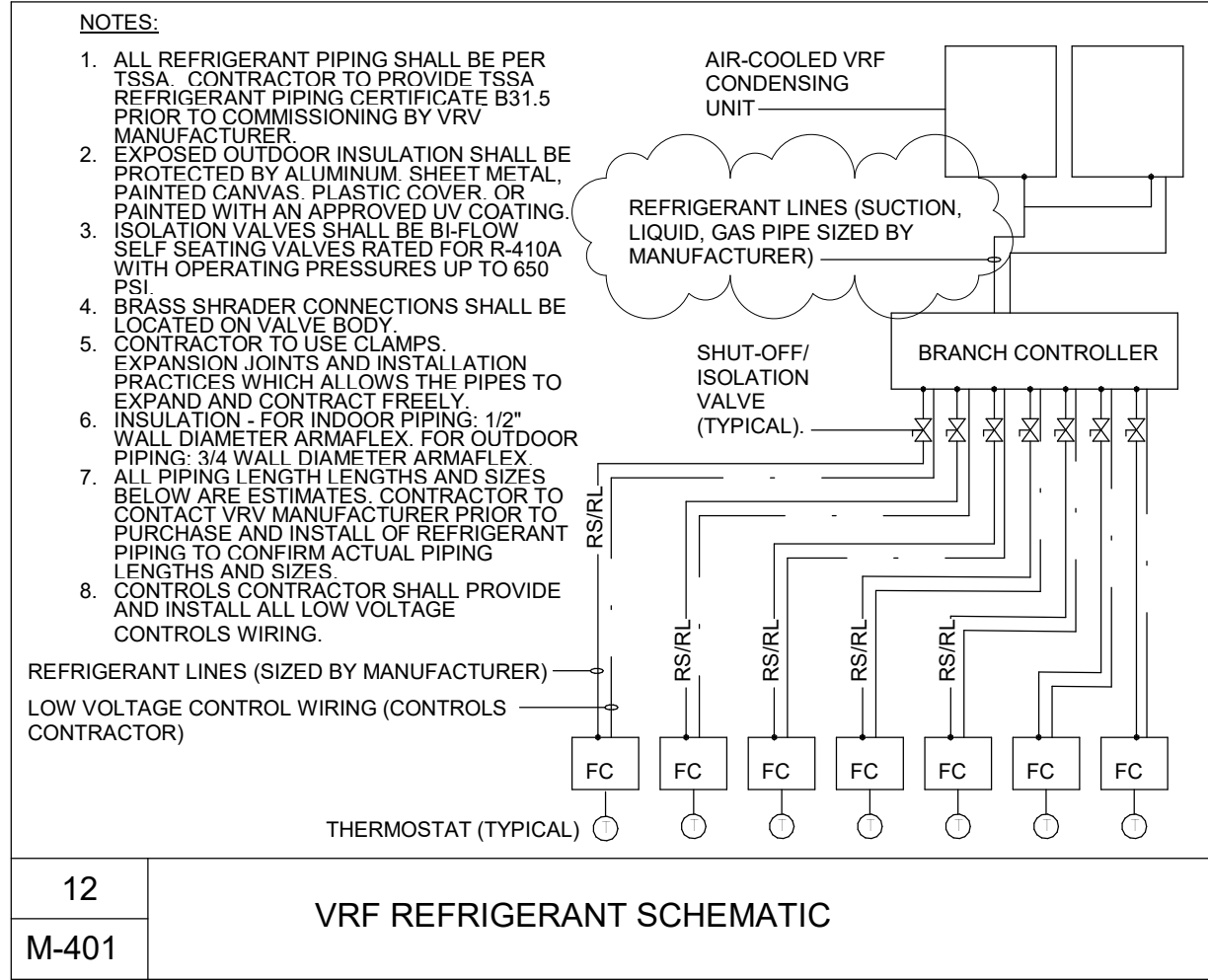
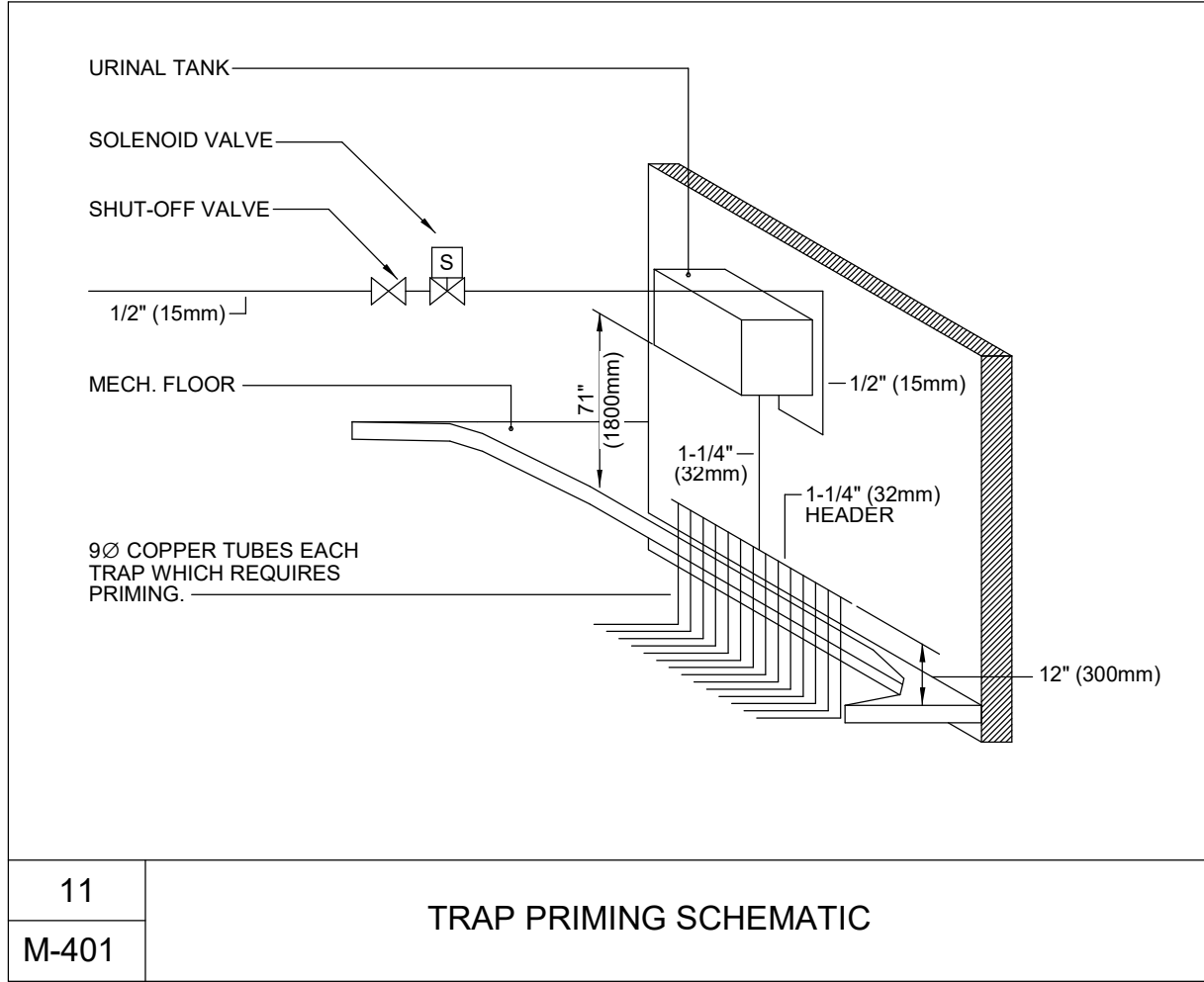
