

March 26, 2025

Client: Barry Bryan Associates
201-250 Water Street
Whitby, ON L1N 0G5

RE: Mill Courtland Community Centre
Addition & Renovation
Kitchener, ON

Job #: 24030

Attn: Lorraine Okungbowa, March., BArch Sci., Intern Architect/
Cassandra Cautius, OAA, Director of Architecture

ADDENDUM 01

MECHANICAL

Item 1

- 1.0 Reference Attached Specification Section 25 40 11 'Building Automation System'
 - .1 Revise Item 1.6.7 to remove the requirement for Niagara Framework.
 - .2 Revise sequence of operations Sections 2.17 and 2.18.
 - .3 Refer to added Sections 2.19 and 2.20.

Item 2

- 2.0 Reference Attached Reissued Drawings M102 and M103
 - .1 Revise VVT control damper schedule as shown on attached reissued drawing M102.
 - .2 Provide detail for the extension of the existing 25 mm water service at existing shed, as shown on attached reissued drawing M103.

Item 3

- 3.0 Reference Attached Reissued Drawing M302
 - .1 Remove fire smoke damper in Office 128 and provide new fire smoke dampers, as shown on attached reissued drawings M302.

ELECTRICAL

Item 1

- 1.0 Reference Attached Reissued Drawing E103
 - .1 On site plan, provide five (5) electrical vehicle charger rough-ins as indicated.

Item 2

- 2.0 Reference Attached Reissued Drawing E105
 - .1 Update electrical symbol legend as indicated.

Item 3

- 3.0 Reference Attached Reissued Drawing E107
 - .1 Drawing E107 included in the drawing set.
 - .2 Provide details A, B, and C as indicated.



Item 4

4.0 Reference Attached Reissued Drawing E201

- .1 In Mech Room 130, delete one (1) heat detector as indicated.
- .2 In Outside Storage 128, delete one (1) heat detector as indicated.

Item 5

5.0 Reference Attached Reissued Drawing E302

- .1 In Activity/Banquet Room 123, provide two (2) alarm strobes complete with wire guards. Revise locations of two (2) combination horn/strobes.
- .2 On building exterior, adjacent Multi-purpose Program Room 131, provide stainless steel lockbox complete with four (4) 120V-20A ground fault style receptacles and circuit as indicated.
- .3 In Corridor 112, provide power and fire alarm connections to one (1) 120V fire smoke damper. Circuit as indicated. Revise location of one (1) fire smoke damper from Office 128 to Corridor 112.

Item 6

6.0 Reference Attached Reissued Drawing E401

- .1 On distribution riser, delete one (1) electrical vehicle charger, fed from Panel 'F', as indicated.

Item 7

7.0 Reference Attached Reissued Drawing E602

- .1 Revise Panel 'F' to 84-circuit, double-tub style panelboard. Update panel schedule as indicated.



Michael Pace, P.Eng.

Consulting Engineer, Partner

24030 Addendum 01 (M&E-BAS Revisions, VVT, FSD)(various reissued dwgs) Mar 26 25.docx
hb/mpd/dve/smb



Part 1 General

1.1 RELATED SECTIONS

- .1 Conform to the General Mechanical requirements.
- .2 Conform to the General Electrical requirements.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- .1
- .2 Ductwork Accessories:
 - .1 Airflow Stations
 - .2 Terminal Unit Controls.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- .1 Rooftop Air-Handling Equipment:
 - .1 Thermostats

1.4 PRODUCTS NOT FURNISHED OR INSTALLED BUT INTEGRATED WITH THE WORK OF THIS SECTION

- .1 Rooftop Air-Handling Equipment:
 - .1 Discharge Air Temperature Control
 - .2 Economizer Control
 - .3 Volume Control
- .2 VAV Terminal Units:
 - .1 Cross-Flow Velocity Sensor
- .3 Variable Frequency Drives.

1.5 DESCRIPTION

- .1 General: The control system shall be as shown and consist of a high-speed, peer-to-peer network of DDC controllers and remote access thru the internet using a PC. Thru the WEB, a PC shall allow a user to interface with the network via dynamic color graphics. Each mechanical system, building floor plan, and control device will be depicted by point-and-click graphics. A WEB access will be provided for remote access to the network and for paging the operators when an alarm occurs.
- .2 The system will directly control
 - .1 Each existing and new air-handling unit by maintaining discharge air temperature, duct and building static pressure, and outside air economizer control.
 - .2 The existing hot water boiler plant and pumping system will operate to reset the hot water supply temperature based upon outside air temperature and pump lead-lag control.

- .3 Each terminal variable air volume (VAV) and fan-powered VAV unit will be controlled by individual DDC zone controllers networked with the primary DDC panels.
- .4 Each zone controller will provide for occupied/unoccupied mode of operation by individual zone.
- .5 For energy conservation, the system will be programmed for optimal Start/Stop, night setback, and night purge control.
- .6 Lighting control.
- .7 Fire alarm monitoring.
- .8 Security system arm/disarm, monitoring of exterior lights.
- .9 Terminal heating devices (force flow, perimeter radiation, unit heaters, etc.).
- .10 Domestic hot water recirc pump.
- .11 All existing exhaust fans.
- .3 The system will provide for future expansion.
- .4 Phase 2 of this project will include a renovation of the Warehouse Area (TDC) and a truck storage facility. This proposed Building Automation System shall be capable of accommodating the future developments.

1.6 EXISTING BUILDING

- .1 The existing building currently has a controls system by automated logic.
- .2 This renovation shall be an expansion of the existing automated logic control system.
- .3 The successful contractor shall locate the communication line and identify its entire length with yellow caution tape. The successful contractor shall maintain it during construction and verify proper operation after construction. Educate other trades and repair all damages that may have occurred.
- .4 Relocate controls and wiring to accommodate new services being installed i.e. ductwork, piping, etc.
- .5 Non compatible manufacturers shall provide their own communication loop in the building for their new services. Wherever possible both communication loops shall be beside each other.
- .6 Non compatible manufacturers (i.e. Siemens and Tour Anderson) shall be in addition to providing graphics. Provide for a monolithic programming so the operator does not have to alter between software programs. All systems shall be graphically shown on the same floor plan of the building.
- .7 The new building automation system (BAS) shall be open protocol using BACnet communication. Only systems that built on the Niagara 4 Frameworks shall satisfy the requirements of this project. AD01

1.7 APPROVED CONTROL SYSTEM CONTRACTORS AND MANUFACTURERS

- .1 The following are the approved Control System Contractors and manufacturers: automated logic, no alternates.

Notes:

- .1 The above list of Contractors is printed in random order and does not display a preference.

- .2 The Contractor shall use only products from the corresponding manufacturer and product line listed.
- .3 The above list of manufacturers applies to controller software, the custom application programming language, Building Controllers, Custom Application Controllers, and Application Specific Controllers.
- .4 All other products specified herein (e.g. sensors, valves, dampers, and actuators) need not be manufactured by the above manufacturers.

1.8 QUALITY ASSURANCE

- .1 Contractor/Manufacturer Qualifications
 - .1 The Installer shall have an established working relationship with the Control System Manufacturer of not less than three years.
 - .2 The Installer shall have successfully completed Control System Manufacturer's classes on the control system. The Installer shall present for review the certification of completed training, including the hours of instruction and course outlines upon request.

1.9 CODES AND STANDARDS

- .1 All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids of the following codes:
 - .1 National Electric Code (NEC)
 - .2 Uniform Building Code (UBC)
 - .1 Section 608, Shutoff for Smoke Control
 - .2 Section 403.3, Smoke Detection Group B Office Buildings and Group R, Division 1 Occupancies
 - .3 Section 710.5, Wiring in Plenums
 - .4 Section 713.10, Smoke Dampers
 - .5 Section 1106 Refrigeration Machinery Rooms
 - .6 Section 1107, Refrigeration Machinery Room Ventilation
 - .7 Section 1108, Refrigeration Machinery Room Equipment and Controls
 - .8 Section 1120, Detection and Alarm Systems
 - .3 Uniform Mechanical Code (UMC).
 - .4 The Ontario Building Code (OBC).

1.10 SYSTEM PERFORMANCE

- .1 Performance Standards. The system shall conform to the following:
 - .1 Performance: Programmable controllers shall be able to execute DDC PID control loops at a selectable frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
 - .2 Multiple Alarm Annunciation: All workstations on the network must receive alarms within 5 seconds of each other.

- .3 Reporting Accuracy: The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.
- .4 Stability of Control. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.

1.11 SUBMITTALS

- .1 Product Data and Shop Drawings: Meet requirements of Section 15001 on Shop Drawings, Product Data, and Samples. In addition, Contractor shall provide shop drawings or other submittals on all hardware, and installation to be provided. No work may begin on any segment of this project until submittals have been successfully reviewed for conformity with the design intent.
- .2 Submittals shall be provided within 2 weeks of contract award. Submittals shall include:
 - .1 Direct Digital Control System Hardware:
 - .1 A complete bill of materials of equipment to be used indicating quantity, manufacturer, model number, and other relevant technical data.
 - .2 Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:
 - .1 Direct Digital Controller (controller panels)
 - .2 Transducers/Transmitters
 - .3 Sensors (including accuracy data)
 - .4 Actuators
 - .5 Valves
 - .6 Relays/Switches
 - .7 Control Panels
 - .8 Power Supply
 - .9 Batteries
 - .10 Operator Interface Equipment
 - .11 Wiring
 - .3 Wiring diagrams and layouts for each control panel. Show all termination numbers.
 - .4 Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware.
 - .2 Central System Hardware and Software:
 - .1 A complete bill of material of equipment used, indicating quantity, manufacturer, model number, and other relevant technical data.
 - .2 Manufacturer's description and technical data, such as product specification sheets and installation/maintenance instructions for the items listed below and other relevant items not listed below:
 - .1 Interface Equipment Between WEB portal and Control Panels
 - .2 Operating System Software
 - .3 Operator Interface Software

- .4 Color Graphic Software
 - .5 Third-Party Software
 - .3 Schematic diagrams for all control, communication, and power wiring.
 - .4 Riser diagrams of wiring between central control unit and all control panels.
 - .5 A list of the color graphic screens to be provided. For each screen, provide a conceptual layout of pictures and data and show or explain which other screens can be directly accessed.
- .3 Controlled Systems:
 - .1 A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
 - .2 A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name. All terminals shall be labeled.
 - .3 An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
 - .4 A mounting, wiring, and routing plan-view drawing. The drawing shall be done in ¼ in. scale. The design shall take into account HVAC, electrical, and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work.
 - .5 A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
 - .6 A point list for each system controller including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device. Software flag points, alarm points, etc.
- .3 Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and shall include:
 - .1 Project Record Drawings. These shall be as-built versions of the submittal shop drawings.

1.12 TESTING AND COMMISSIONING

- .1 Testing and Commissioning Reports and Checklists. Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3: "Control System Demonstration and Acceptance."

1.13 OPERATION AND MAINTENANCE MANUAL

- .1 Operation and Maintenance (O & M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O & M manual shall include:
 - .1 Names, addresses, and 24-hour telephone numbers of contractors installing equipment and the control systems and service representatives of each.
 - .2 Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point reports, trending data, overriding computer control, and changing set points and other variables.
 - .3 One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation.
 - .4 Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware.
 - .5 A listing and documentation of all custom software created using the programming language, including the set points, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided.
 - .6 One set of magnetic/optical media containing files of all color graphic screens created for the project.
 - .7 A list of recommended spare parts with part numbers and suppliers.
 - .8 Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors.
 - .9 Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
 - .10 Licenses, guarantees, and warranty documents for all equipment and systems.
 - .11 Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions.

1.14 TRAINING MANUAL

- .1 The contractor shall provide a course outline and training manuals for all training classes at least six weeks prior to the first class. The consultant may modify any or all of the training course outline and training materials to meet the needs of the owner. Review and approval by the consultant shall be completed at least three weeks prior to the first class.

1.15 WARRANTY

- .1 Labour and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the owner. The contractor shall respond to the owner's request for warranty service within 24 hours during normal business hours.

- .2 All work shall have a single warranty date, even when the owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.
- .3 At the end of the final start-up, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the consultant, the consultant shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of this specification. The date of acceptance shall be the start of warranty.
- .4 Project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above-mentioned items also can be provided during the warranty period for an additional charge to the owner by purchasing an in-warranty service agreement from the contractor. Written authorization by the owner must, however, be granted prior to the installation of any of the above-mentioned items.

1.16 OWNERSHIP OF PROPRIETARY MATERIAL

- .1 All project-developed software and documentation shall become the property of the owner. These include, but are not limited to:
 - .1 Project graphic images
 - .2 Record drawings
 - .3 Project database
 - .4 Project-specific application programming code
 - .5 All documentation.

1.17 TESTING AND BALANCING

- .1 During the system testing and balancing by an independent agency fully demonstrate the operation of all sensors, dampers, actuators, controls, valves, etc. This contractor shall be present during the testing and balancing and make adjustments as often as necessary to satisfy the testing and balancing agency.

1.18 WIRING

- .1 Provide all wiring, conduit in accordance with Electrical Division, labour, including calibration, commissioning, software programming and data base generation, generation of colour graphics and additional work necessary to provide a complete and fully operating system.
- .2 Provide 120 Volt, 20 amp circuits to field panels and other devices requiring a main supply from circuits. supplied by Electrical Division.
- .3 Surge transient protection shall be incorporated in design of system to protect electrical components.
- .4 Obtain Hydro permit and inspection.

Part 2 Products

2.1 General

- .1 Scope
 - .1 Furnish all labor, materials and equipment necessary for a complete and operating Building Automation System (BAS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer bus over a single LonTalk open protocol bus.
 - .2 System head end manufacturer shall be based on a Niagara System.
 - .3 Head end will require a fully open Niagara Compatibility Statement (NiCS).
 - .4 NiCS will include in and out compatibility for both station and tool compatibility.
 - .5 Controls contractor shall provide a new BAS server for the client that is capable of integrating future Niagara based controls systems by other vendors.
 - .6 The BAS server shall host all graphic files for the control system.
 - .7 System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via existing vendor protocols including, as a minimum, LonTalk, BACnet, and Modbus.
 - .8 System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
 - .9 All control devices furnished with this Section shall be programmable directly from the Niagara 4™ Workbench embedded toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
 - .10 Any control vendor that must provide additional BAS server software shall be unacceptable.
- .2 Installation Contractor Requirements
 - .1 Contractor needs to be Niagara certified.
 - .2 Contractor needs to have completed a minimum of five (5) Niagara 4™ installations, with at least one of these installations having in excess of five (5) JACE controllers.
 - .3 Prime contractor needs to have the ability to provide 24/7 response in under 4 hours during the project by a Niagara 4™ certified technician.
 - .4 Prime contractor shall have in excess of four (4) Niagara 4™ certified staff members and be located within a 100 km radius of the project site.
- .3 Software Ownership
 - .1 The Owner shall have full ownership and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BAS.

- .4 Open, Interoperable, Integrated Architecture
 - .1 The supplied software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet® or LonWorks® or Modbus® control equipment, such as VFD's, Boilers, Computer Room Air Conditioning Units, Variable Refrigerant Flow Units, Main Electrical Distribution Panels, shall be via Ethernet.
 - .2 All air handlers, even if packaged controls exist, shall be fitted with District standard level 1 or level 2 controllers.
 - .3 The supplied system must incorporate the ability to access all data web enabled browsers without requiring plug-ins or proprietary operator interface and configuration programs. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the Operating System Server currently located on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.
 - .4 A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
 - .1 Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - .2 Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.
 - .5 Level 1 controllers shall provide overall system coordination, accept control programs, perform automated DDC and energy management functions, control peripheral devices, and perform all necessary mathematical functions.
 - .1 Level 1 controllers shall permit multi-user operation from workstations and laptop computers connected either locally or over the Level 1 network.
 - .2 Level 1 controllers shall be housed in a locking. The enclosure will include knockouts on all sides of the cabinet for connection to field and power wiring.
 - .3 The 120VAC power wiring to each Level 1 controller shall be a dedicated run with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device. Multiple Level 1 controllers in the same cabinet may utilize the same circuit.
 - .4 All Level 1 controllers shall have a dedicated battery backup in a separate enclosure. Pre-approved product is Altronix eFlow3N with substitutions upon approval.
 - .6 Level 2 controllers shall provide intelligent stand-alone control of HVAC. Each unit shall have its own internal RAM memory and will continue to operate all local control functions in the event of a failure to any Level 1 controller. In addition, it shall be able to share information with and from the entire network for full global control.

- .7 Level 1 controllers shall be JACE 8000-O JACE Controllers with a minimum of:
 - .1 WEB-8000 Base unit includes two RS485 ports, two 10/100MB Ethernet ports, USB Backup & Restore and WiFi.
 - .2 Required Selections of Device/Point Core (NC-8005, NC-8010, NC-8025, NC-8100 or NC-8200) and Upgrade Device/Point Packs (DEVICE-10, DEVICE-25 or DEVICE-50) as required to support all connected Level 2 controllers.
 - .3 Software Maintenance Agreement (SMA) to provide five (5) years of coverage for all software updates, patches and revision upgrades based on Device/Point quantity. (SMA-8005-5YR, SMA-8010-5YR, SMA-8025-5YR, SMA-80100-5YR or SMA-8200-5YR)
 - .4 If LonWorks devices are to be connected, include one (1) NPB-8000-LON add on single port LON FTT10A module to support a maximum of fifty (50) LonWorks devices per wired communication bus segment. Provide additional modules as required.
- .8 Each site will have a minimum of one Level 1 controller. All Level 1 controllers shall be compatible with the Niagara supervisor.
- .5 System Network Controller (SNC)
 - .1 Level One - These controllers are designed to manage communications between the programmable equipment controllers (PEC), application specific controllers (ASC), and advanced unitary controllers (AUC) which are connected to its communications trunks, manage communications between itself and other system network controllers (SNC) and with any operator workstations (OWS) that are part of the BAS, and perform control and operating strategies for the system based on information from any controller connected to the BAS.
 - .2 The controllers must be fully programmable to meet the unique requirements of the facility it must control.
 - .3 The controllers must be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via modem or connected via the Internet.
 - .4 The communication protocols utilized for peer-to-peer communications between SNC's shall be FOX, Tridiums TCP/IP based protocol included with Niagara 4 Framework. Use of any other proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.
 - .5 The SNC shall be capable of executing application control programs to provide:
 - .1 Calendar functions
 - .2 Scheduling
 - .3 Trending
 - .4 Alarm monitoring and routing
 - .5 Time synchronization
 - .6 Integration of LonWorks, BACnet, and ModBus controller data
 - .7 Network management functions for all SNC, PEC and ASC based devices
 - .6 The SNC must provide the following hardware features as a minimum:
 - .1 Two Ethernet Port-10/100 Mbps
 - .2 Two isolated RS-485 port

- .3 Capability to add LonWorks Interface Port – 78KB FTT-10A if required
- .4 1GB DDR3 SDRAM
- .5 Integrated 24VAC/DC Global Power Supply
- .6 4GB Flash Total Storage / 2GB User Storage
- .7 WiFi (client or WAP)
- .7 The SNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.
- .8 The SNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
- .9 The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network, or wide-area network.
 - .1 Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - .1 Alarm,
 - .2 Return to normal,
 - .3 To default.
 - .2 Alarms shall be annunciated in any of the following manners as defined by the user:
 - .1 Screen message text,
 - .2 Email of complete alarm message to multiple recipients.
 - .3 Pagers via paging services that initiate a page on receipt of email message.
 - .4 Graphics with flashing alarm object(s).
 - .3 The following shall be recorded by the SNC for each alarm (at a minimum):
 - .1 Time and date
 - .2 Equipment (air handler #, accessway, etc.)
 - .3 Acknowledge time, date, and user who issued acknowledgement.
- .10 Programming software and all controllers “Setup Wizards” shall be embedded into the SNC.
- .11 Level 2 controllers prequalified are:
 - .1 Spyder Sylk Enhanced
 - .2 Spyder Micro
- .12 Level 2 controllers shall provide stand-alone control of HVAC control. Each controller shall have its own control programs and will continue to operate in the event of a failure to its associated Level 1 controller.
- .13 Each piece of HVAC equipment will have its points and programs contained in a single Level 2 controller. Equipment programming may not extend across multiple controllers. Level 1 controllers may be used in lieu of Level 2 controllers.

- .14 Each Level 2 controller shall be able to have its program edited and/or modified either locally through a laptop computer or through a workstation connected to a Level 1 controller. Each Level 2 controller shall complete its internal scan in less than one second. Each scan shall consist of updating of inputs, importing of data from other controllers, performing mathematical calculations, and sequencing appropriate outputs for local loop control.
- .15 POWER SUPPLY:
 - .1 The Level 2 controller shall have a built-in supply operating at 24 VAC 50/60 Hz with an accuracy of $\pm 20\%$.
 - .2 Power supplies should have a built in breaker to protect transformers.
 - .3 When using power supplies sharing 24Vac to power level 2 controllers power supplies should be labeled to what they serve.
 - .4 The 120VAC power wiring to Level 2 controllers shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.
 - .5 A true earth ground must be available in the building. Do not use a corroded or galvanized pipe, or structural steel.
- .16 Level 2 controllers shall be housed in a panel mounted enclosure. The enclosure will include a removable cover for access to field and power wiring.
- .6 System Network Software
 - .1 The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP\IP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
 - .2 The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support Microsoft and Netscape Navigator browsers (latest versions), and Windows as well as non-Windows operating systems. No special software or plug-ins, other than free public domain programs shall be required to be installed on PC's used to access the BAS via a web browser.
 - .3 The BAS server software must support at least the following server platforms (Windows, and/or Linux). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
 - .4 The web browser GUI shall provide a completely interactive user interface and must offer and be configured with the following features as a minimum:
 - .1 Trending
 - .2 Scheduling
 - .3 Electrical demand limiting
 - .4 Duty Cycling
 - .5 Downloading Memory to field devices
 - .6 Real time 'live' Graphic Programs
 - .7 Tree Navigation
 - .8 Parameter change of properties

- .9 Setpoint Adjustments
 - .10 Alarm / Event information
 - .11 Configuration of operators
 - .12 Execution of global commands
 - .13 Add, delete, and modify graphics and displayed data
- .5 Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project .BAS software components shall include:
 - .1 Server Software, Database and Web Browser Graphical User Interface
 - .2 System Configuration Utilities for future modifications to the system, and controllers.
 - .3 Graphical Programming Tools
 - .4 Direct Digital Control software
 - .5 Application Software
 - .6 Any required third party software
 - .7 If licensing credits are required provide a minimum of 10% additional to as built control system requires.
- .6 BAS Server Database: The BAS server software shall utilize the integral database installed during the loading of the N4 Supervisor software included with the software platform built on the Niagara 4™ Framework. BAS systems written to other Non -Standard and/or Proprietary databases are not acceptable.
- .7 Database Open Connectivity: The BAS server database shall allow real time access of data via the following standard mechanisms:
 - .1 Open protocol standard like SOAP
 - .2 OLE/OPC (for Microsoft Client's/Server platform only)
 - .3 Import/Export of the database from or to XML (extensible Mark-up Language)
- .8 Communication Protocol(s): The native protocol for the BAS server software shall be TCP/IP over Ethernet. Proprietary protocols over TCP/IP, other than FOX are not acceptable.
- .9 Thin Client – Web Browser Based: The GUI shall be browser based.
- .7 Programmable Equipment Controller (PEC)
 - .1 Level Two - HVAC control shall be accomplished using BACnet based devices where the application has a BACnet profile defined. The controller platform shall provide options and advanced system functions, programmable and configurable using the N4 software platform built on the Niagara 4™ Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".
 - .2 All PECs shall be application programmable and shall at all times maintain their BACnet certification. All control sequences within or programmed into the ILC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.
 - .3 The PECs shall communicate with the SNC at a baud rate of not less than 78.8K baud. The PEC shall provide LED indication of communication and controller performance to the technician, without cover removal.

- .4 The following integral and remote Inputs/Outputs shall be supported per each PEC:
 - .1 Eight integral dry contact digital inputs.
 - .2 Any two digital inputs may be configured as pulse counters with a maximum pulse read rate of 15 Hz.
 - .3 Eight integral analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
 - .4 Six integral 4-20 ma analog outputs.
 - .5 Eight integral 24 Vac Triac digital outputs, configurable as maintained or floating motor control outputs.
 - .6 One integral 20 Vdc, 65-mA power supply for auxiliary devices.
 - .7 If a 20 Vdc 65-mA power supply terminal is not integral to the ILC, provide at each PEC a separate, fully isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices
- .5 Each PEC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules
- .6 PEC Controllers shall support the following control techniques:
 - .1 Ten configurable general-purpose control loops that can incorporate Demand Limit Control strategies, Setpoint reset, adaptive intelligent recovery, and time of day bypass.
 - .2 Ten general-purpose, non-linear control loops.
 - .3 Eight start/stop Loops.
 - .4 Thirty-two If/Then/Else logic loops.
 - .5 Thirty six Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV, ENTHALPY).
- .8 Advanced Unitary Controller (AUC)
 - .1 Level Two - The advanced unitary controller (AUC) platform shall be designed specifically to control HVAC – ventilation, filtration, heating, cooling, humidification, and distribution. Equipment includes: constant volume air handlers, VAV air handlers, packaged RTU, heat pumps, unit vents, fan coils, natural convection units, and radiant panels. The controller platform shall provide options and advanced system functions, programmable and configurable using the N4 software platform built on the Niagara 4™ Framework, that allow standard and customizable control solutions required in executing the “Sequence of Operation”. Spyder Independent License Controller (ILC) option is not required.
 - .2 Minimum Requirements:
 - .1 The controller shall be fully programmable with full functionality on software platform built on the Niagara 4 Framework.
 - .1 Support downloads and uploads using Supervisor or Supervisor Workbench via WEB-8000 JACE controller connected to TCP/IP network.
 - .2 Support online and offline simulation/debug mode of the controller.
 - .3 Maintain native GUI.

- .4 Native function-block programming within the Niagara 4 environment.
- .2 The controller shall be capable of either integrating with other devices or stand-alone operation.
- .3 The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications. Controller memory minimum requirements include:
 - .1 FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
 - .2 FLASH Memory settings retained for ten years.
 - .3 RAM: 2 Kilobytes
- .4 The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
- .5 The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - .1 Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.
 - .2 Accuracy: ± 1 minute per month at 77° F (25° C).
 - .3 Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).
- .6 The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
- .7 The controller shall have an internal DC power supply to power external sensors.
 - .1 Power Output: 20 VDC $\pm 10\%$ at 75 mA.
- .8 The controller shall have a visual indication (LED) of the status of the device:
 - .1 Controller operating normally.
 - .2 Controller in process of download.
 - .3 Controller in manual mode under control of software tool.
 - .4 Controller lost its configuration.
 - .5 No power to controller, low voltage, or controller damage.
 - .6 Processor and/or controller are not operating.
- .9 The minimum controller Environmental ratings
 - .1 Operating Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
 - .2 Storage Temperature Ambient Rating: -40° to 150° F (-40° to 65.5° C).
 - .3 Relative Humidity: 5% to 95% non-condensing.

- .10 The controller shall have the additional approval requirements, listings, and approvals:
 - .1 UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - .2 CSA (LR95329-3) Listed
 - .3 Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - .4 Meets Canadian standard C108.8 (radiated emissions).
 - .5 Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity)
 - .6 Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission)
- .11 The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
- .12 The controller shall have a mix of digital inputs (DI), digital Triac outputs (DO), analog outputs (AO), and universal inputs (UI).
 - .1 Analog outputs (AO) shall be capable of being configured as digital outputs (DO)
 - .2 Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
 - .3 Input and Output wiring terminals shall be designated with color coded labels.
 - .4 Universal inputs shall be capable of being configured as binary inputs, resistive inputs, voltage inputs (0-10 VDC), or current inputs (4-20 mA).
- .13 The controller shall provide for "user defined" Network Variables (NV) for customized configurations and naming using Niagara 4™ Framework.
 - .1 The controller shall support 62 Network Variables with a byte count of 31 per variable.
 - .2 The controller shall support 1,922 separate data values.
- .14 The controller shall be capable of continuous automated loop tuning with an Adaptive Integral Algorithm Control Loop.
- .15 Timed local override switches should be installed on air handlers which may be needed to run occasionally after hours.
- .16 The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized "sequence of operations" as outlined in Section 4.
 - .1 Discharge air control and low limit
 - .2 Pressure-dependent dual duct without flow mixing.
 - .3 Variable air volume with return flow tracking.
 - .4 Economizer with differential enthalpy.
 - .5 Minimum airflow coordinated with CO2.
 - .6 Unit ventilator cycle (1,2,3) 2-pipe.
 - .7 Unit ventilator cycle (1,2,3) 2-pipe with face/bypass.
 - .8 Unit ventilator cycle (1,2,3) 4-pipe.