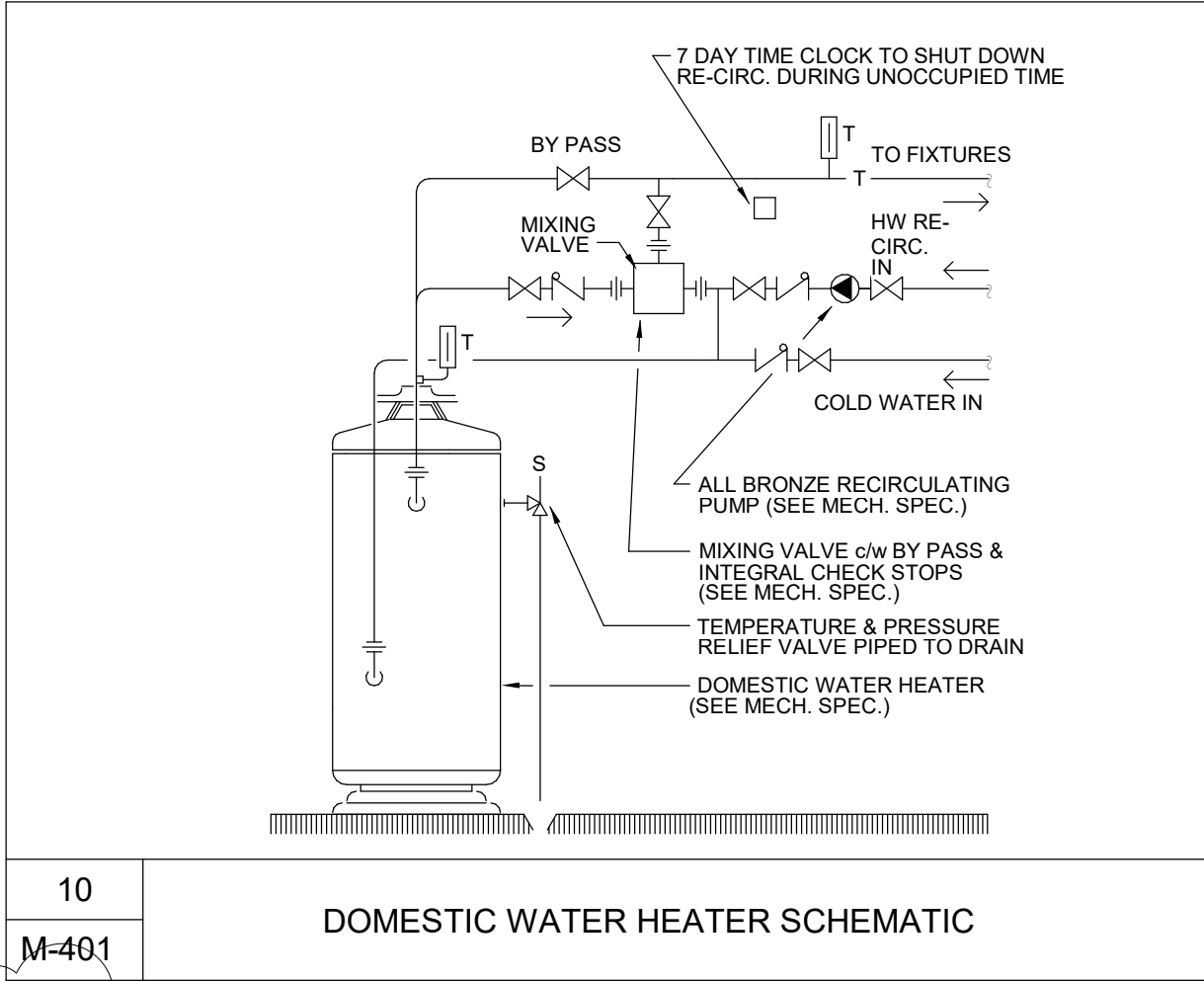
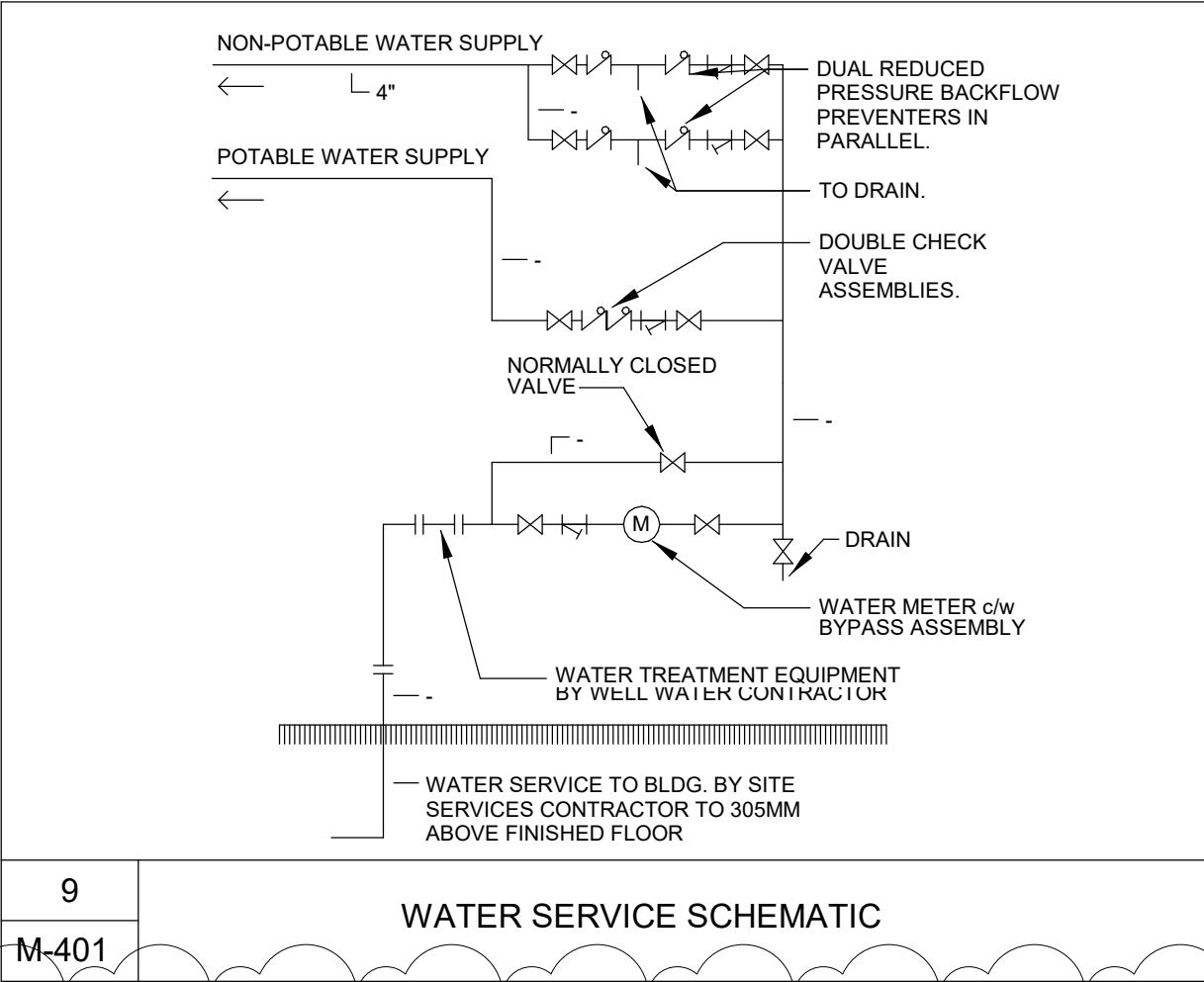
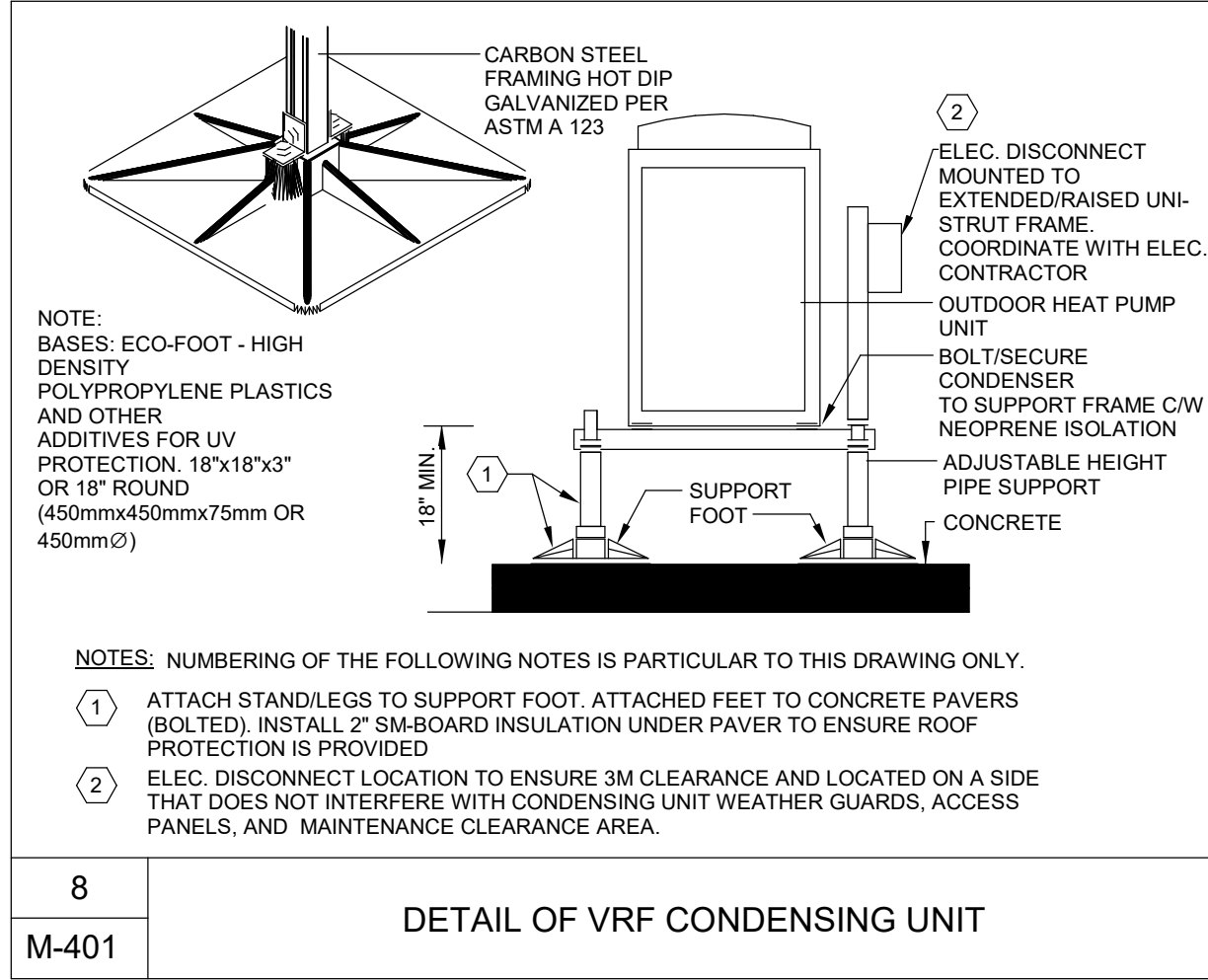