- .9 Unit ventilator cycle (1,2,3) 4-pipe with EOC valve.
- .9 Advanced Specific Controller (ASC)
 - .1 Level Two - The advanced specific controller platform shall be designed specifically for room-level control – pressure-independent air flow control, pressure dependent damper control, supply and exhaust pressurization/de-pressurization control; temperature, humidity, complex CO2, occupancy, and emergency control. Equipment includes: Terminal HVAC Equipment. The controller platform shall provide options and advanced system functions, programmable and configurable using the N4 software platform built on the Niagara 4™ Framework, that allow standard and customizable control solutions required in executing the “Sequence of Operation”.
 - .2 Minimum requirements:
 - .1 The controller shall be fully programmable with full functionality on N4 software platform built on the Niagara 4 Framework.
 - .1 Support downloads and uploads using N4 Supervisor or N4 Supervisor Workbench via JACE controller connected to TCP/IP network.
 - .2 Support online and offline simulation/debug mode of the controller.
 - .3 Maintain native GUI.
 - .4 Native function-block programming within the Niagara 4 environment.
 - .2 The controller shall be capable of either integrating with other devices or stand-alone room-level control operation.
 - .3 The controller shall have an internal velocity pressure sensor.
 - .1 Sensor Type: Microbridge air flow sensor with dual integral restrictors.
 - .2 Operating Range: 0 to 1.5 in. H2O (0 to 374 Pa).
 - .3 Accuracy: ±2% of full scale at 32° to 122°F (0° to 50° C); ±1% of full scale at null pressure.
 - .4 The controller shall have two microprocessors. The Host processor contains on-chip FLASH program memory, FLASH information memory, and RAM to run the main HVAC application. The second processor for network communications.
 - .1 FLASH Memory Capacity: 60 Kilobytes with 8 Kilobytes for application program.
 - .2 FLASH Memory settings retained for ten years.
 - .3 RAM: 2 Kilobytes
 - .5 The controller shall have an FTT transformer-coupled communications port interface for common mode-noise rejection and DC isolation.
 - .6 The controller shall have an internal time clock with the ability to automatically revert from a master time clock on failure.
 - .1 Operating Range: 24 hour, 365 day, multi-year calendar including day of week and configuration for automatic day-light savings time adjustment to occur on configured start and stop dates.

- .2 Accuracy: ± 1 minute per month at 77° F (25° C).
- .3 Power Failure Backup: 24 hours at 32° to 122° F (0° to 50° C).
- .7 The controller shall have Significant Event Notification, Periodic Update capability, and Failure Detect when network inputs fail to be detected within their configurable time frame.
- .8 The controller shall have an internal DC power supply to power external sensors.
 - .1 Power Output: 20 VDC $\pm 10\%$ at 75 mA.
- .9 The controller shall have a visual indication (LED) of the status of the device:
 - .1 Controller operating normally.
 - .2 Controller in process of download.
 - .3 Controller in manual mode under control of software tool.
 - .4 Controller lost its configuration.
 - .5 No power to controller, low voltage, or controller damage.
 - .6 Processor and/or controller are not operating.
- .10 The minimum controller Environmental ratings:
 - .1 Operating Temperature Ambient Rating: 32° to 122° F (0° to 50° C).
 - .2 Storage Temperature Ambient Rating: 32° to 122° F (0° to 50° C).
 - .3 Relative Humidity: 5% to 95% non-condensing.
- .11 The controller shall have the additional approval requirements, listings, and approvals:
 - .1 UL/cUL (E87741) listed under UL916 (Standard for Open Energy Management Equipment) with plenum rating.
 - .2 CSA (LR95329-3) Listed
 - .3 Meets FCC Part 15, Subpart B, Class B (radiated emissions) requirements.
 - .4 Meets Canadian standard C108.8 (radiated emissions).
 - .5 Conforms requirements European Consortium standard EN 61000-6-1; 2001 (EU Immunity)
 - .6 Conforms requirements European Consortium standard EN 61000-6-3; 2001 (EU Emission)
- .12 The controller housing shall be UL plenum rated mounting to either a panel or DIN rail (standard EN50022; 7.5mm x 35mm).
- .13 The controller shall provide an integrated actuator option.
 - .1 Actuator type: Series 60 Floating.
 - .2 Rotation stroke: 95° $\pm 3^\circ$ for CW or CCW opening dampers.
 - .3 Torque rating: 44 lb-in. (5 Nm).
 - .4 Run time for 90° rotation: 90 seconds at 60 Hz.

- .14 The controller shall have four digital inputs (DI), eight digital Triac outputs (DO) or six digital Triac outputs (DO) with Integrated Actuator, three analog outputs (AO), and six universal inputs (UI).
 - .1 Analog outputs (AO) shall be capable of being configured as digital outputs (DO).
 - .2 Input and Output wiring terminal strips shall be removable from the controller without disconnecting wiring.
 - .3 Input and Output wiring terminals shall be designated with color coded labels.
- .15 The controller shall provide for user defined Network Variables (NV) for customized configurations and naming using Niagara 4™ Framework.
 - .1 The controller shall support a range of Network Variables to 62 with a byte count of 31 per variable.
 - .2 The controller shall support 1,922 separate data values.
- .16 The controller shall be capable of continuous automated loop tuning with an Adaptive Integral Algorithm Control Loop.
- .17 The controller shall have a loop execution response time of 1 second.
- .18 The controller platform shall have standard HVAC application programs that are modifiable to support both the traditional and specialized “sequence of operations” as outlined in Section 4.
 - .1 VAV terminal unit.
 - .2 VAV terminal unit fan speed control.
 - .3 Series fan.
 - .4 Parallel fan.
 - .5 Regulated air volume (room pressurization/de-pressurization).
 - .6 CV dual-duct.
 - .7 Room CO2 control.
 - .8 Room Humidity.
 - .9 TOD occupancy sensor stand-by setpoints.
- .10 WEB Browser Graphical User Interface
 - .1 Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to “feel” like a single application and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.
 - .2 Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator’s role privileges, and geographic area of responsibility.

- .3 Navigation: Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program), and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
 - .1 Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
 - .2 Groups View shall display Scheduled Groups and custom reports.
 - .3 Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).
- .4 Action Panel: The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
 - .1 Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh.
 - .2 Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
 - .3 Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy (using the navigation tree).
 - .4 Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
 - .5 Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling
 - .6 Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
 - .7 Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.
- .5 Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated .gifs or .jpg, vector scalable, active setpoint graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
 - .1 Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color. Match standard graphic sizing already implemented on N4 Supervisor.
 - .2 General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.

- .3 Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective setpoints. The colors shall be updated dynamically as a zone's actual comfort condition changes.
- .4 Global HVAC Air Balancing Table: A graphic showing the HVAC System, i.e. all VAV boxes on their individual air handling system, on the same screen with the individual VAV Name, AHU served by, Room Served, Occ_mode, Rm Temp, Current STP, Valve Pos, Valve OVR, FTR Vlv Pos, FTR Vlv OVR, DMPR Pos, Damper OVR, Air Flow CFM showing. The purpose for this graphic is to open all of the boxes to their maximum cooling CFM settings so the duct static pressure setting can be optimized, from that of the design value. Global hot water valve override (Fan specific, global override located on fan graphic for VAV's served by associated fan) See exhibit below.
- .5 Global HVAC Hot Water Balancing Table: A graphic showing the Boiler System, i.e. all heating coils on their individual pumping system, on the same screen with the individual GPM values showing, if available. The purpose for this graphic is to open all of the hot water valves to their maximum settings so the heating piping pressure setting can be optimized, from that of the design value. Global hot water valve override (pump specific, global override located on fan graphic for coils served by associated pump).
- .6 Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability. If there are more than one fan or pump, all fans or pumps must be shown, if there are multiple coils or dampers, all of these components must be shown.
 - .1 Each piece of equipment monitored or controlled including each terminal unit
 - .2 Each HVAC mechanical system: chiller-pumps, boiler-pumps, AHU-EF-VAV, ventilation
- .7 Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
 - .1 Each building
 - .2 Each floor and zone controlled, with alarm representations when space temperatures go outside of the set limits
- .8 Graphics shall incorporate room numbers
- .9 Backgrounds on the graphics shall not be on a white background. Dark background colors are not acceptable.

- .6 Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system would be automatically downloaded with the 'Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.
- .1 Schedules: Schedules shall comply with the LonWorks standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
- .1 Types of schedule shall be Normal, Holiday or Override
- .2 A specific date,
- .3 A range of dates,
- .4 Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any)
- .5 Wildcard (example, allow combinations like second Tuesday of every month).
- .2 Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
- .3 Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an 'individual tenant' group – who may occupy different areas within a building or buildings. Schedules applied to the 'tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the 'tenant group'
- .4 Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler, and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
- .5 Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).

- .6 Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
- .7 Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an 'Alarms' view. Alarms, and reporting actions shall have the following capabilities:
 - .1 Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report, and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
 - .2 Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
 - .3 Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
 - .4 Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
 - .5 Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
 - .6 Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A 'network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
 - .7 Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement, and total number of Alarms in the BAS Server database.
 - .8 Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.

- .9 Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
 - .1 Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
 - .2 Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
 - .3 File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
 - .4 Write Property: The write property reporting action updates a property value in a hardware module.
 - .5 SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
 - .6 Run External Program: The Run External Program reporting action launches specified program in response to an event.
- .8 Trends: Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
 - .1 Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
 - .2 Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
 - .3 Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
 - .4 Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.

- .5 Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
- .6 Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
- .7 Copy/Paste. The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
- .9 Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:
 - .1 Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
 - .1 View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
 - .2 Edit Privileges shall comprise: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
 - .3 Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.
 - .2 Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.
- .10 Graphical Programming
 - .1 The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL is a method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

- .2 Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- .3 Graphic Sequence: The clarity of the graphic sequence must be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation. Graphics and navigation shall follow existing MPS standards. See drawings and the example below.
- .4 GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
 - .1 Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 - .2 Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 - .3 Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
 - .4 Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
 - .5 Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
 - .6 Parameter: A parameter shall be a value that may be tied to the input of a microblock.
 - .7 Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
 - .8 Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.

- .9 Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
- .10 Live Graphical Programs: The Graphic Programming software must support a 'live' mode, where all input/output data, calculated data, and setpoints shall be displayed in a 'live' real-time mode.
- .11 All BAS Control Sequences will be shown on a separate Mechanical Plan Sheet. Examples are shown below.
- .11 Network Management
 - .1 Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
 - .2 The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.
 - .3 The network management database shall be resident in the Network Area Controller (NAC), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system shall not be accepted.
- .12 Third Party Integration Management – Open Protocol Devices
 - .1 PURPOSE: The purpose of the Integration is to gather and use a larger number of points from specific mechanical equipment units that will provide more information and controllability to the BAS system than just by adding a few sensors. Mechanical equipment, which can have BACnet, LonWorks, Modbus, OPC, SMS devices are: variable frequency drives, chillers, boiler controllers, packaged energy recovery units, make up air units, computer room air conditioning units, etc. The actual values the equipment it is controlling are to be displayed to aid with future troubleshooting and understanding equipment performance where the offset value shown from a second independent sensor may hide the root problem.
 - .2 CONTROLS CONTRACTOR RESPONSIBILITIES: The successful controls contractor is to research do planning and reading to figure out how to implement the integration. The controls contractor and mechanical contractor must call the phone number on the installations and operations manual of the successful equipment supplier and discuss a plan and details with factory tech support. There will be a point's list and description somewhere that helps define each value.
 - .3 COMMUNICATIONS CARD AND PROTOCOL: The mechanical contractor shall purchase the communication card to be provided on the mechanical equipment. Specific protocols; Use BACnet, LonWorks, Modbus, OPC, SMS or what other specific manufacturer has chosen to standardize on. If a standard factory option, provide a self-discovery protocol like BACnet or LonWorks.

- .4 NETWORK MANAGEMENT COMMUNICATIONS TRUNK: Keep the wiring to integrated pieces of equipment separated from the field controllers. Run a separate comm port and comm wire segment to support the integrated equipment because it expedites the process to rule out many of the first tech support questions like; address conflict, comm bus length and routing, interference from other types of controllers. It also helps to adjust baud rate, parity and other comm settings where if you have to change all the other controllers on a comm bus, this can really take time. Comm wires should get polled as a test to make sure comm drop and this problem is reflected on the Niagara system. However, "if after all the steps above are completed and the integration fails, then the contractor is not responsible for going any further"
- .5 VERIFICATION OF INTEGRATED VALUES: Integrated values must be verified, double-check against an LCD display or measured values from an instrument. Typically just one point of each type of facet needs to be verified to confirm any conversion factors or zero shifting and the remaining points are all done the same way.
- .13 Continuity of Operation after Electric Power Interruption
 - .1 Equipment and associated factory-installed controls, field installed controls, electrical equipment and power supplies connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without the need for manual interventions by operator when power is restores either through backup power source or through normal power is restored before backup power is brought online.

2.2 POWER SUPPLIES AND LINE FILTERING

- .1 Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
 - .1 DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
 - .1 Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MIL-STD 810C for shock and vibration.
 - .2 Line voltage units shall be UL recognized and CSA approved.
- .2 Power line filtering.
 - .1 Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - .1 Dielectric strength of 1000 volts minimum
 - .2 Response time of 10 nanoseconds or less

- .3 Transverse mode noise attenuation of 65 dB or greater
- .4 Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.3 MOTORIZED CONTROL DAMPERS

- .1 Control dampers shall be the parallel or opposed blade type as below or as scheduled on drawings.
 - .1 Outdoor and/or return air mixing dampers and face and bypass (F & BP) dampers shall be parallel blade, arranged to direct air-streams toward each other.
 - .2 Other modulating dampers shall be the opposed blade type.
 - .3 Two-position shutoff dampers may be parallel or opposed blade type with blade and side seals.
- .2 Damper frames shall be 13 gauge galvanized steel channel or 1/8 in. extruded aluminum with reinforced corner bracing.
- .3 Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades are to be suitable for medium velocity performance (10 m/s [2000 fpm]). Blades shall be not less than 16 gauge.
- .4 Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze or better.
- .5 All blade edges and top and bottom of the frame shall be provided with replaceable butyl rubber or neoprene seals. Side seals shall be spring-loaded stainless steel. The blade seals shall provide for a maximum leakage rate of 50 L/s m² (10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential pressure. Provide air foil blades suitable for a wide-open face velocity of 7.5 m/s (1500 fpm).
- .6 Individual damper sections shall not be larger than 125 cm x 150 cm (48 in. x 60 in.). Provide a minimum of one damper actuator per section.
- .7 Modulating dampers shall provide a linear flow characteristic where possible.
- .8 Dampers shall have exposed linkages.

2.4 ELECTRIC DAMPER/VALVE ACTUATORS

- .1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
- .2 Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided.
- .3 Proportional actuators shall accept a 0 to 10 VDC or 0 to 20 mA control signal and provide a 2 to 10 VDC or 4 to 20 mA operating range.
- .4 All 24 VAC/VDC actuators shall operate on Class 2 wiring.
- .5 All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N m (60 in.-lb) torque capacity shall have a manual crank for this purpose.

2.5 CONTROL VALVES

- .1 Control valves shall be two-way or three-way type for two-position or modulating service as shown.
- .2 Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - .1 Water Valves:
 - .1 Two-way: 150% of total system (pump) head.
 - .2 Three-way: 300% of pressure differential between ports A and B at design flow or 100% of total system (pump) head.
 - .3 Water Valves:
 - .1 Body and trim style and materials shall be in accordance with manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.
 - .2 Sizing Criteria:
 - .1 Two-position service: Line size.
 - .2 Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 5 psi, whichever is greater.
 - .3 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa (5 psi) maximum.
 - .4 Valves 1/2 in. through 2 in. shall be bronze body or cast brass ANSI Class 250, spring-loaded, PTFE packing, quick opening for two-position service. Two-way valves to have replaceable composition disc or stainless steel ball.
 - .5 Valves 2 1/2 in. and larger shall be cast iron ANSI Class 125 with guided plug and PTFE packing.
 - .6 Water valves shall fail normally open or closed, as scheduled on plans, or as follows:
 - .7 Water zone valves-normally open preferred.
 - .8 Heating coils in air handlers-normally open.
 - .9 Chilled water control valves-normally closed.
 - .10 Other applications-as scheduled or as required by sequences of operation.

2.6 TEMPERATURE DEVICES

- .1 Low-voltage space thermostat shall be 24 V, bimetal-operated, mercury-switch type, with either adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) set point range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

- .2 Line-voltage space thermostat shall be bimetal-actuated, open contact type, or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listed for electrical rating, concealed setpoint adjustment, 13°C to 30°C (55°F to 85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
- .3 Low-limit thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type, with an element of 6 m (20 ft) minimum length. Element shall respond to the lowest temperature sensed by any 30 cm (1 ft) section. The low-limit thermostat shall be manual reset only.

2.7 THERMOSTATS

- .1 DDC Temperature Thermostat
 - .1 Digital room sensors shall have LCD display, day / night override button, and setpoint slide adjustment to $\pm 5^{\circ}\text{C}$ adjustment and override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment.

Temperature monitoring range	+20/120°F (13° to 49°C)
Output signal	Changing resistance
Accuracy at Calibration point	$\pm 0.5^{\circ}\text{F}$ (+/- 0.3°C)
Set Point and Display Range	55° to 95° F (13° to 35°C)
 - .2 Provide guards on thermostat in common areas.
- .2 Line voltage thermostat
 - .1 Wall-mounted thermostat for [heating] [cooling] [heating-cooling] with:
 - .1 Full load rating: [6] A at [120] V.
 - .2 Temperature setting range: 10°C to 27°C.
 - .3 Thermometer range: 7°C to 29°C.
 - .4 Markings in [10] [5] degree increments.
 - .5 Differential temperature fixed at 1.1°C.
 - .3 Heavy-duty line voltage
 - .1 Wall mounted thermostat for [heating] [cooling] [electric heating].
 - .1 Full load rating: [8] A at [120] V.
 - .2 Temperature setting range: 10°C to 27°C.
 - .3 Thermometer range: 7°C to 29°C.
 - .4 Markings in [10] [5] degree increments.
 - .5 Differential temperature fixed at 1.1°C.

.4 Line voltage [wall mounted] [integral] electric heating thermostat with:

- .1 Full load rating: [22] A at [120] V.
- .2 Temperature setting range: 10°C to 25°C.
- .3 [Single] [Double] pole.
- .4 Thermometer range: 10°C to 25°C.
- .5 Scale markings: Off-5-10-15-20-25°C.

.5 Low voltage

- .1 Wall mounted thermostat:
 - .1 For use on 24 V circuit at 1.5 A capacity.
 - .2 [With] heating anticipator adjustable [0.1 to 1.2] A.
 - .3 Temperature setting range: 10°C to 25°C.
 - .4 [Without] sub-base.

2.8 TEMPERATURE SENSORS

- .1 Temperature sensors shall be Resistance Temperature Device (RTD) or thermistor.
- .2 Duct sensors shall be single point or averaging as shown. Averaging sensors shall be a minimum of 1.5m (5ft) in length per 1 m² (10 ft²) of duct cross section.
- .3 Immersion sensors shall be provided with a separable stainless steel well. Pressure rating of well is to be consistent with the system pressure in which it is to be installed. The well must withstand the flow velocities in the pipe.
- .4 Space sensors shall be equipped with set point adjustment, override switch, display, and/or communication port as shown.
- .5 Provide matched temperature sensors for differential temperature measurement.

2.9 HUMIDITY SENSORS

- .1 Duct and room sensors shall have a sensing range of 20% to 80%.
- .2 Duct sensors shall be provided with a sampling chamber.
- .3 Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall be suitable for ambient conditions of -40°C to 75°C (-40°F to 170°F).
- .4 Humidity sensor's drift shall not exceed 1 % of full scale per year.

2.10 FLOW SWITCHES

- .1 Flow-proving switches shall be either paddle or differential pressure type, as shown.
- .2 Paddle type switches (water service only) shall be UL listed, SPDT snap-acting with pilot duty rating (125 VA minimum) and shall have adjustable sensitivity with NEMA I enclosure unless otherwise specified.
- .3 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as specified.

2.11 CO₂ DETECTOR

- .1 Technical Performance – Infrared CO₂ monitor complete with 4-20mA or 0-5 VDC output, accuracy of +/- 40 ppm +3% reading.
- .2 Standard of Acceptance:
 - .1 Duct Mounted Vulcain 90DM4DT-C-2000
 - .2 Wall Mounted Vulcain 90DM4ASM.

2.12 ELECTRICAL DEVICES

- .1 Relays
 - .1 Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
 - .2 Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable $\pm 200\%$ (minimum) from set point shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.
- .2 Override timers.
 - .1 Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0-to-6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.
- .3 Current transmitters.
 - .1 AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A full scale, with internal zero and span adjustment and +1 % full-scale accuracy at 500 ohm maximum burden.
 - .2 Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.
 - .3 Unit shall be split-core type for clamp-on installation on existing wiring.
- .4 Current transformers.
 - .1 AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.
 - .2 Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
 - .3 Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

- .5 Voltage transmitters.
 - .1 AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
 - .2 Ranges shall include 100 to 130 VAC, 200 to 250 VAC, 250 to 330 VAC, and 400 to 600 VAC full-scale, adjustable, with ± 1 % full-scale accuracy with 500 ohm maximum burden.
 - .3 Transmitters shall be UL/CSA Recognized at 600 VAC rating and meet or exceed ANSI/ISA S50.1 requirements.
- .6 Voltage transformers.
 - .1 AC voltage transformers shall be UL/CSA Recognized, 600 VAC rated, complete with built-in fuse protection.
 - .2 Transformers shall be suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and shall provide ± 0.5 % accuracy at 24 VAC and a 5 VA load.
 - .3 Windings (except for terminals) shall be completely enclosed with metal or plastic material.
- .7 Power monitors.
 - .1 Power monitors shall be the three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers, and UL Listed split-core current transformers.
 - .2 They shall provide a selectable rate pulse output for kWh reading and a 4 to 20mA output for kW reading. They shall operate with 5 A current inputs with a maximum error of ± 2 % at 1.0 power factor or ± 2.5 % at 0.5 power factor.
- .8 Current switches.
 - .1 Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

2.13 PRESSURE TRANSDUCERS

- .1 Transducer shall have linear output signal. Zero and span shall be field adjustable.
- .2 Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
- .3 Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
- .4 Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and five-valve manifold.
- .5 Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA I enclosure, with scale range and differential suitable for intended application or as shown.

- .6 Pressure-Electric (PE) Switches.
 - .1 Shall be metal or neoprene diaphragm actuated, operating pressure rated 0-175 kPa (0-25 psig), with calibrated scale setpoint range of 14-125 kPa (2-18 psig) minimum, UL listed.
 - .2 Provide one- or two-stage switch action SPDT, DPST, or DPDT, as required by application. Electrically rated for pilot duty service (125 VA minimum) and/or for motor control.
 - .3 Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA I unless otherwise specified.
 - .4 Shall have a permanent indicating gauge on each pneumatic signal line to PE switches.
- .7 Electro-pneumatic (E/P) transducers.
 - .1 Electronic/pneumatic transducer shall provide a proportional 20 to 100 kPa (3 to 15 psig) output signal from either a 4 to 20 mA or 0 to 10 VDC analog control input.
 - .2 E/P transducer shall be equipped with the following features:
 - .1 Separate span and zero adjustments
 - .2 Manual output adjustments
 - .3 Pressure gauge assembly
 - .4 Feedback loop control
 - .5 Air consumption of 0.05 L/s (0.1 scfm) at mid-range

2.14 LOCAL CONTROL PANELS

- .1 All indoor control cabinets shall be fully enclosed NEMA I construction with (hinged door) key-lock latch and removable subpanels. A single key shall be common to all field panels and subpanels.
- .2 Interconnections between internal and face-mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/ interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
- .3 Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.15 WIRING AND RACEWAYS

- .1 General: Provide copper wiring, plenum cable, and raceways.
- .2 All insulated wire to be copper conductors, ULC labeled for 90°C minimum service.

2.16 FIBER OPTIC CABLE SYSTEM

- .1 Optical cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. The sheath shall be UL Listed OFNP in accordance with NEC Article 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 mm.
- .2 Connectors: All optical fibers shall be field-terminated with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

2.17 HVAC UNIT CONTROL (ROOFTOP VVT) – AD01

.1 Fan Start-Stop Control

- .1 The HVAC unit is started and stopped based on a time schedule. If the outdoor air is less than 10°C, the system is in the heating mode. The optimum start and stop calculations will be based on heating parameters. When the system is not in the heating mode, the calculations will be based on cooling parameters.
 - .2 Night Cycle: When the room temperature falls below the unoccupied low limit setpoint, then the HVAC unit will start and continue to run until the room temperature rises by 3°C. If the room temperature rises above the unoccupied high limit setpoint, then the unit will start and continue to run until the room temperature falls by 3°C.
 - .3 Morning Warm-up: When the HVAC unit starts-up after the unoccupied period and the space temperature is below the warm-up mode setpoint, 20°C (adj.), the warm-up mode is in effect. The outdoor air damper will close fully and the gas valve will open until the space temperature exceeds warm-up mode setpoint. Cooling stages will be locked-out during the warm-up mode.
 - .4 Supply Fan Shutdown Delay: If the fan system is shut down while heating or cooling stages are energized, the stages will immediately de-energize and the fan will continue to run for 60 sec. (heating mode, adj.) or 30 sec. (cooling mode, adj.) more, then shut down.
 - .5 Manual Override Timer: The supply fan will also be started if the manual override timer switch is activated. The fan will then run until the switch times out.
- .2 Fan "OFF" Mode: The cooling and heating stages are disabled. The outdoor air and relief air dampers are fully closed and the return air damper is open. The bypass damper is open to bypass.
- .3 Fan "ON" Mode, Room Temperature Control: The gas valve and two DX cooling stages will be activated appropriately to maintain the supply air temperature at its setpoint.
- .1 Cooling Stages: As the space temperature of the cooling zone of highest demand rises above the setpoint, the first stage of cooling will energize for a minimum of 4 minutes (adj.). On a continued rise in room temperature, the first stage will remain on and if the minimum time between stages has elapsed (2 minutes), the second stage will energize for a minimum of 4 minutes (adj.). Cooling stages will remain energized until the cooling demand of the zone with the highest cooling requirement is satisfied. When satisfied, the stages will deenergize in the reverse process.
- Once a stage is de-energized, it will remain off until the minimum off time has elapsed. The cooling minimum on, off and interstage times are separately configured from the heating stage times.

- .2 Heating Stages: As the space temperature of the zone with the lowest heating requirement falls below setpoint, the gas valve modulates opens to maintain a discharge temperature of 23°C for a minimum of 4 minutes (adjustable). On further drop in room temperature, the gas valve modulates to full open 32°C (adjustable). When the heating demand is satisfied, the gas valve will close in the reverse process. Once a stage is de-energized, it will remain off until the minimum off time has elapsed.
- .3 Economizer: The mixed air dampers will be under the control of unit manufacturer.
- .4 HVAC-1 Static Pressure Control: The bypass damper will be modulated to maintain the static pressure 2/3 of the way down the supply air duct at its setpoint.
- .4 Mechanical cooling low temperature protection: If the outdoor air temperature falls below its Mechanical Cooling Lockout setpoint, it will prevent the mechanical cooling stages from being energized.
- .5 Discharge Air High/Low Temperature: While in the heating mode with heat stages on, an alarm will be generated whenever the discharge air temperature rises above or drops below the Discharge Air Temperature Heating High or Low limits for a duration of 1 min (adj.). Similarly, while in the cooling mode with cooling stages on, an alarm will be generated whenever the discharge air temperature rises above or drops below the Discharge Air Temperature Cooling High or Low limits for a duration of 1 min (adj.).
- .6 Fan System Failure Alarm: An alarm is generated whenever the supply fan fails to respond to start-stop commands.