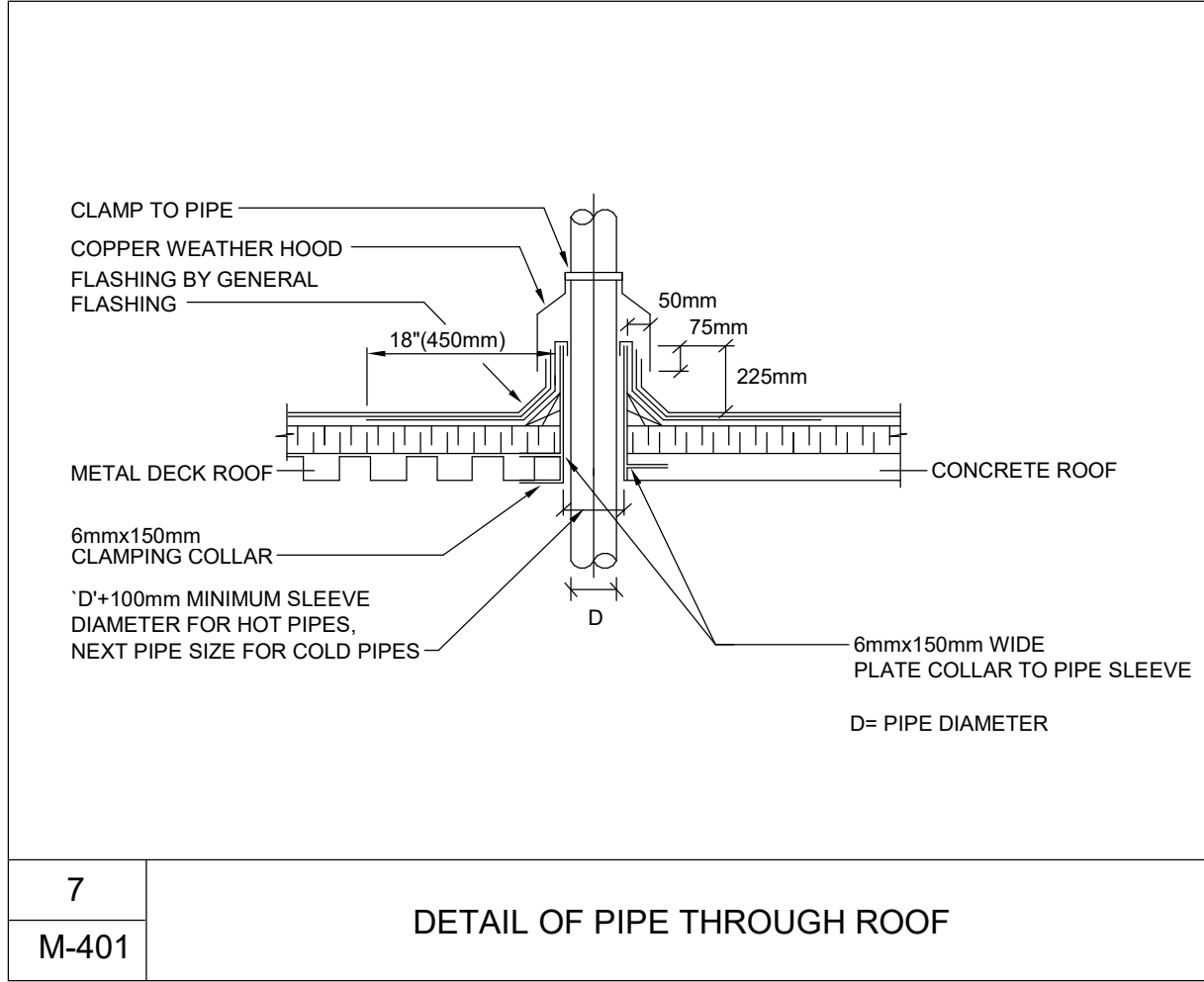
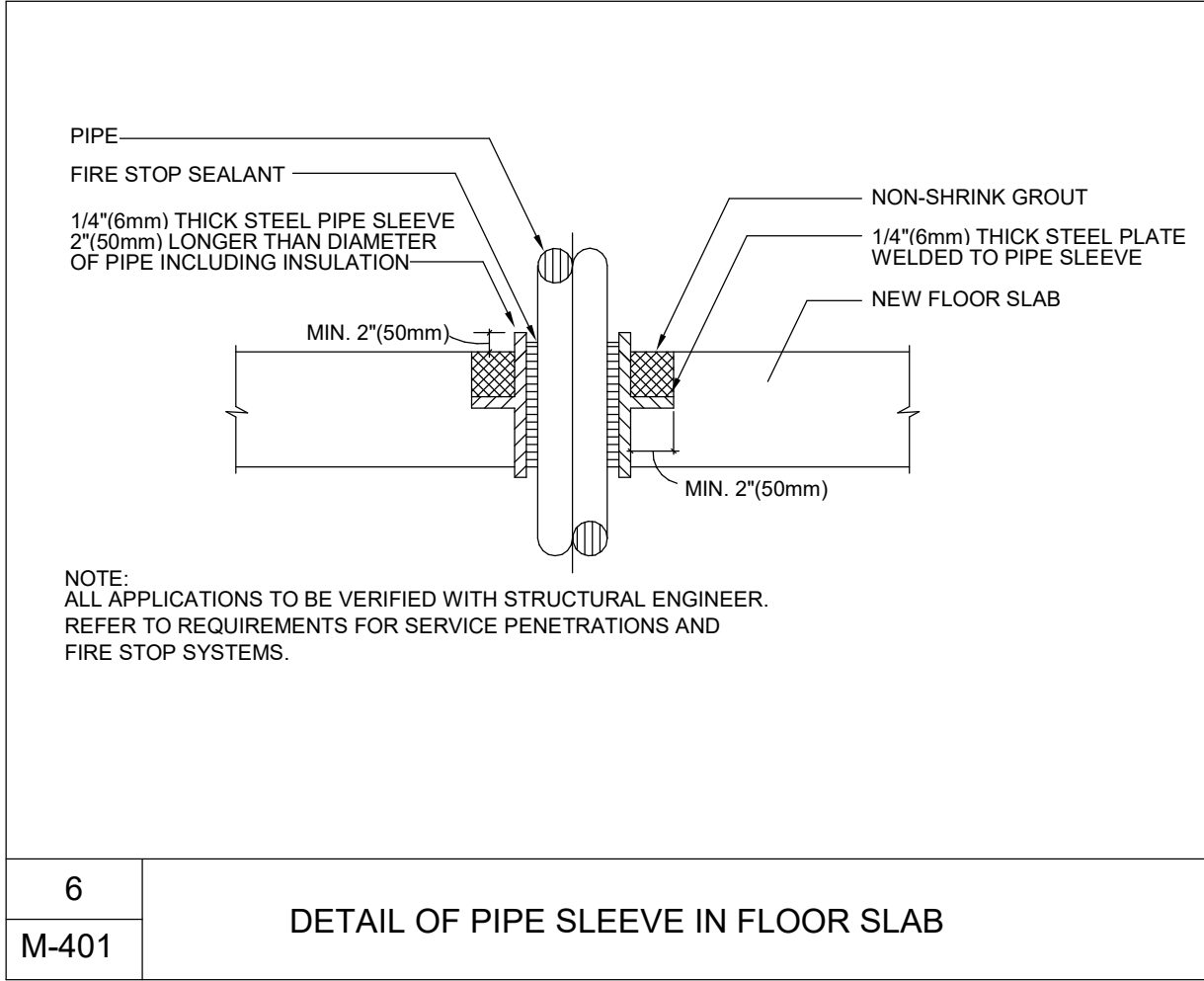
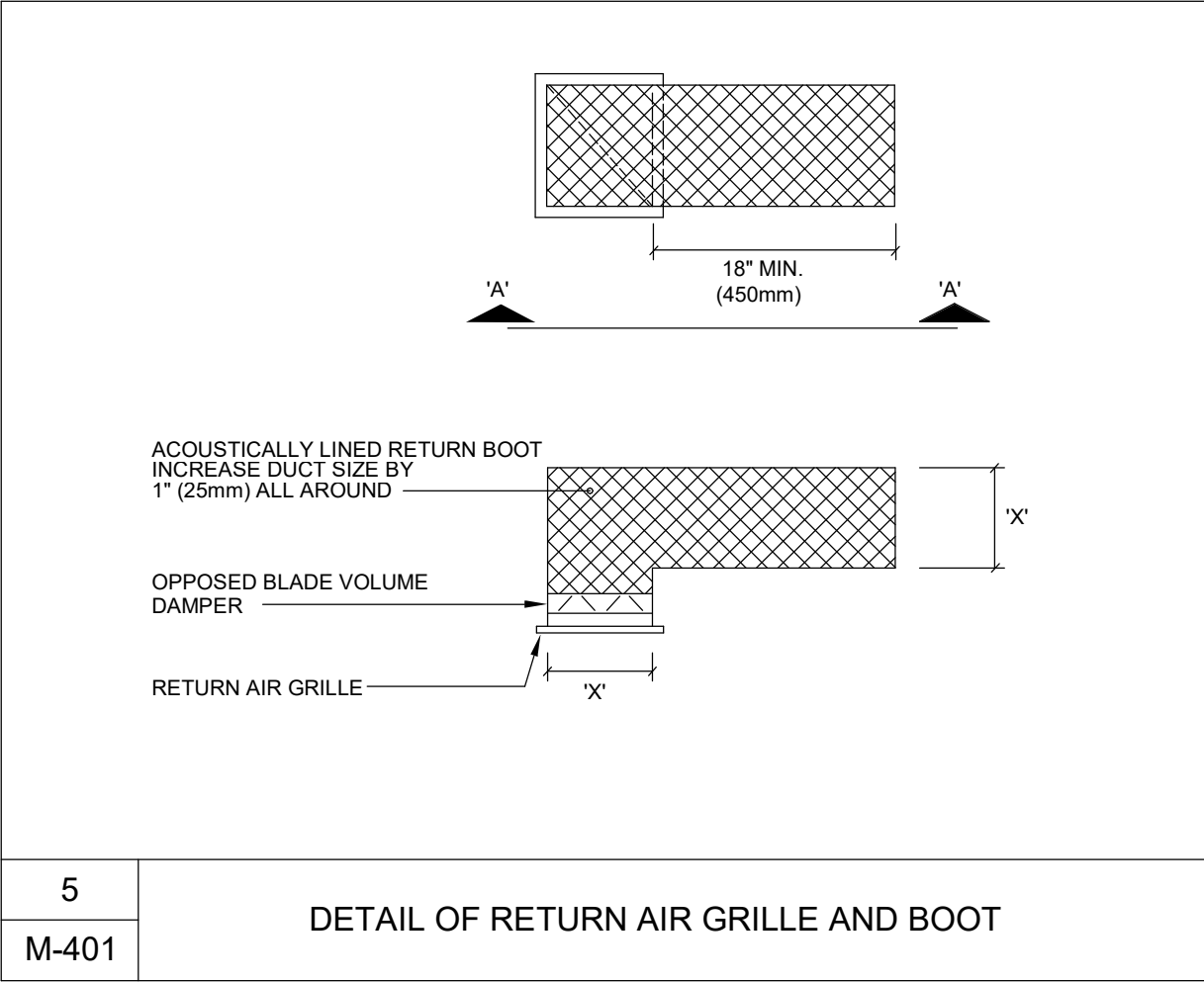
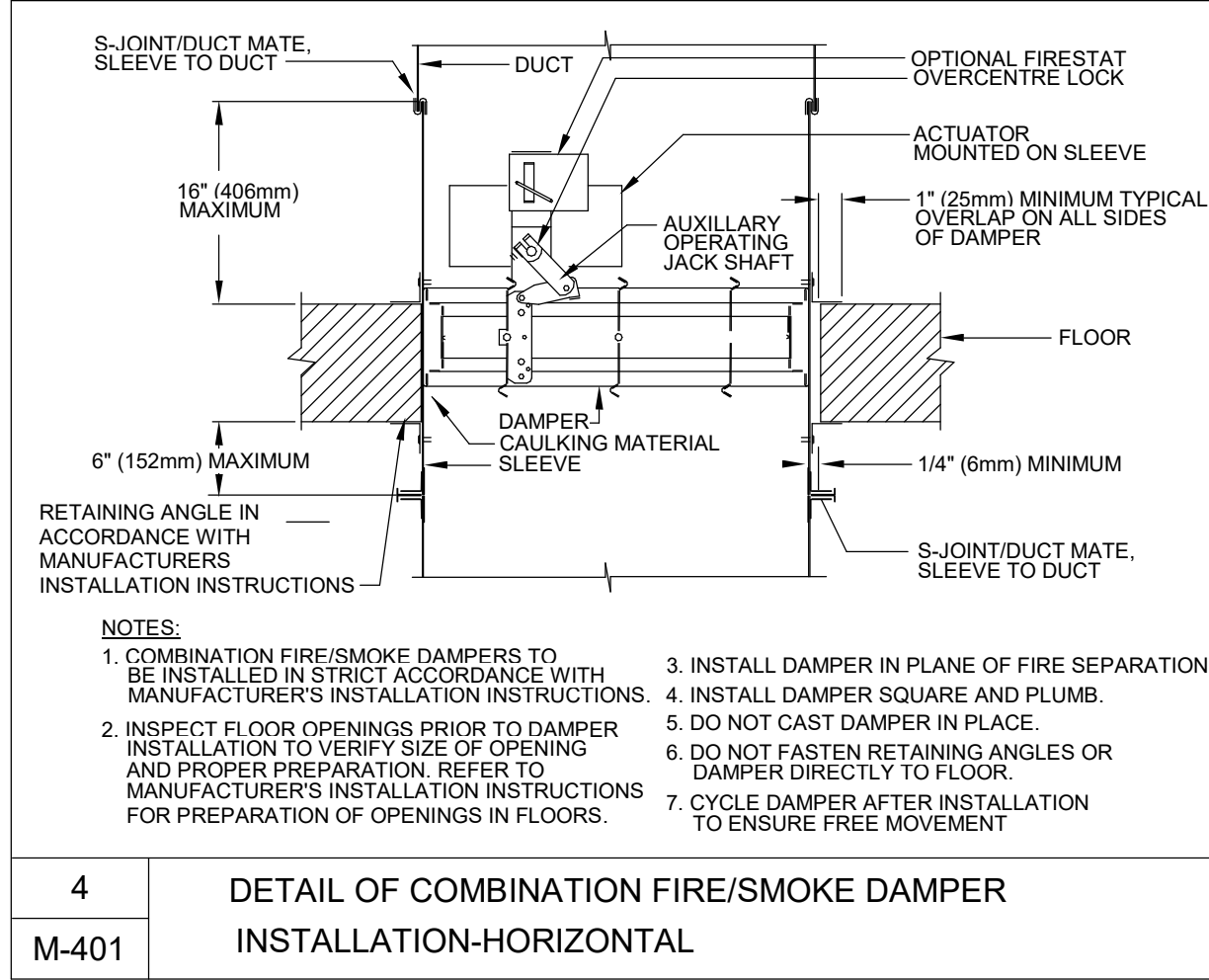
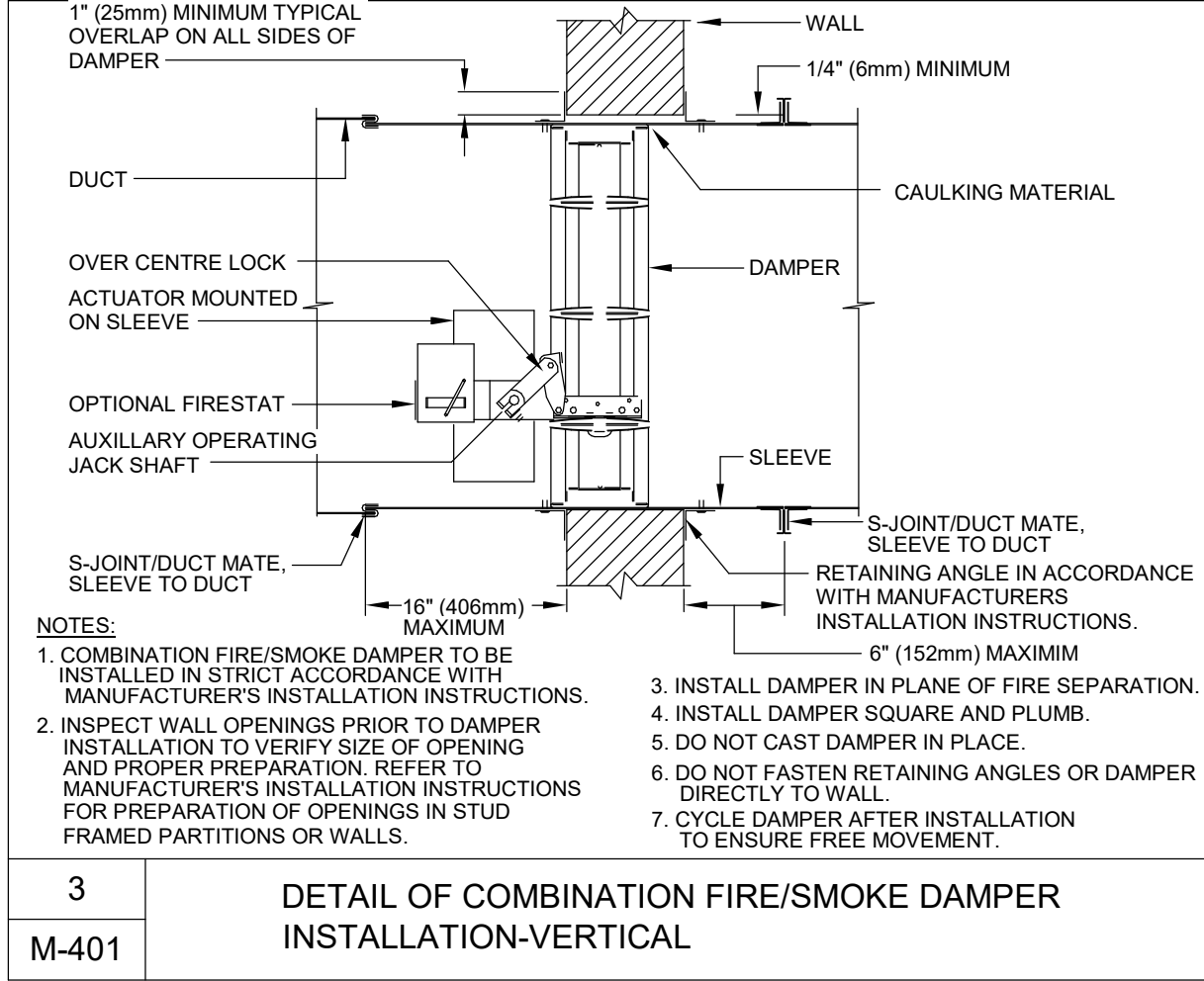