2.18 ROOM VVT CONTROL - AD01

- .1 A room sensor provides local room control.
- .2 Ventilation Mode:
The VVT damper is normally held to a minimum of 80% airflow measured by the air flow sensor adjacent to each damper, in the ventilation mode as long as the supply air temperature from the unit is within the ventilation band of the room temperature. As the room temperature goes further off setpoint (heating/cooling) the demand signal broadcast to the rooftop unit increases to request heating or cooling.
- .3 Heating Mode:
If the temperature in an individual room falls below the room heating set point and the rooftop is supplying heat, the damper modulates open 100% to anticipate a heating demand. All other zones will also be commanded open until the heating setpoint is exceeded. Above the setpoint the VVT dampers will modulate to a minimum position (30%) to prevent overheating. When the calling room is satisfied the rooftop unit is returned to ventilation mode. The VVT dampers are returned to the minimum of 80% airflow when the rooftop unit's supply air temperature drops to within 3°C (adjustable) of the ventilation.
Where a reheat coil and/or radiant panel is installed, on a call for heat, the two-way valve is energized to maintain set point.
- .4 Cooling Mode:
If the temperature in an individual room rises above the room cooling set point and the rooftop is supplying cooling the damper modulates open 100% to anticipate a cooling demand. All other zones will also be commanded open until the cooling setpoint is satisfied. Below the setpoint the VVT dampers will modulate to a minimum position to prevent overcooling. The VVT damper is returned to the minimum of 80% airflow when the rooftop unit's supply air temperature increases to within 3°C (adjustable) of the ventilation band of the room temperature.

- .5 Static pressure control: the bypass damper will be modulated to maintain the static pressure (0.5" WG adjustable) as its setpoint.

2.19 EXHAUST FANS (WASHROOM) – AD01

- .1 Start/stop exhaust fans on time of day schedule.
- .2 The DDC system uses a current switch to confirm fan operation. Provide a dual voltage relay adjacent to the BAS panel. DDC system generates an alarm if status deviates from DDC start/stop control.
- .3 Points List

Name	AI	AO	DI	DO
Exhaust Fan Command				X
Exhaust Fan Status	X			

2.20 DOMESTIC WATER SYSTEM CONTROL (SIMPLE) – AD01

- .1 Provide supply temperature indication with strap on sensor on domestic hot water pipe for two (2) domestic hot water systems.
- .2 The recirculation pumps will be started/stopped on a time of day schedule.
- .3 Recirculation pump status shall be monitored.
- .4 Alarms shall be provided for the following:
- .1 Recirc pump start/stop/status mismatch (5 minute delay).
 - .2 Domestic hot water supply temperature rises above 62 degrees C for kitchen loop.
 - .3 Domestic hot water supply temperature rises above 45 degrees C for main building loop.
- .5 Points List

Name	AI	AO	DI	DO
Supply Water Temperature	X			
Recirc Pump Command				X
Recirc Pump Status	X			

2.21 EXAMINATION

- .1 The project plans and renovation sites shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/consultant 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 consultant 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 consultant and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the contractor to report such discrepancies shall be made by-and at the expense of-this contractor.

2.22 PROTECTION

- .1 The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.
- .2 The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

2.23 COORDINATION

- .1 Site
- .1 Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment. If the contractor installs his/her work before coordinating with other trades, so as to cause any interference with work of other trades, the contractor shall make the necessary changes in his/her work to correct the condition without extra charge.
- .2 Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.
- .2 Submittals. Refer to the "Submittals" article in Part 1 of this specification for requirements.
- .3 Test and Balance
- .1 The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- .2 The contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
- .3 In addition, the contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
- .4 The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- .4 Life Safety
- .1 Duct smoke detectors required for air handler shutdown are supplied under the mechanical section of this specification. The contractor shall interlock smoke detectors to air handlers for shutdown as described in Part 3, "Sequences of Operation."
- .2 Smoke dampers and actuators required for duct smoke isolation are provided under mechanical section. The contractor shall interlock these dampers to the air handlers as described in Part 3, "Sequences of Operation."

- .3 Fire/smoke dampers and actuators required for fire rated walls are provided under another Section of mechanical section. Control of these dampers shall be by electrical. The contractor shall provide control air to the dampers.
- .5 Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
 - .1 All communication media and equipment shall be provided as specified in Part 2, "Communication" of this specification.
 - .2 Each supplier of a controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section.
 - .3 The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
 - .4 The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
 - .5 The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

2.24 GENERAL WORKMANSHIP

- .1 Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- .2 Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .3 Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- .4 Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
- .5 All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

2.25 FIELD QUALITY CONTROL

- .1 All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.
- .2 Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- .3 Contractor shall have work inspected by local and/ or state authorities having jurisdiction over the work.

2.26 EXISTING EQUIPMENT

- .1 Wiring: The contractor may reuse any abandoned wires. The integrity of the wire and its proper application to the installation are the responsibility of the contractor. The wire shall be properly identified and tested in accordance with this specification. Unused or redundant wiring must be properly identified as such.} {Interconnecting control wiring shall be removed and become the property of the contractor, unless specifically noted or shown to be reused.
- .2 Unless otherwise directed, the contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the consultant is to be notified immediately.
- .3 Temperature Sensor Wells: The contractor may reuse any existing wells in piping for temperature sensors. These wells shall be modified as required for proper fit of new sensors.
- .4 Indicator Gauges: Where these devices remain and are not removed, they must be made operational and recalibrated to ensure reasonable accuracy. Maintain the operation of existing pneumatic transmitters and gauges.
- .5 Room Thermostats: Shall be removed and become the property of the contractor, unless otherwise noted.
- .6 Electronic Sensors and Transmitters: Unless specifically noted otherwise, become the property of the contractor.
- .7 Controllers and Auxiliary Electronic Devices: Become the property of the contractor.
- .8 Damper Actuators, Linkages, and Appurtenances: Salvage, recondition, and reuse.
- .9 Control Valves: Replace with new.
- .10 Control Compressed Air System: {Deliver to owner and replace with new system} {Salvage, recondition, and reuse} {Becomes the property of the contractor, unless otherwise noted}.
- .11 The mechanical system must remain in operation between the hours of 6 a.m. and 6 p.m., Monday through Friday. No modifications to the system shall cause the mechanical system to be shut down for more than 15 minutes or to fail to maintain space comfort conditions during any such period. Perform cut-over of controls that cannot meet these conditions outside of those hours.
- .12 The scheduling of fans through existing or temporary time clocks or control system shall be maintained throughout the DDC system installation.
- .13 Install control panels in existing Mechanical Rooms.
- .14 Modify existing starter control circuits, if necessary, to provide hand/off/auto control of each starter controlled. If new starters or starter control packages are required, these shall be included as part of this contract.
- .15 Patch holes and finish to match existing walls.

2.27 WIRING

- .1 All control and interlock wiring shall comply with national and local electrical codes and the Electrical sections of this specification. Where the requirements of this section differ from those in the Electrical Division, the requirements of this section shall take precedence.
- .2 All NEC Class 1 (line voltage) wiring shall be UL Listed in approved raceway according to NEC and the Electrical Division requirements.
- .3 All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.)
- .4 Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.
- .5 All wiring in mechanical, electrical, or service rooms-or where subject to mechanical damage- shall be installed in raceway at levels below 3 m (10 ft).
- .6 Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).
- .7 Do not install wiring in raceway containing tubing.
- .8 Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.
- .9 Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.
- .10 All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.
- .11 All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- .12 All wiring concealed in walls and chases and all exposed wiring shall be run in conduit.
- .13 Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.
- .14 All wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- .15 Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.
- .16 Size of raceway and size and type of wire shall be the responsibility of the contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.
- .17 Include one pull string in each raceway 2.5 cm (1 in.) or larger.
- .18 Use coded conductors throughout with conductors of different colors.

- .19 Control and status relays are to be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- .20 Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
- .21 Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.
- .22 Adhere to this specification's Electrical Division6 requirements where raceway crosses building expansion joints.
- .23 Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.
- .24 The Contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- .25 Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than 1/2 in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.
- .26 Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes and ends not terminating in boxes shall have bushings installed.

2.28 COMMUNICATION WIRING

- .1 The contractor shall adhere to the items listed in the "Wiring" article in Part 3 of the specification.
- .2 All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- .3 Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.
- .4 Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- .5 Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- .6 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.
- .7 All runs of communication wiring shall be unspliced length when that length is commercially available.
- .8 All communication wiring shall be labeled to indicate origination and destination data.
- .9 Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

2.29 FIBER OPTIC CABLE SYSTEM

- .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 and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.

2.30 INSTALLATION OF THERMOSTATS

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.
- .3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- .4 All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- .5 Install thermostats at handicapped elevations 1200 mm above finish floor (AFF).
- .6 Where not indicated on drawing, place where directed by consultant.
- .7 Co-ordinate location with architectural and electrical items.

2.31 INSTALLATION OF SENSORS

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Mount sensors rigidly and adequately for the environment within which the sensor operates.
- .3 Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- .4 All wires attached to sensors shall be air in EMT raceways.
- .5 Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- .6 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m (10 ft.) of sensing element for each 1m2 (1 ft of sensing element for each 1 ft2) of coil area.
- .7 All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- .8 Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

- .9 Differential air static pressure.
 - .1 Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
 - .2 Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
 - .3 Building Static Pressure: Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure port to a location behind a thermostat cover.
 - .4 The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
 - .5 All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
 - .6 All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

2.32 FLOW SWITCH INSTALLATION

- .1 Use correct paddle for pipe diameter.
- .2 Adjust flow switch in accordance with manufacturer's instructions.

2.33 ACTUATORS

- .1 Mount and link control damper actuators according to manufacturer's instructions.
 - .1 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - .2 Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - .3 Provide all mounting hardware and linkages for actuator installation.
- .2 Electric/Electronic
 - .1 Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
 - .2 Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

2.34 WARNING LABELS

- .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:

CAUTION

“Operating under automatic control”. “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:

CAUTION

“Fed from more than one power source”.

2.35 IDENTIFICATION OF HARDWARE AND WIRING

- .1 All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 5 cm (2 in.) of termination with the DDC address or termination number.
- .2 Permanently label or code each point of field terminal strips to show the instrument or item served.
- .3 Identify control panels with minimum 1 cm (1/2 in.) letters on laminated plastic nameplates.
- .4 Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- .5 Identify room sensors relating to terminal box or valves with nameplates.
- .6 Manufacturers’ nameplates and UL or CSA labels are to be visible and legible after equipment is installed.
- .7 Identifiers shall match record documents.
- .8 **All pneumatic tubing shall be labeled at each end within 5 cm (2 in.) of termination with a descriptive identifier.**

2.36 CONTROLLERS

- .1 Provide a separate controller for each AHU or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.
- .2 Building Controllers and Custom Application Controllers shall be selected to suit the application (i.e. fan powered box, heat pump, VAV etc.)

2.37 PROGRAMMING

- .1 Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.

- .2 Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- .3 Software Programming
 - .1 Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - .1 Text-based:
 - .1 Must provide actions for all possible situations
 - .2 Must be modular and structured
 - .3 Must be commented
 - .2 Graphic-based:
 - .1 Must provide actions for all possible situations
 - .2 Must be documented
 - .3 Parameter-based:
 - .1 Must provide actions for all possible situations
 - .2 Must be documented
- .4 Operator Interface
 - .1 Standard graphics-Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
 - .2 Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
 - .3 The contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

2.38 CONTROL SYSTEM CHECKOUT AND TESTING

- .1 Start-up Testing: All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. Submit test worksheets to the consultant. This testing shall be completed before the owner's representative is notified of the system demonstration.
 - .1 The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 - .2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

- .3 Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.
- .4 Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are rect.
- .5 Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
- .6 Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum start/stop routines.
- .7 Alarms and Interlocks:
 - .1 Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
 - .2 Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - .3 Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

2.39 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- .1 Demonstration
 - .1 Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
 - .2 The tests described in this section are to be performed in addition to the tests that the contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The consultant will be present to observe and review these tests. The consultant shall be notified at least 10 days in advance of the start of the testing procedures.
 - .3 The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
 - .4 The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
 - .5 As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
 - .6 Demonstrate compliance with Part 1, "System Performance."

- .7 Demonstrate compliance with sequences of operation through all modes of operation.
- .8 Demonstrate complete operation of operator interface.
- .9 Additionally, the following items shall be demonstrated:
 - .1 DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - .2 Demand limiting. The contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.
 - .3 Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - .4 Interface to the building fire alarm system.
 - .5 Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the architect/consultant. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.
- .10 Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.
- .2 Acceptance
 - .1 All tests described in this specification shall have been performed to the satisfaction of both the consultant and owner prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the consultant. Such tests shall then be performed as part of the warranty.

2.40 CLEANING

- .1 The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- .2 At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

- .3 At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

2.41 TRAINING

- .1 Provide a minimum of one on-site or classroom training sessions, throughout the contract period for personnel designated by the owner.
- .2 Provide two additional training sessions at one month following building's turnover. Each session shall be for one day in length and must be coordinated with the building owner.
- .3 Train the designated staff of owner's representative and owner to enable them to do the following:
 - .1 Day-to-day Operators:
 - .1 Proficiently operate the system
 - .2 Understand control system architecture and configuration
 - .3 Understand DDC system components
 - .4 Understand system operation, including DDC system control and optimizing routines (algorithms)
 - .5 Operate the workstation and peripherals
 - .6 Log on and off the system
 - .7 Access graphics, point reports, and logs
 - .8 Adjust and change system set points, time schedules, and holiday schedules
 - .9 Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - .10 Understand system drawings and Operation and Maintenance manual
 - .11 Understand the job layout and location of control components
 - .12 Access data from DDC controllers and ASCs
 - .13 Operate portable operator's terminals
 - .2 Advanced Operators:
 - .1 Make and change graphics on the workstation
 - .2 Create, delete, and modify alarms, including annunciation and routing of these
 - .3 Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals
 - .4 Create, delete, and modify reports
 - .5 Add, remove, and modify system's physical points
 - .6 Create, modify, and delete programming
 - .7 Add panels when required
 - .8 Add operator interface stations
 - .9 Create, delete, and modify system displays, both graphical and others
 - .10 Perform DDC system field checkout procedures

- .11 Perform DDC controller unit operation and maintenance procedures
- .12 Perform workstation and peripheral operation and maintenance procedures
- .13 Perform DDC system diagnostic procedures
- .14 Configure hardware including PC boards, switches, communication, and I/O points
- .15 Maintain, calibrate, troubleshoot, diagnose, and repair hardware
- .16 Adjust, calibrate, and replace system components
- .17 System Managers/Administrators:
- .18 Maintain software and prepare backups
- .19 Interface with job-specific, third-party operator software
- .20 Add new users and understand password security procedures
- .4 These objectives will be divided into three logical groupings. Participants may attend one or more of these, depending on level of knowledge required.
 - .1 Day-to-day Operators: parts 1-13
 - .2 Advanced Operators: parts 1-29
 - .3 System Managers/Administrators: parts 1-13 and 30-32
- .5 Provide course outline and materials in accordance with the "Submittals" article in Part I of this specification. The instructor(s) shall provide one copy of training material per student.
- .6 The instructor(s) shall be factory-trained instructors experienced in presenting this material.
- .7 Classroom training shall be done using a network of working controllers representative of the installed hardware.