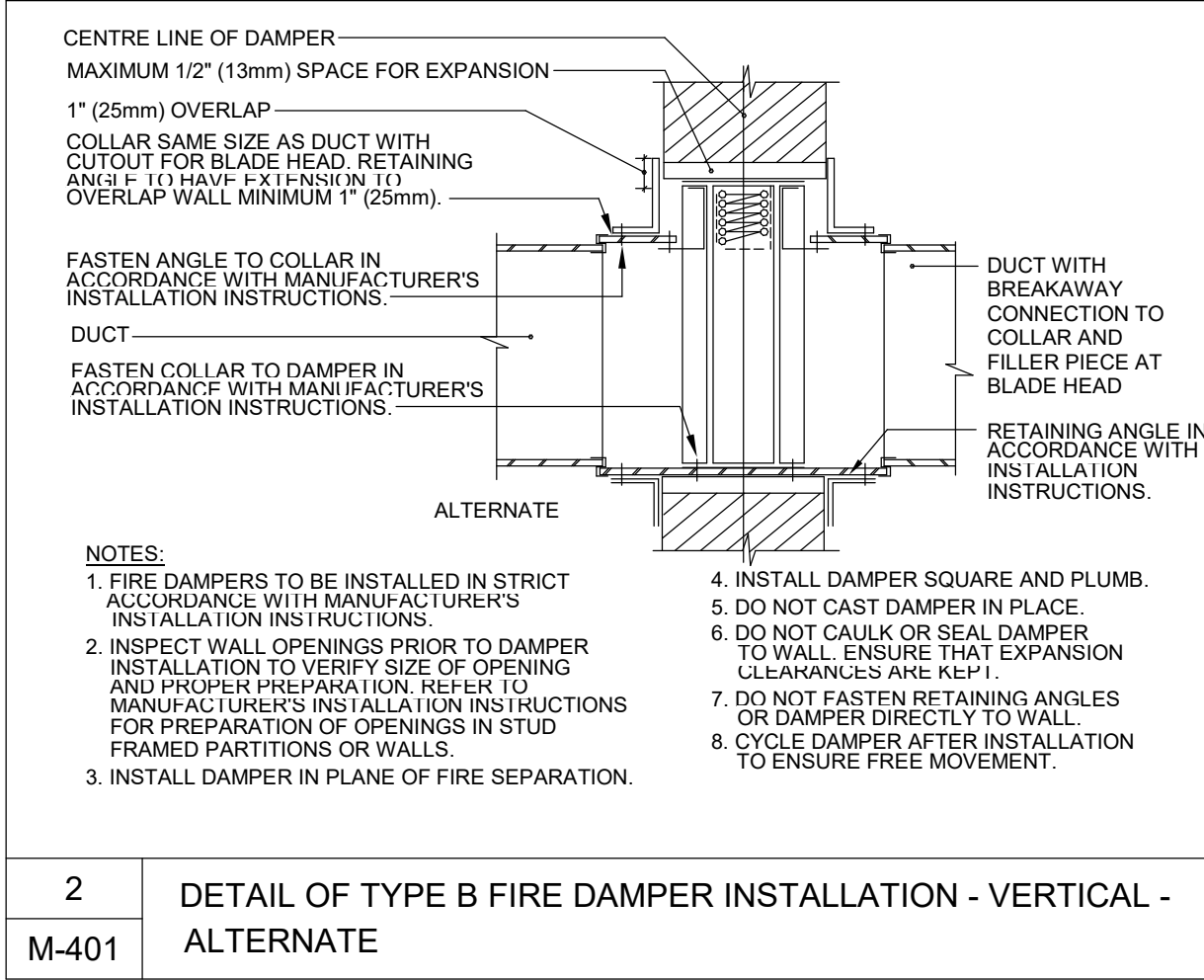
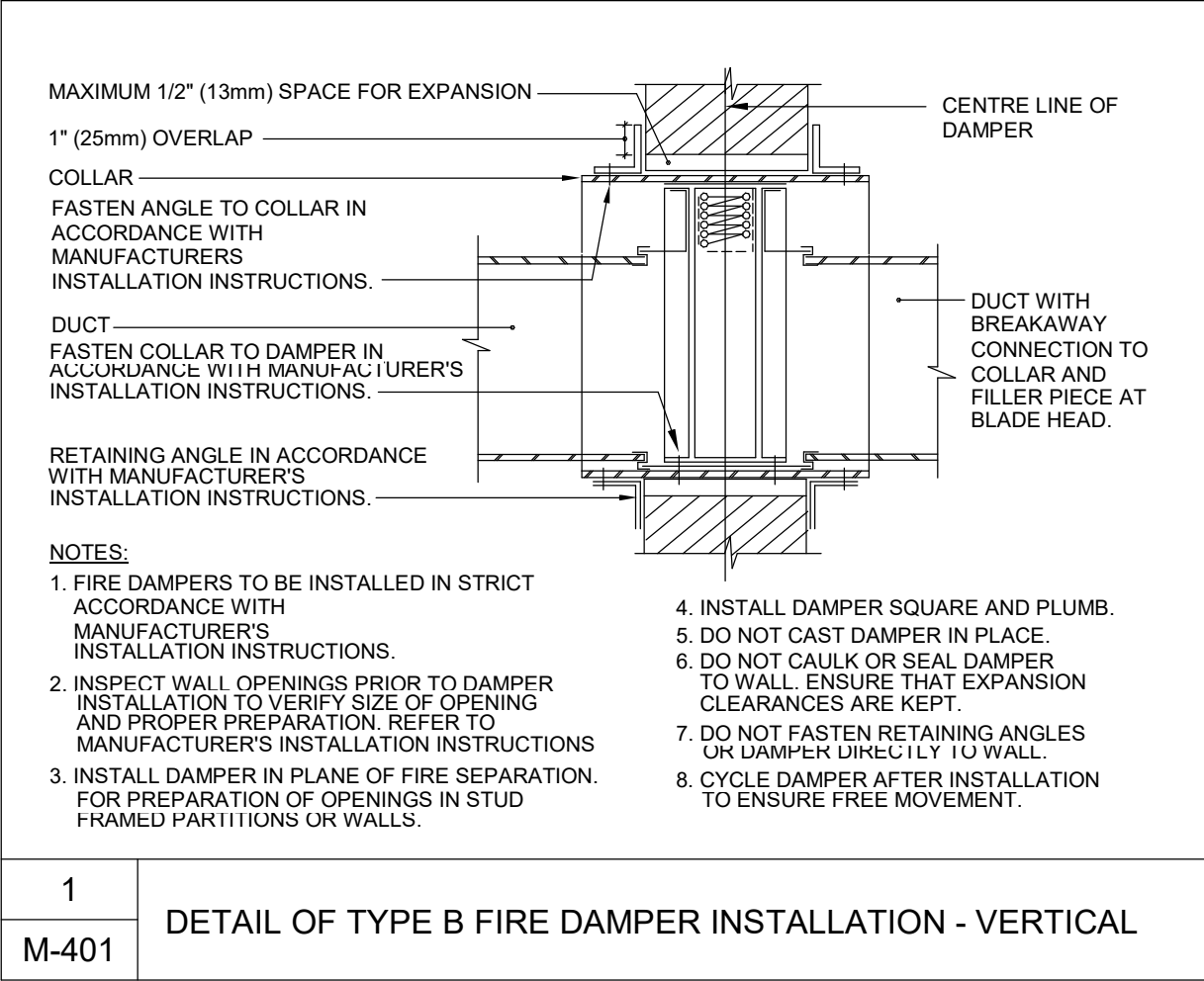


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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

MECHANICAL DETAILS

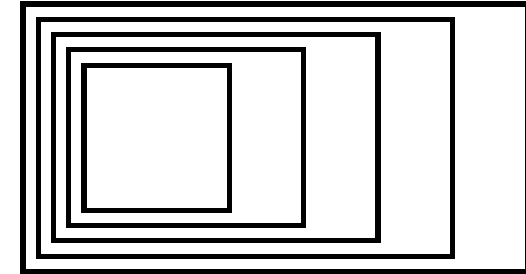
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Project Number:
23-088

Drawn By:
Author

Checked By:
Checker

M401.1



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6	ADDENDUM ME-02	2024-10-24
5	ADDENDUM ME-01	2024-10-10
4	ISSUED FOR TENDER	2024-09-24
3	ISSUED FOR 100%	2024-08-29
2	ISSUED FOR PERMIT	2024-08-16
1	ISSUED FOR 60% PROGRESS	2024-07-12

No.	ISSUED/REVISED	DATE
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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

LOWER LEVEL FLOOR PLAN - POWER & SYSTEMS

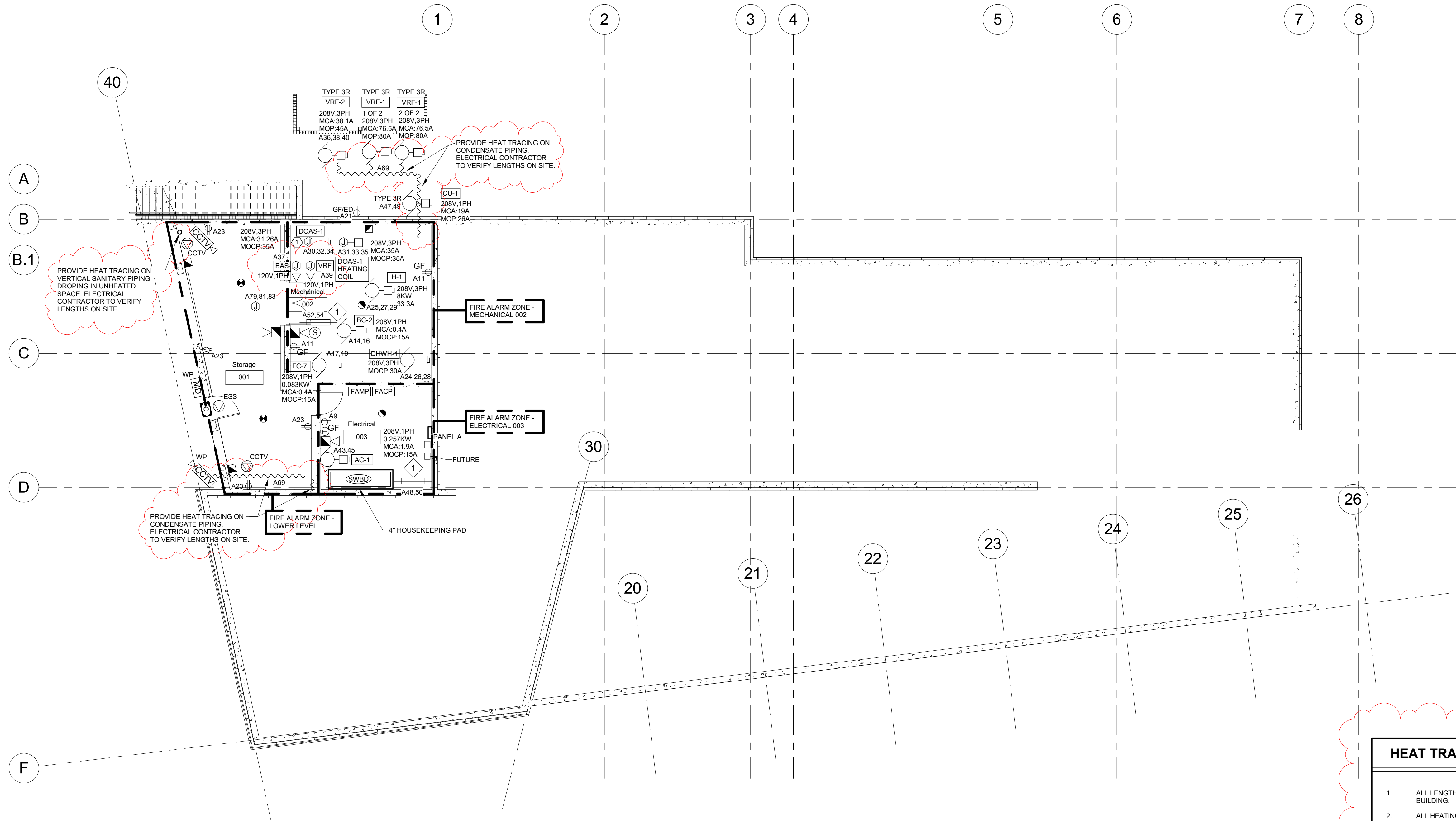
Scale: As indicated

Project Number:
23-088

Drawn By:
SD/YY

Checked By:
PR/ELC

E400.2



1 LOWER LEVEL - POWER & SYSTEMS

1 : 100

HEAT TRACING NOTES

- ALL LENGTHS OF CABLES TO BE FIELD MEASURED OR CONFIRMED PRIOR TO INSTALLATION. RUN CABLEING 36" (915mm) INTO BUILDING.
- ALL HEATING CABLE SUPPLIED AND INSTALLED BY ELECTRICAL CONTRACTOR. HEATING CABLE TO BE RATED AT 120 VOLT AND MINIMUM OF 4 WATTS PER LINEAR FOOT. CABLE TO EQUAL TO PYROTENAX OR RAYCHEM C/W AUTOMATIC MOISTURE/TEMPERATURE CONTROLLER, POWER CONNECTION KIT, SPLICE KIT, TEE KIT, ATTACHMENT KIT, AND SEAL KIT, ETC. TO MAKE A COMPLETE INSTALLATION AS PER MANUFACTURER'S RECOMMENDATIONS.
- ELECTRICAL CONTRACTOR TO CONFIRM PIPE CONSTRUCTION PRIOR TO INSTALLATION. PIPING TO BE INSULATED BY MECHANICAL TRADE AFTER TRACING HAS BEEN INSTALLED.
- PROVIDE GROUND FAULT BREAKER (30mA) ON TRACING CIRCUITS AS PER CODE AND MANUFACTURER'S RECOMMENDATIONS.

ELECTRIC HEAT SCHEDULE

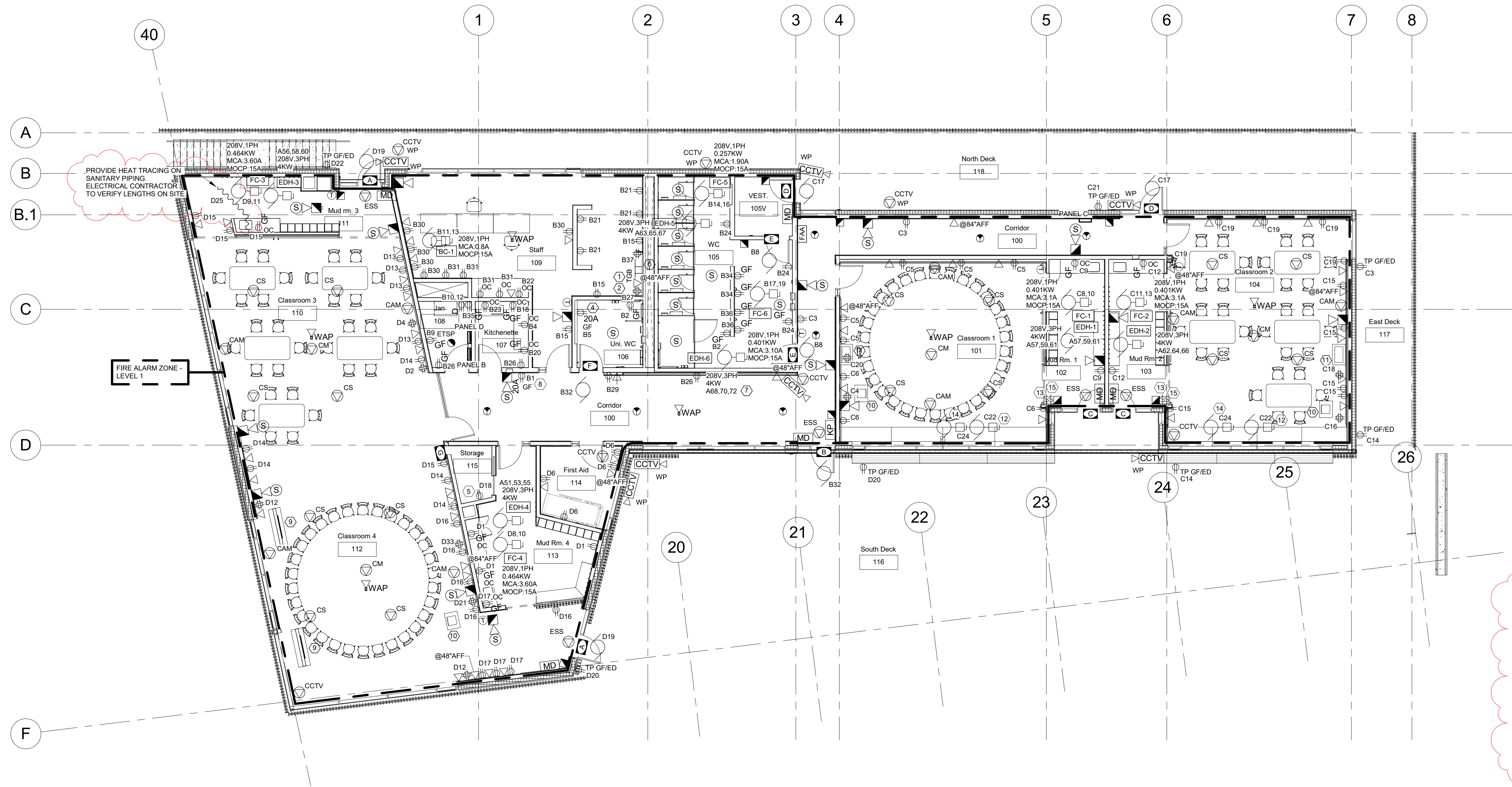
TAG	WATTS	VOLTS	TYPE	MOUNTING TYPE	DESCRIPTION	QUANTITY#
1	1500	208V. 1Ø	UNIT HEATER	CEILING MOUNTED	ALMOND EPOXY/POLYESTER POWDER PAINT C/W UNIT-MOUNTED DISCONNECT SWITCH AND THERMOSTAT.	OHV02000AM