2.42 CONTROL VALVE INSTALLATION

- .1 Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.
- .2 Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
- .3 Valves shall be installed in accordance with the manufacturer's recommendations.
- .4 Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
- .5 Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. (*Note to designer: this must also be shown.*) Unions shall be installed at all connections to screw-type control valves.
- .6 Provide tags for all control valves indicating service and number. Tags shall be brass, 1.5 inch in diameter, with 1/4" high letters. Securely fasten with chain and hook. Match identification numbers as shown on approved controls shop drawings.

2.43 CONTROL DAMPER INSTALLATION

- .1 Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
- .2 Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure 1/4 in. larger than damper dimensions and shall be square, straight, and level.
- .3 Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within 0.3 cm (1/8 in.) of each other.
- .4 Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
- .5 Install extended shaft or jackshaft according to manufacturer's instructions. (Typically, a sticker on the damper face shows recommended extended shaft location. Attach shaft on labeled side of damper to that blade.)
- .6 Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
- .7 Provide a visible and accessible indication of damper position on the drive shaft end.
- .8 Support ductwork in area of damper when required to prevent sagging due to damper weight.
- .9 After installation of low-leakage dampers with seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

2.44 DUCT SMOKE DETECTION

- .1 Submit data for coordination of duct smoke detector interface to HVAC systems as required in Part 1, "Submittals."
- .2 This Contractor shall provide a dry-contact alarm output in the same room as the HVAC equipment to be controlled.

2.45 CONTROLS COMMUNICATION PROTOCOL

- .1 General. The electronic controls packaged with this equipment shall communicate with the building direct digital control (DDC) system. The DDC system shall communicate with these controls to read the information and change the control set points as shown in the points list, sequences of operation, and control schematics. The information to be communicated between the DDC system and these controls shall be in the standard object format as defined in *ANSI/ASHRAE Standard 135* (BACnet). Controllers shall communicate with other BACnet objects on the internetwork using the Read (Execute) Property service as defined in Clause 15.5 of Standard 135.
- .2 Distributed Processing. The controller shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
- .3 I/O Capacity. The controller shall contain sufficient I/O capacity to control the target system.

- .4 Communication. The controller shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. Each network of controllers shall be connected to one building controller.
- .5 The Controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator's tool.
- .6 Environment. The hardware shall be suitable for the anticipated ambient conditions.
 - .1 Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at -40°C to 65°C (-40°F to 150°F).
 - .2 Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 50°C (32°F to 120°F).
- .7 Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
- .8 Memory. The Controller shall maintain all BIOS and programming information in the event of a power loss for at least 90 days. Immunity to Power and Noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. 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).
- .9 Transformer. Power supply for the Controller must be rated at minimum of 125% of ASC power consumption and shall be fused or current limiting type.

2.46 STARTUP AND CHECKOUT PROCEDURES

- .1 Start up, check out, and test all hardware and software and verify communication between all components.
- .2 Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
- .3 Verify that all analog and binary input/output points read properly.
- .4 Verify alarms and interlocks.
- .5 Verify operation of the integrated system.
- .6 Submit report to the consultant and include as built information.

END OF SECTION

GRILLE SCHEDULE						CAPACITY INDICATED ON SCHEDULE REFER TO SPECIFICATION FOR CONSTRUCTION STANDARDS, ACCESSORIES AND ADDITIONAL INFORMATION.									
Item	Type	Equalizing Grid	Volume Damper	Acceptable Manufacturer		Description									
D1	SQUARE CEILING DIFFUSER	YES	NONE	EH PRICE	SCDA	MULTICONE, FULLY ADJUSTABLE, 24x24, ALUMINUM CEILING DIFFUSER W/ROUND NECK. SUITABLE FOR LAY-IN T-BAR CEILING, OR DRYWALL CEILING WHEN C/W FRAME.									
LD1	LINEAR CEILING DIFFUSER	NO	NONE	EH PRICE	SDS-100, SDAI	3 SLOT (1" WIDE) LINEAR DIFFUSER, EXTRUDED ALUMINUM CONSTRUCTION, 180° AIR PATTERN ADJUSTMENT, SUITABLE FOR STANDARD LAY-IN T-BAR CEILING W/MITRED END FLANGES, & INSULATED PLENUM. LENGTH AS INDICATED.									
R1	CEILING RETURN GRILLE (DUCTED)	NO	NONE	EH PRICE	80-FA	1/2x1/2x1/2 ALUMINUM EGGCRATE CORE, C/W 1 1/4" FLAT BORDER & SCREWED FASTENING FOR SURFACE MOUNTING.									
E1	CEILING EXHAUST GRILLE (DUCTED)	NO	NONE	EH PRICE	80-FA	1/2x1/2x1/2 ALUMINUM EGGCRATE CORE, C/W 1 1/4" FLAT BORDER & SCREWED FASTENING FOR SURFACE MOUNTING.									
DG1	DOOR GRILLE	NO	NONE	EH PRICE	STG1-BF	HEAVY DUTY, STEEL, LOUVRED FACED GRILLE C/W 1 1/4" FLAT BORDER ON BOTH SIDES & SCREWED FASTENING FOR SURFACE MOUNTING.									
GENERAL DIFFUSER/GRILLE NOTES: 1. ACCEPTABLE MANUFACTURERS: EH PRICE, NAILOR, TITUS, KRUEGER, CARNES, METALAIRE, TUTTLE & BAILEY 2. GRILLE COLOURS ARE SELECTED BY ARCHITECT FROM STANDARD COLOUR CHART, UNLESS OTHERWISE NOTED. 3. PAINT INTERIOR OF DUCTWORK BEHIND GRILLE MATT BLACK (WHERE VISIBLE THRU GRILLE).															

HUMIDIFICATION EQUIPMENT SCHEDULE

Mark	Description	Capacity lbsa/h	Fill Rate gpm	Drain Rate gpm	MAX. PRESSURE PSI	Acceptable Manufacturer	Voltage	MCA	MOCP	Description
HG-1	STEAM GENERATING HUMIDIFIER	47	3.8	6.7	80	CONDAIR RS 045/550-600/3	575/3/60	15.4	20.0	STEAM GENERATING C/W RO SYSTEM WATER

WATER HEATER SCHEDULE

Item	Type	Input		Water Side			Manufacturer & Model	Remarks							
		Capacity	Medium	Storage Gallons	Storage Litres	Recovery 1/h									
WH-1	DOMESTIC WATER HEATER	18kW	ELECTRIC	119	450	279	AO SMITH DRE-120-18	ELECTRIC WATER HEATER, 3 ELEMENTS @ 6kW 575/3/60, C/W THERMOSTATIC MIXING VALVE.							

PACKAGED HEAT PUMP HVAC UNIT SCHEDULE

Item	Type	Nominal Capacity					ESP in wc	Motor hp	Cooling				Heating			Electrical Data			Acceptable Manufacturer	Notes
		tons	Outdoor Air cfm	Supply Air cfm	HP COP @ 47°F	HP COP @ 17°F			Total Cap. MBH	Sens. Cap. MBH	Ent db/wb °F	LVG db/wb °F	High Gas Input MBH	HP Output @ 47°F MBH	HP Output @ 17°F MBH	Voltage	MCA	MOCP		
HVAC-1	PACKAGED ASHP ROOFTOP HVAC UNIT WITH BACK-UP GAS HEAT	10.0	710	4000	3.29	2.96	1.5	5	139.9	99.7	75.4/ 62.4	53.9/ 52.9	195	103.9	67.0	575/3/60	29	35	AAON RN-011	SIDE DISCHARGE & DOWN RETURN, C/W 24" INSULATED ROOF CURB, ERV WHEEL (75.1% MIN EFFECTIVENESS)
HVAC-3	PACKAGED ASHP ROOFTOP HVAC UNIT WITH BACK-UP GAS HEAT	10.0	710	4000	3.20	2.76	1.5	5	143.2	101.3	75.3/ 62.3	53.3/ 52.0	270	108.5	64.9	575/3/60	26	35	AAON RN-011	DOWN DISCHARGE & RETURN, C/W 24" INSULATED ROOF CURB, ERV WHEEL (75.1% MIN EFFECTIVENESS)
GENERAL HVAC UNIT NOTES: 1. ACCEPTABLE MANUFACTURERS: DAIKIN, AAO, VALENT. 2. UNITS HAVE 5:1 GAS MODULATING BURNER (UNDER 7.5 TONS) AND 10:1 MODULATING BURNER ABOVE, MODULATING INVERTER COMPRESSOR AND FLOATING HEAD PRESSURE CONTROL HEAT PUMP SYSTEM C/W REVERSING VALVE FOR HEATING AND COOLING, PLUS 0-100% MODULATING ECONOMIZER, DIRECT DRIVE PLENUM FANS. PROVIDE STANDARD INSULATED 24" HIGH ROOF CURB, CONDENSER COIL GUARD, POWER EXHAUST ON UNITS 7.5 TONS AND LARGER, ECONOMIZER, AND ALL HOODS & INLET SCREENS, 2 SETS OF MERV 13 DISPOSABLE FILTERS. 3. CONTROLS: SYSTEM CONTROLS BY BAS CONTRACTOR, PROVIDE INTEGRAL BACnet CONTROLLER CONVERTED TO METRIC UNITS. ECONOMIZER AND POWER EXHAUST CONTROL VIA THE BAS.																				

FAN SCHEDULE

Item	Type	Capacity cfm	ESP in. wc	Fan Speed rpm	hp	Motor Voltage	Acceptable Manufacturer	Description
EF-1	INLINE EXHAUST FAN	600	0.5	895	Fhp	120/1/60	GREENHECK CSP-A900	IN-LINE FAN WITH A DIRECT DRIVE MOTOR, ACOUSTICALLY INSULATED GALV STEEL HOUSING, FORWARD INCLINED CENTRIFUGAL FAN, SIDE ACCESS PANELS, C/W BACKDRAFT DAMPER, VIBRATION ISOLATION HANGERS AND A SPEED CONTROLLER.
EF-2	CEILING EXHAUST FAN	150	0.20	710	Fhp	120/1/60	BROAN L150MG	ACOUSTICALLY INSULATED STEEL HOUSING, CENTIFUGAL BLOWER WHEEL, 90° DISCHARGE OUTLET W/BACKDRAFT DAMPER, C/W WHITE PAINTED ENAMEL STEEL GRILLE, VIBRATION ISOLATORS. 1.8 SONES
GENERAL FAN NOTES: 1. ACCEPTABLE MANUFACTURERS: GREENHECK, PENN-BARRY, COOK, ACME, TWIN CITY, JENCO, BUFFALO. (CEILING FANS: BROAN, GREENHECK, ZONEX)								

WT CONTROL DAMPER SCHEDULE

Item	Type	Capacity (cfm)						Size		Electrical		Manufacturer & Model	Remarks
		Design	Min. Vent	Heating		Cooling				Capacity (kW)	Voltage		
				Min	Max	Min	Max	Neck	Box				
WT-1.0	BYPASS	38x12											
WT-1.1	SINGLE TERMINAL CONTROL BOX	300	120	180	240	90	390	8	10	3.0	575/3/60	KRUGER: LMHS EH PRICE: SDV	C/W 36" ATTENUATOR, ELECTRIC REHEAT COIL, & 2 ACCESS DOORS C/W CAM LATCHES
WT-1.2	SINGLE TERMINAL CONTROL BOX	500	200	300	400	150	650	10	12	5.0	575/3/60	KRUGER: LMHS EH PRICE: SDV	C/W 36" ATTENUATOR, ELECTRIC REHEAT COIL, & 2 ACCESS DOORS C/W CAM LATCHES

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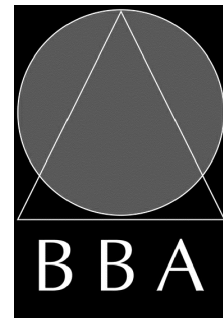
PROJECT:

MILL COURTLAND
COMMUNITY CENTRE
ADDITION

216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:

SCHEDULES
(2 OF 2)