POWER AND SYSTEMS GENERAL NOTES

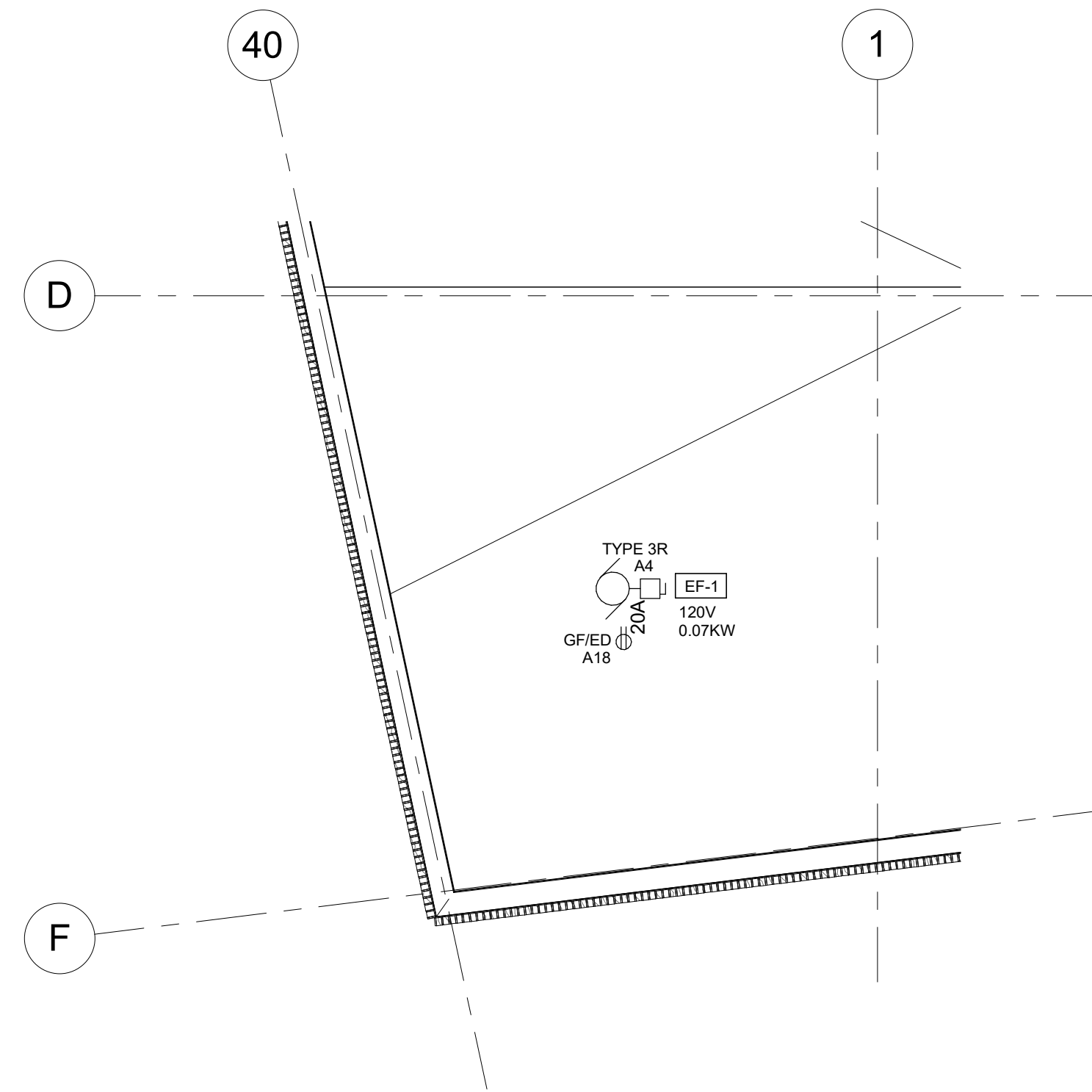
- DO NOT SCALE DRAWINGS FOR INSTALLATION PURPOSES. OBTAIN ALL DIMENSIONS FROM ARCHITECTURAL PLANS, MANUFACTURER'S SHOP DRAWINGS, AND ON SITE INSPECTIONS.
- PRIOR TO INSTALLATION OF BOXES IN WALLS, VERIFY THAT NO INTERFERENCES EXIST. CHECK ARCHITECTURAL PLANS AND ELEVATIONS.
- MECHANICAL AND ELECTRICAL TRADES SHALL WORK IN CONJUNCTION WITH ONE ANOTHER SO AS TO AVOID INTERFERENCES BETWEEN PIPING, DUCTWORK, CONDUIT, LIGHTING LUMINAIRES, ETC.
- REVIEW ARCHITECTURAL, MECHANICAL, AND STRUCTURAL, ELECTRONIC SAFETY AND SECURITY, AUDIOVISUAL, AND COMMUNICATIONS DRAWINGS AND PROVIDE ON SITE INSPECTIONS TO DETERMINE FULL EXTENT OF PROJECT PRIOR TO SUBMITTING BID.
- REFER TO DOOR DETAILS ON SHEET E700 FOR ADDITIONAL INFORMATION.
- EXCEPT FOR THE FOLLOWING AREAS, PROVIDE TAMPER-RESISTANT RECEPTACLES FOR ALL INDOOR AND EXTERIOR 15AMP AND 20AMP 120V RECEPTACLES (TYPES 5-15R AND 5-20R):
 - MECHANICAL 002
 - ELECTRICAL 003
 - JANITOR 108

POWER AND SYSTEMS KEY NOTES

- INSTALL 600V-208V 3 PHASE TRANSFORMER SUPPLIED BY MECHANICAL CONTRACTOR



1 LEVEL 1 - POWER & SYSTEMS
1 : 100



2 ROOF PLAN - POWER & SYSTEMS
1 : 100

HEAT TRACING NOTES

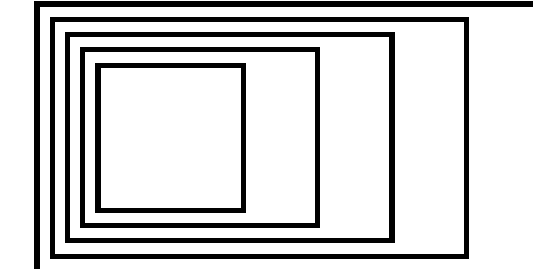
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- PROVIDE GROUND FAULT BREAKER (30mA) ON TRACING CIRCUITS AS PER CODE AND MANUFACTURER'S RECOMMENDATIONS.

POWER AND SYSTEMS GENERAL NOTES

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 - MECHANICAL 002
 - ELECTRICAL 003
 - JANITOR 108

POWER AND SYSTEMS KEY NOTES

- | | |
|----|---|
| 1 | PROVIDE #6 GROUNDING WIRE C/W 2 HOLE COMPRESSION LUGS. |
| 2 | #6 INSULATED STRANDED COPPER GROUND WIRE IN 27mm (1") CONDUIT TO MAIN GROUND BUS BAR IN MAIN ELECTRICAL ROOM 003 |
| 3 | COORDINATE RECEPTACLE INSTALLATION WITH MILLWORK CONTRACTOR PRIOR TO ROUGH-IN. |
| 4 | COORDINATE POWER REQUIREMENTS AND LOCATIONS WITH CHANGE TABLE SUPPLIER PRIOR TO ROUGH-IN. |
| 5 | PROVIDE POWER CONNECTION FOR OPERABLE PARTITION. REFER TO DETAIL G ON SHEET E700 FOR ADDITIONAL INFORMATION. |
| 6 | PROVIDE 72" X 96" X 3/4" COMMUNICATIONS AND SECURITY BACKBOARD C/W TWO DEDICATED RECEPTACLES. |
| 7 | PROVIDE 1/2" (12mm) CONDUIT TO AV RACK IN STAFF ROOM 109 |
| 8 | PROVIDE POWER CONNECTION FOR BOTTLE FILLER. COORDINATE POWER REQUIREMENTS WITH BOTTLE FILLER SUPPLIER PRIOR TO ROUGH-IN. |
| 9 | PROVIDE POWER AND DATA CONNECTION FOR SCREEN HIVE MEDIA SCREEN |
| 10 | PROVIDE POWER AND DATA CONNECTION FOR PORTABLE PODIUM |
| 11 | PROVIDE POWER AND DATA CONNECTION FOR PROJECTOR |
| 12 | PROVIDE POWER CONNECTION FOR MOTORIZED BLINDS. COORDINATE EXACT POWER REQUIREMENTS AND LOCATIONS WITH BLINDS SUPPLIER PRIOR TO ROUGH-IN. |
| 13 | CONNECT CONTROL SWITCH TO MOTORIZED BLINDS. COORDINATE EXACT REQUIREMENTS AND LOCATIONS WITH BLINDS SUPPLIER PRIOR TO ROUGH-IN. |
| 14 | PROVIDE POWER CONNECTION FOR MOTORIZED OPERABLE WINDOWS. COORDINATE EXACT POWER REQUIREMENTS AND LOCATIONS WITH WINDOWS SUPPLIER PRIOR TO ROUGH-IN. |
| 15 | CONNECT CONTROL SWITCH TO MOTORIZED OPERABLE WINDOWS. COORDINATE EXACT REQUIREMENTS AND LOCATIONS WITH WINDOWS SUPPLIER PRIOR TO ROUGH-IN. |



GOW HASTINGS ARCHITECTS

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6	ADDENDUM ME-02	2024-10-24
5	ADDENDUM ME-01	2024-10-10
4	ISSUED FOR TENDER	2024-09-24
3	ISSUED FOR 100%	2024-08-29
2	ISSUED FOR PERMIT	2024-08-16
1	ISSUED FOR 60% PROGRESS	2024-07-12

No.	ISSUED/REVISED	DATE
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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

LEVEL 1 FLOOR PLAN - POWER & SYSTEMS

Scale: As indicated

Project Number:

23-088















Drawn By:

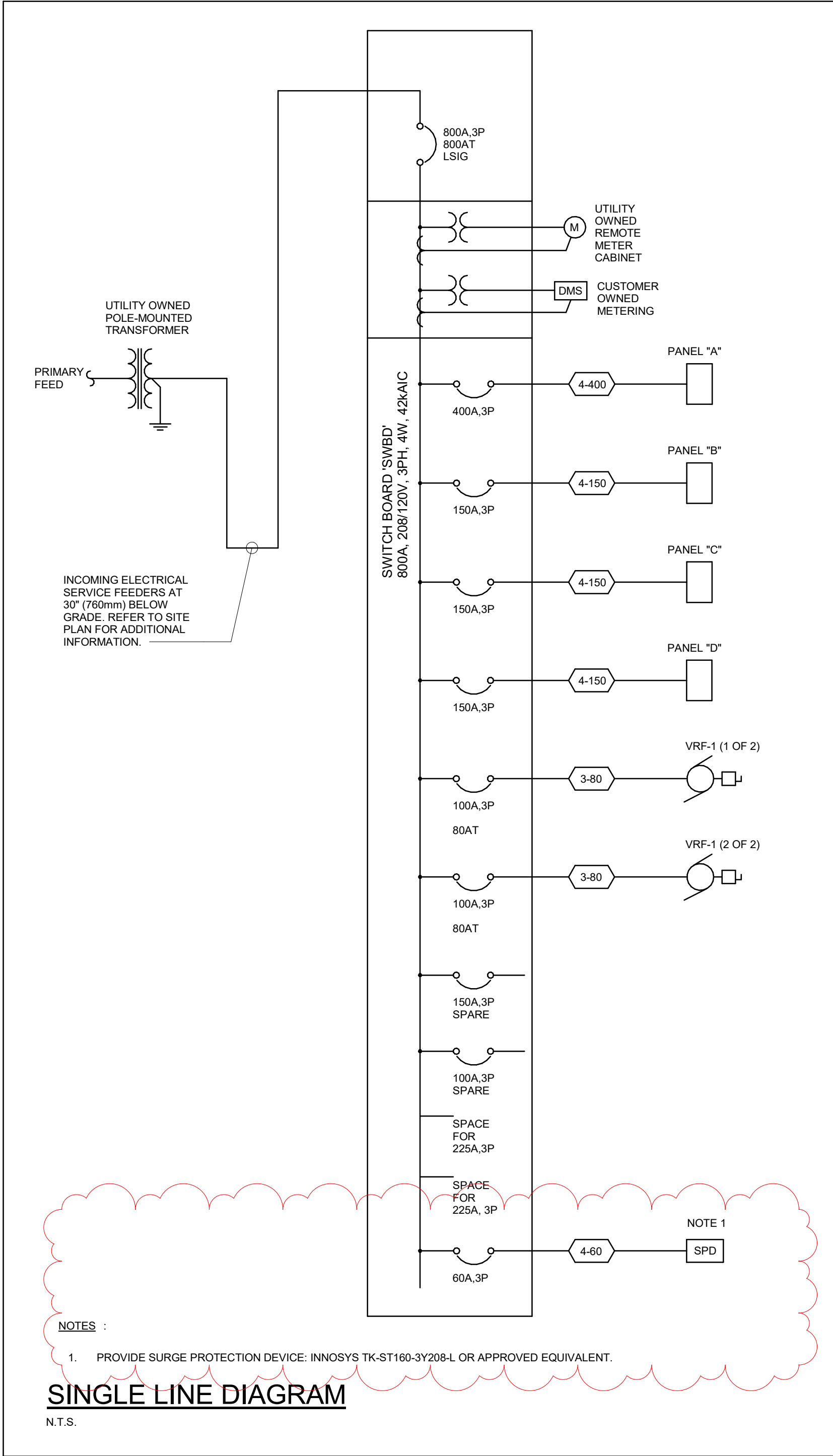
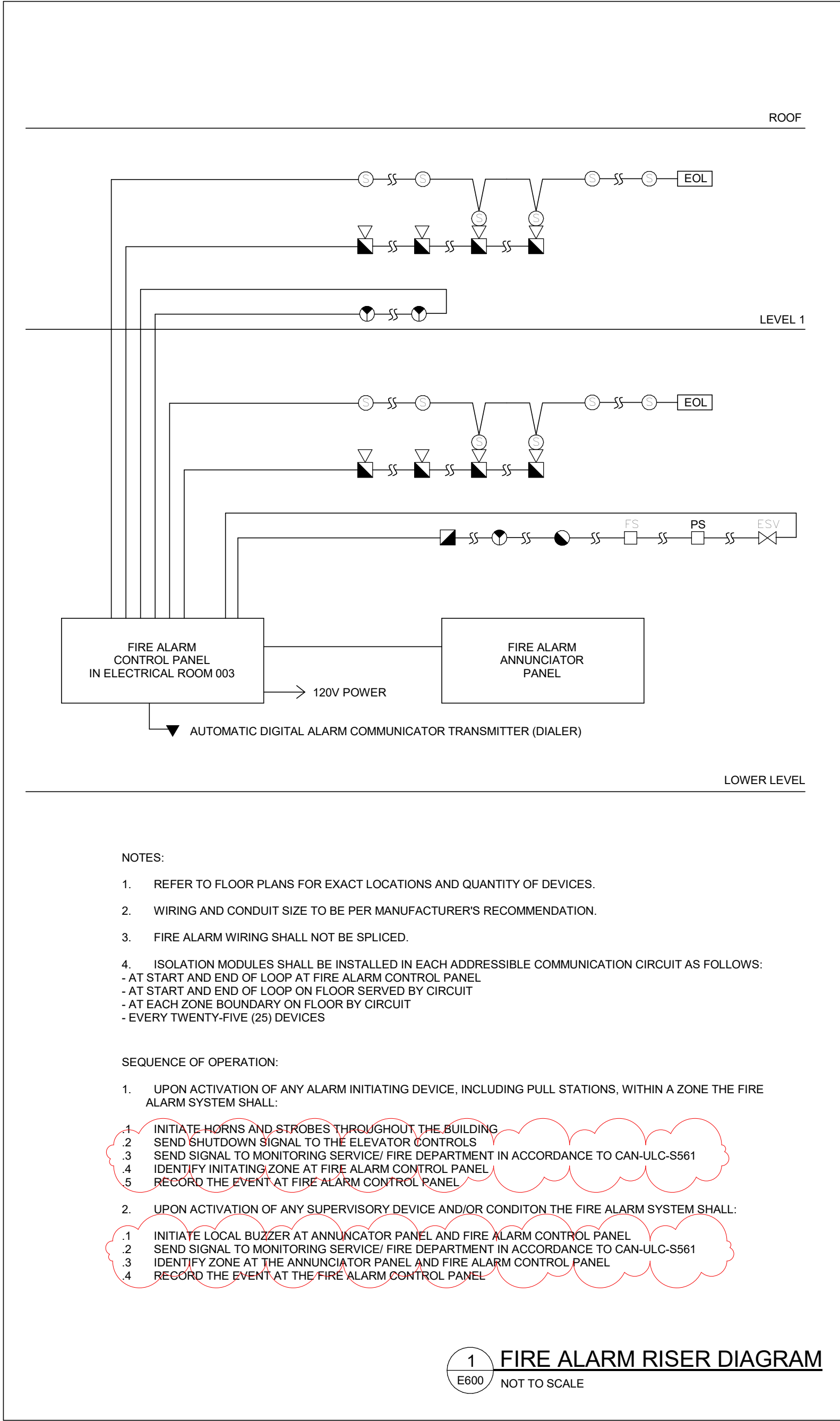
SD/YY

Checked By:

PR/ELC

E401.2

FIRE ALARM SCHEDULE						
IDENTIFICATION	DEVICE	FUNCTION				DESCRIPTION
		AL	SUPV	CONT	ANNUN	
LOWER LEVEL	 LOWER LEVEL	x				LOWER LEVEL FIRE ALARM
	 LOWER LEVEL	x				
	 LOWER LEVEL	x				
MECHANICAL 002	 LOWER LEVEL	x				MECHANICAL ROOM HEAT DETECTOR
	 LOWER LEVEL	x				MECHANICAL ROOM FIRE ALARM HORN AND STROBE LIGHT
ELECTRICAL 003	 LOWER LEVEL	x				ELECTRICAL ROOM HEAT DETECTOR
	 LOWER LEVEL	x				ELECTRICAL ROOM FIRE ALARM HORN
LEVEL 1	 LEVEL 1	x				LEVEL 1 FIRE ALARM
	 LEVEL 1	x				
	 LEVEL 1	x				
	 LEVEL 1	x				
	 LEVEL 1	x				
	 LEVEL 1	x				
	 LEVEL 1	x				
NOTES:						
1. CONFIRM F.A. ZONE IDENTITY WITH CONSULTANT/OWNER PRIOR TO PROGRAMMING.						

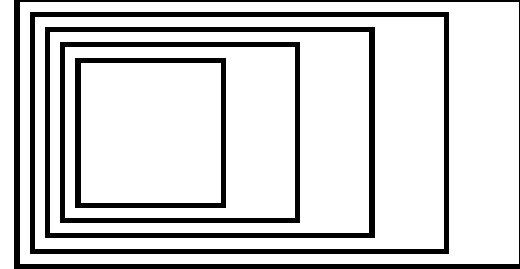


FEEDER SCHEDULE

TAG	QUANTITY & SIZE OF CONDUCTORS AND CONDUITS	FEEDER AMPACITY
4-400	2 (4 #3/0 + #6 GROUND IN 2-1/2" (63mm) CONDUIT)	400
4-150	4 #1/0 + #6 GROUND IN 2" (53mm) CONDUIT	150
3-80	3 #4 + #8 GROUND IN 1-1/4" (35mm) CONDUIT	80
4-60	4 #6 + #10 GROUND IN 1-1/4" (35mm) CONDUIT	60

NOTES:

- ALL CONDUCTORS ARE TO BE RW90 COPPER UNLESS OTHERWISE NOTED. CONDUCTORS SHALL BE RWU90 COPPER WHERE CONDUCTORS RUN BELOW GRADE AND/OR ON THE EXTERIOR OF THE BUILDING.
- CONDUIT AND WIRE SIZES ARE MINIMUM SIZES. THEY SHALL BE INCREASED AS REQUIRED TO SUIT LENGTH OF RUN AND VOLTAGE DROP REQUIREMENTS.
- SCHEDULED CONDUIT SIZES ARE BASED ON ELECTRICAL METALLIC TUBING WITH RW90 CONDUCTORS UNLESS OTHERWISE INDICATED. THE ELECTRICAL CONTRACTOR SHALL ADJUST CONDUIT SIZES INDICATED IN ACCORDANCE WITH OESC WHEN USING ALTERNATE CONDUIT/TUBING TYPES AND CONDUCTOR TYPES TO MEET THE CONTRACT DOCUMENT REQUIREMENTS AND THEIR INSTALLATION REQUIREMENTS ON SITE.
- THE ELECTRICAL CONTRACTOR IS TO COORDINATE EQUIPMENT CABLE LUGS WITH THEIR EQUIPMENT MANUFACTURER PRIOR TO SHOP DRAWING SUBMITTAL TO SUIT FEEDERS SCHEDULED AND THE ELECTRICAL CONTRACTOR'S ON SITE INSTALLATION REQUIREMENTS.
- WHERE NEW FEEDERS ARE SCHEDULED TO BE CONNECTED TO EXISTING EQUIPMENT, THE ELECTRICAL CONTRACTOR SHALL COORDINATE THE SCHEDULE FEEDER WITH THE EXISTING EQUIPMENT LUGS ON SITE AND REVISE THE SCHEDULED FEEDER TO SUIT THEIR ON SITE INSTALLATION REQUIREMENTS.



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SCANLON CREEK NATURE CENTER

2450 LINE 9, BRADFORD, ON

SINGLE LINE DIAGRAM AND FIRE ALARM RISER DIAGRAM AND FIRE ALARM SCHEDULE

Scale: 1 : 1

Project Number:
23-088

Drawn By:
SD/YY

Checked By:
PR/ELC

E600.2