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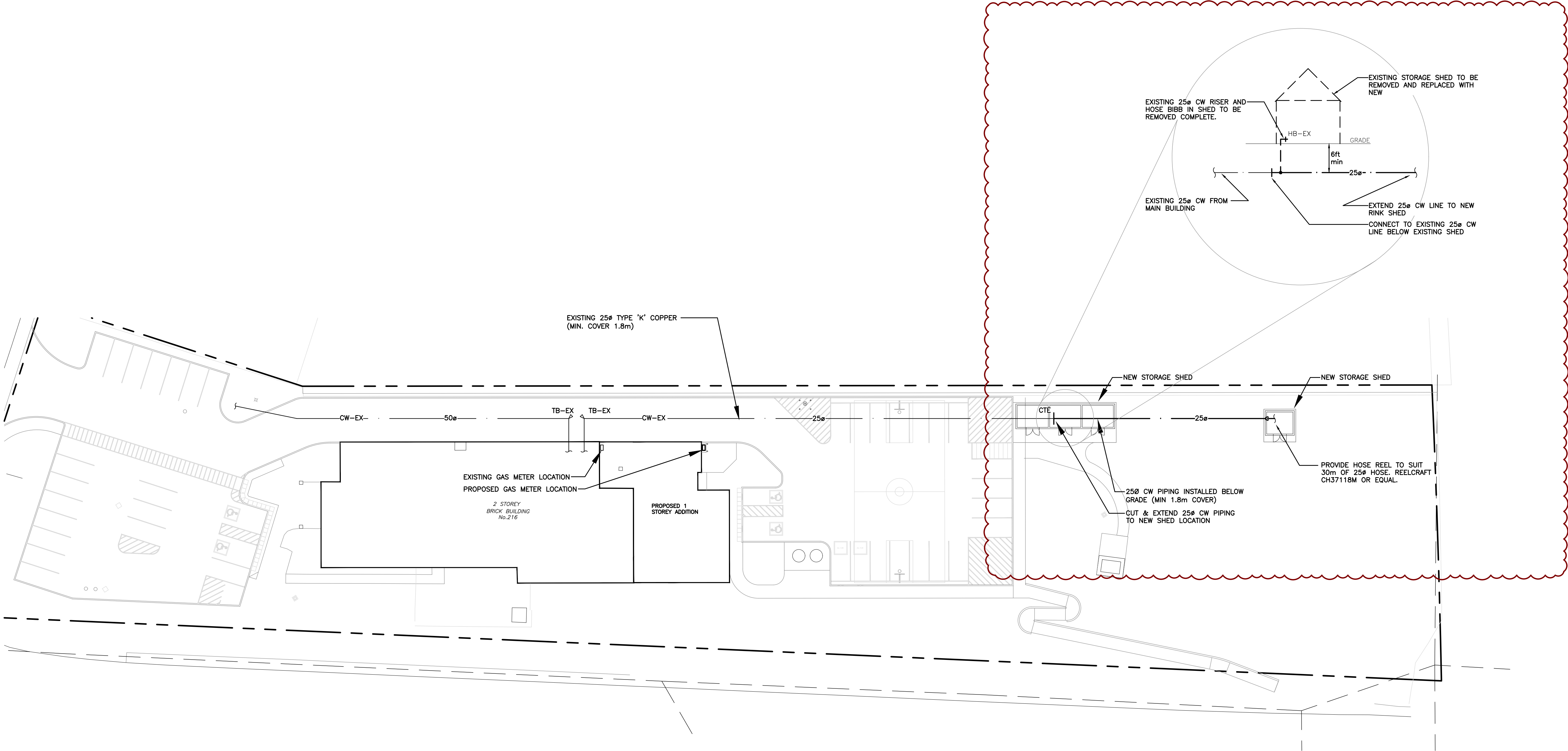
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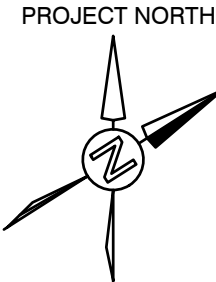
M102



SITE PLAN-RENOVATION
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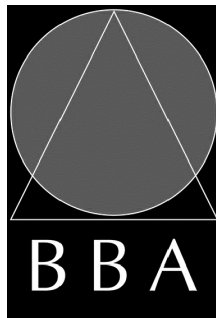
PROJECT:

MILL COURTLAND
COMMUNITY CENTRE
ADDITION

216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:

SITE PLAN



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DRAWING NO:

M103

GENERAL RENOVATION NOTES

- 'ER' INDICATES EXISTING ITEM TO REMAIN.
- 'R' INDICATES EXISTING ITEM IN RELOCATED POSITION.
- ALL DEVICES SHOWN ARE NEW UNLESS OTHERWISE NOTED.
- EXISTING ELECTRICAL EQUIPMENT NOT SHOWN SHALL REMAIN UNLESS OTHERWISE NOTED.
- MAINTAIN SERVICE TO ALL EXISTING DEVICES TO REMAIN.
- REVISE PANEL DIRECTORIES TO SUIT CHANGES (TYPED).

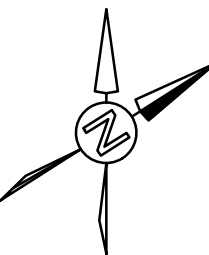
SPECIFIC RENOVATION NOTES

- 1 INDICATES APPROXIMATE LOCATION OF INCOMING SERVICES.
- 2 INDICATES APPROXIMATE LOCATION OF NEW MECHANICAL ROOM.
- 3 CONNECT TO EXISTING BRANCH CIRCUIT WIRING AND CONTROLS MAINTAINED FROM DEMOLITION PHASE.
- 4 INDICATED FIXTURES CONTROLLED VIA CONTACTOR AND TIMECLOCK LOCATED IN MECHANICAL ROOM. REFER TO FLOOR PLANS AND DISTRIBUTION RISER FOR DETAILS.
- 5 INDICATES APPROXIMATE LOCATION OF EXISTING ELECTRICAL ROOM.
- 6 INDICATES APPROXIMATE LOCATION OF EXISTING HYDRO POLES AND OVERHEAD WIRES.
- 7 INDICATED LIGHT FIXTURE INSTALLED WITHIN CANOPY. REFER TO ARCHITECTURAL DRAWINGS FOR DETAILS.
- 8 INDICATES ROUGH-IN FOR FUTURE ELECTRIC VEHICLE CHARGING STATION. PROVIDE EV CHARGER PAD AND CAP CONDUIT ABOVE GRADE.
- 9 PROVIDE HEAT TRACE AS SHOWN. ROOF CLIPS TO BE LAID OUT AND USE SILICONE ADHESIVE TO HOLD IN PLACE. ADHESIVE TO BE EQUAL TO SPEED BONDER CAT.#H3300, H4800; PLEXUS MA300,310; OR MOMENTIVE PERFORMANCE MATERIALS RTZ167. ADHESIVE IS TO BE CONFIRMED WITH LANDLORD'S ROOFING CONTRACTOR PRIOR TO INSTALLATION. PROVIDE TERMINATION KITS AS REQUIRED, REFER TO DETAIL H/E105 FOR FURTHER INFORMATION.

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PROJECT NORTH



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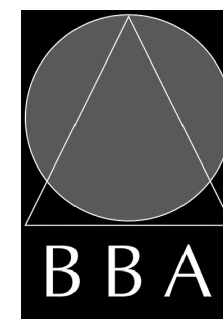
PROJECT:

**MILL COURTLAND
COMMUNITY CENTRE
ADDITION**

216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:

**SITE PLAN-
RENOVATION**



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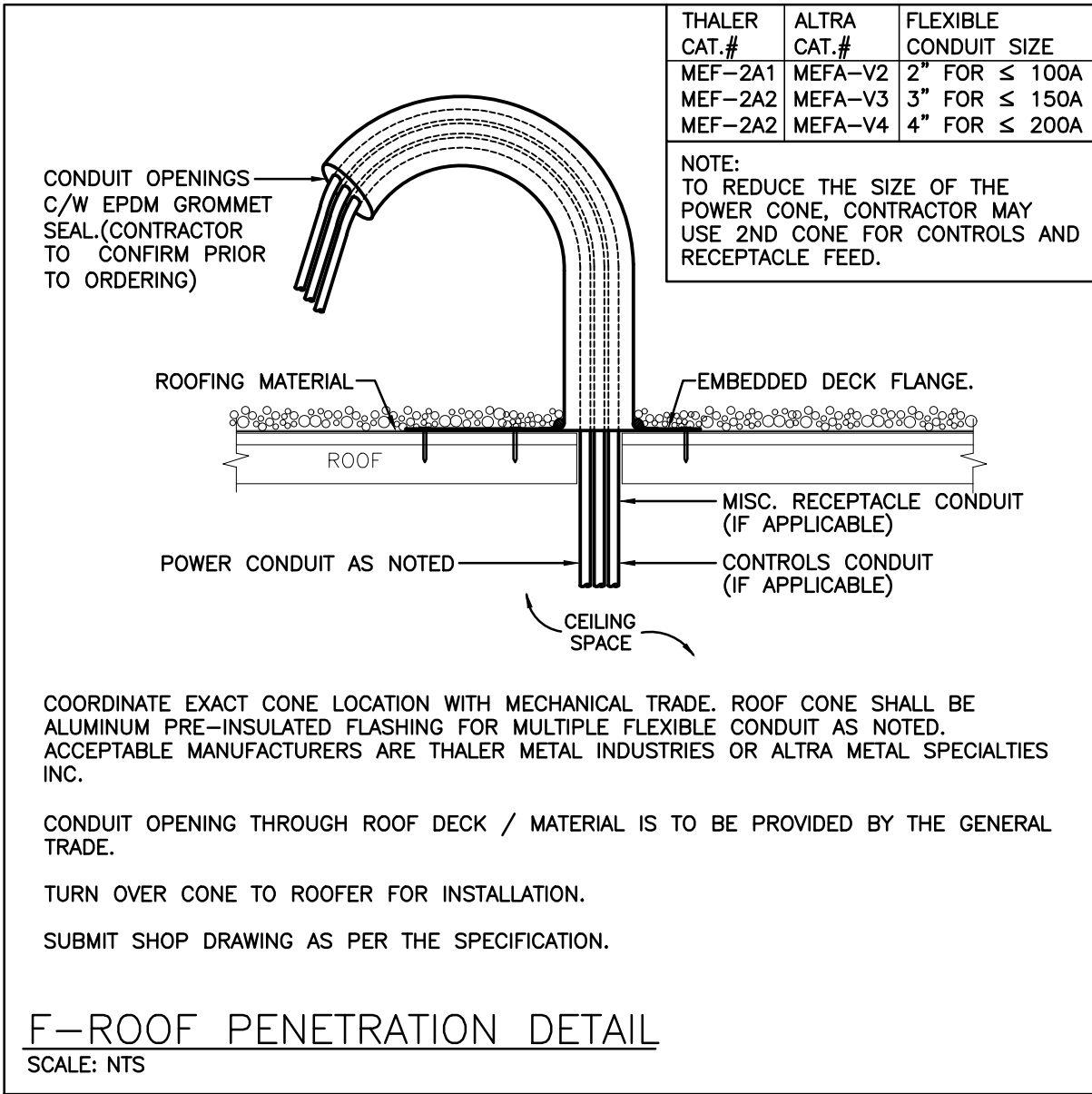
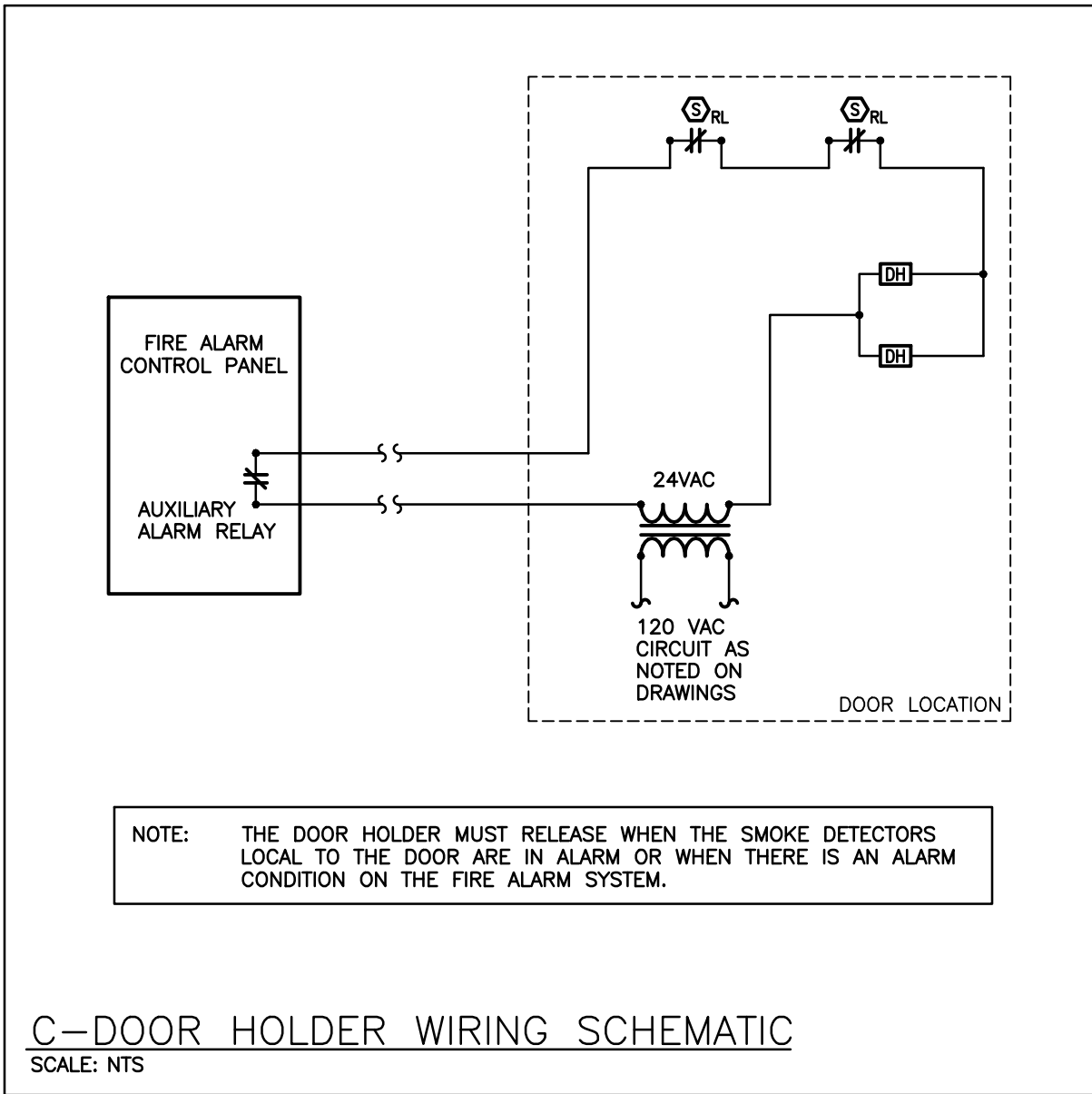
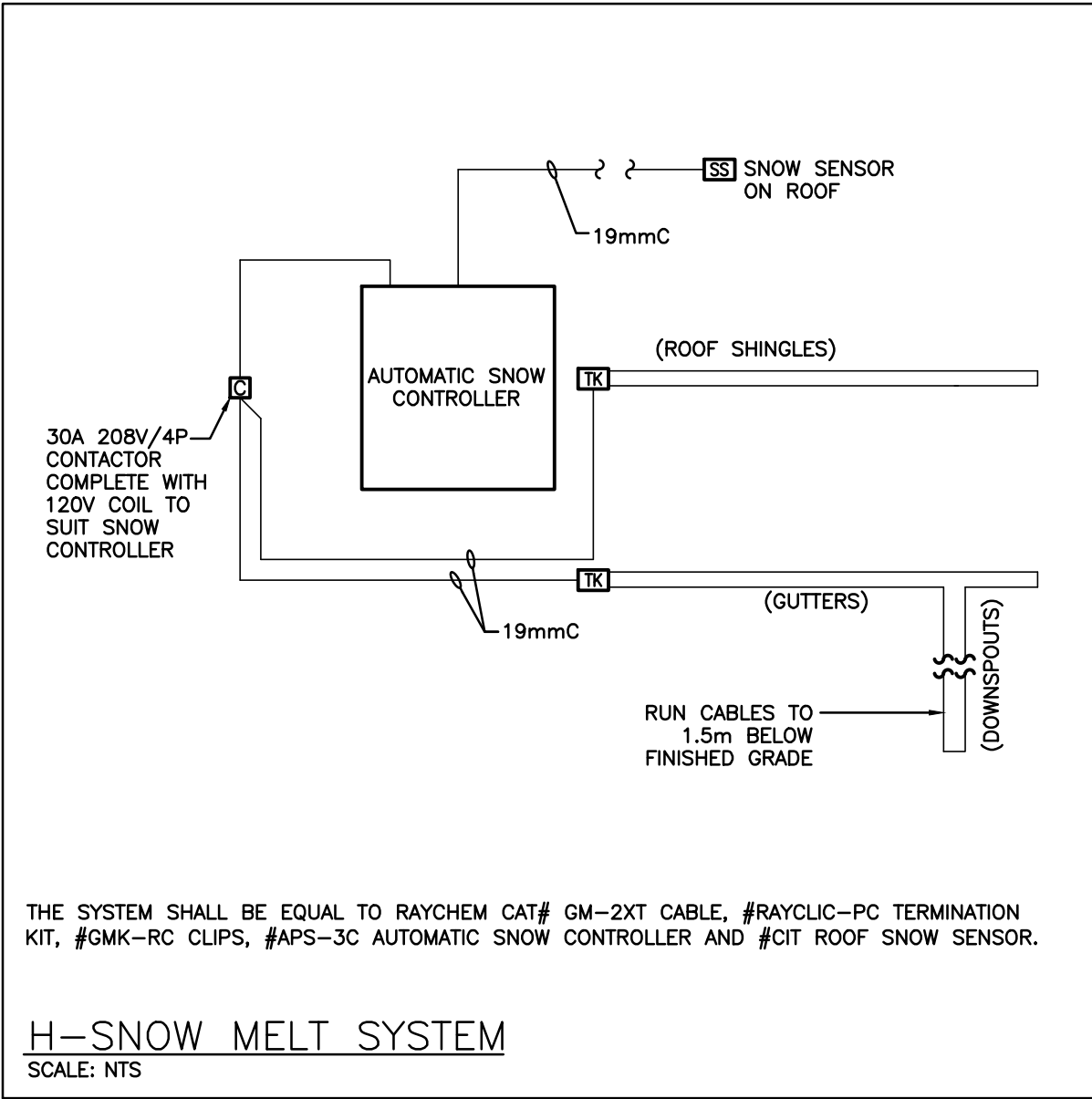
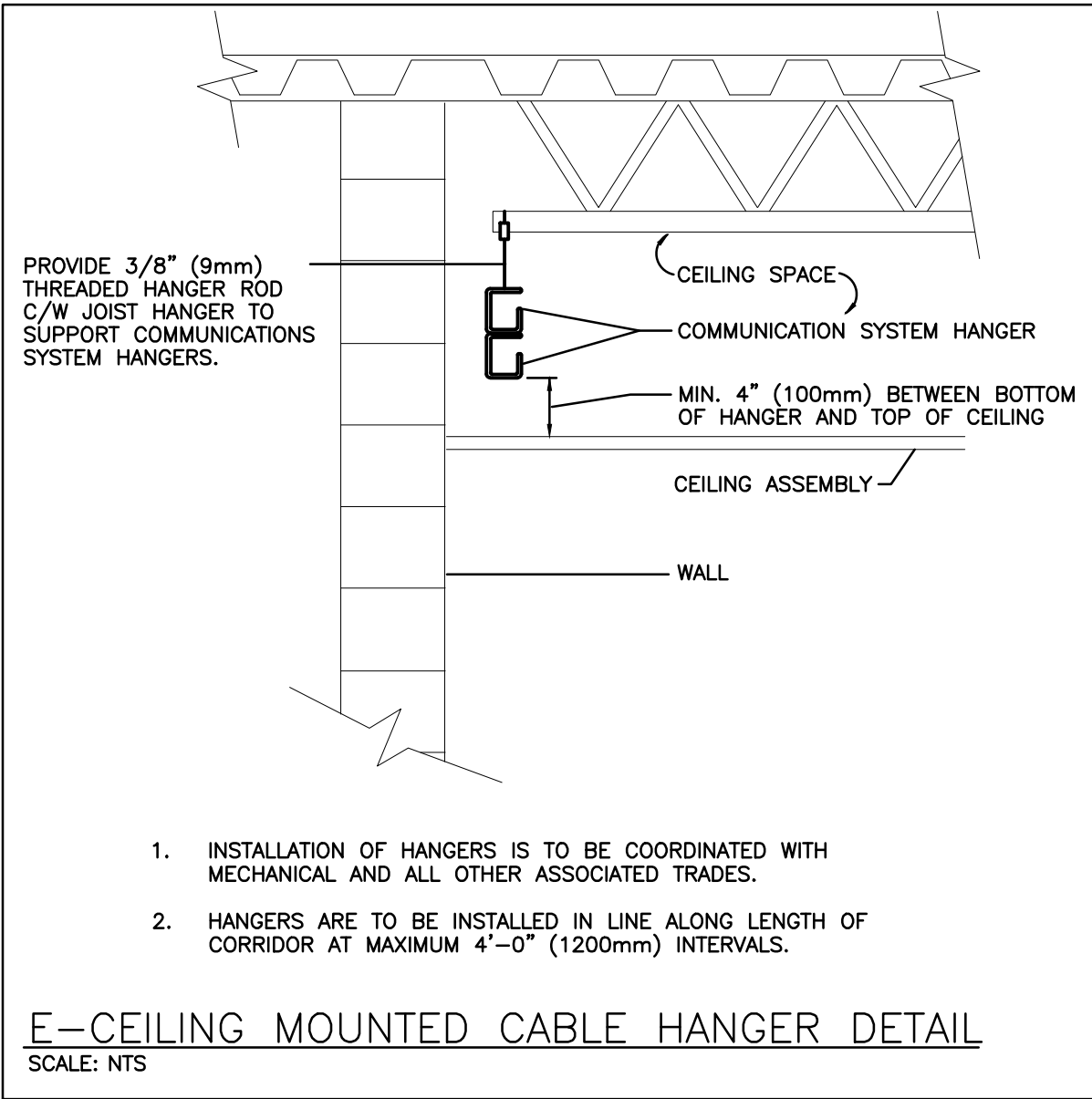
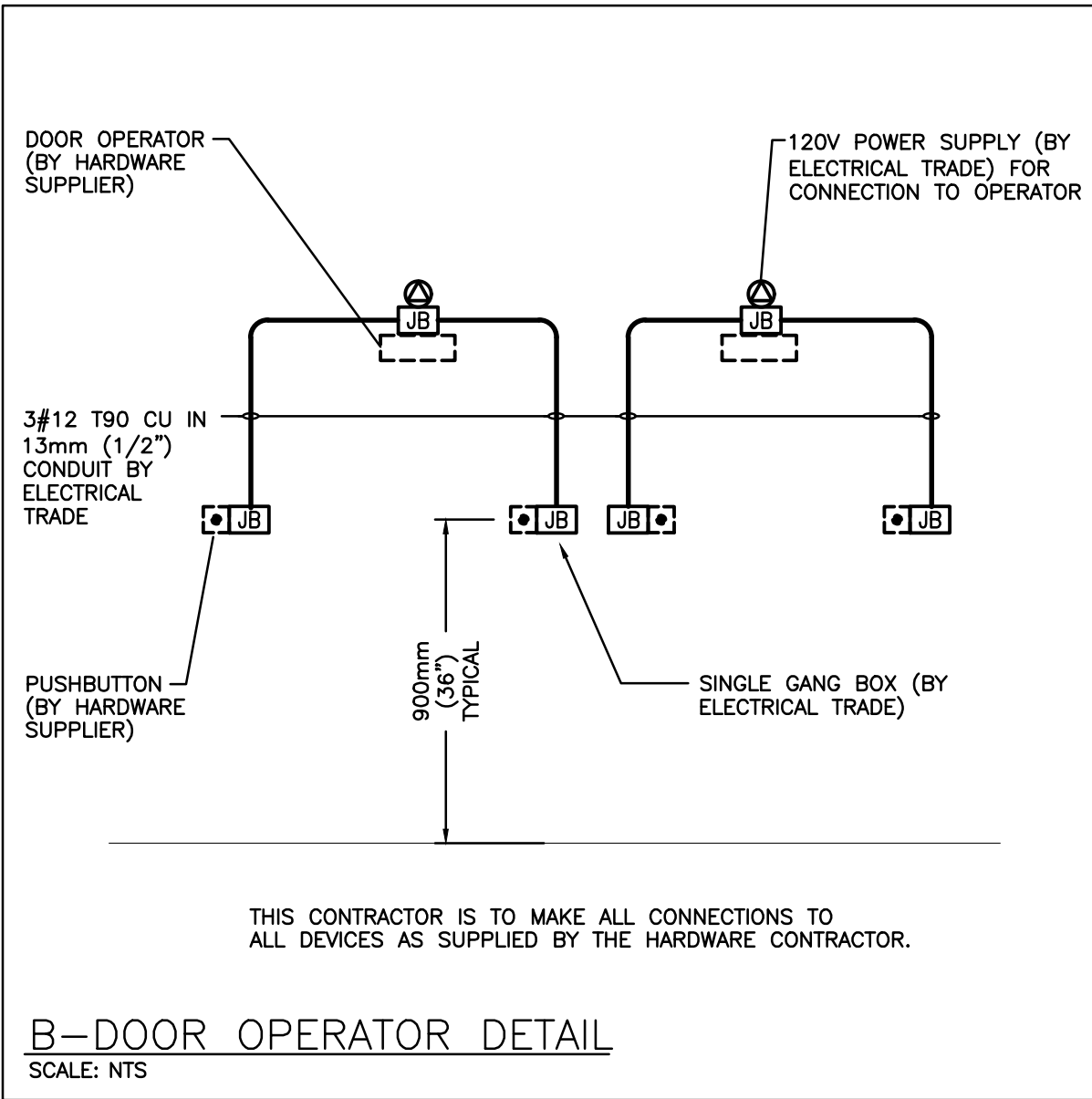
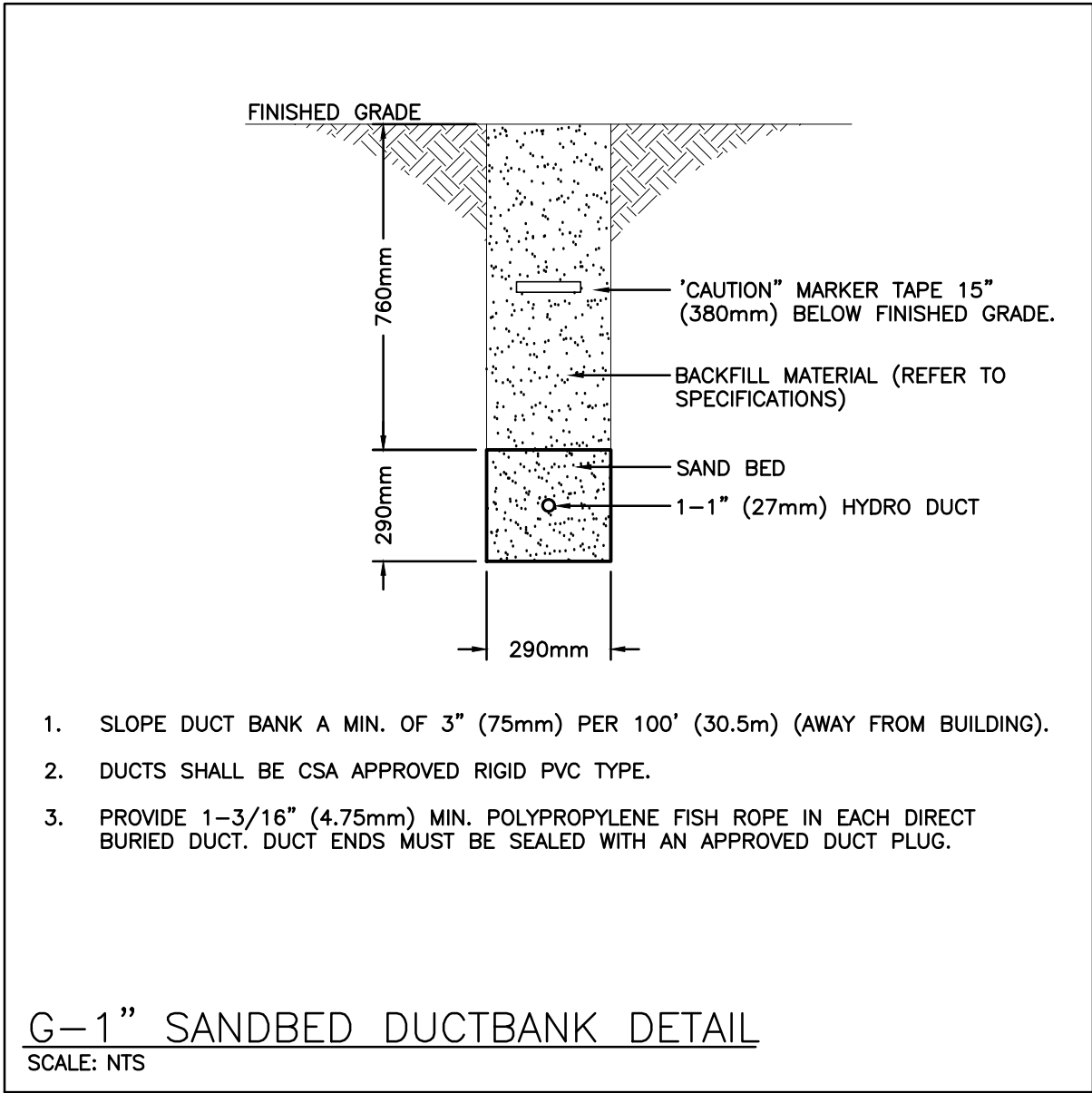
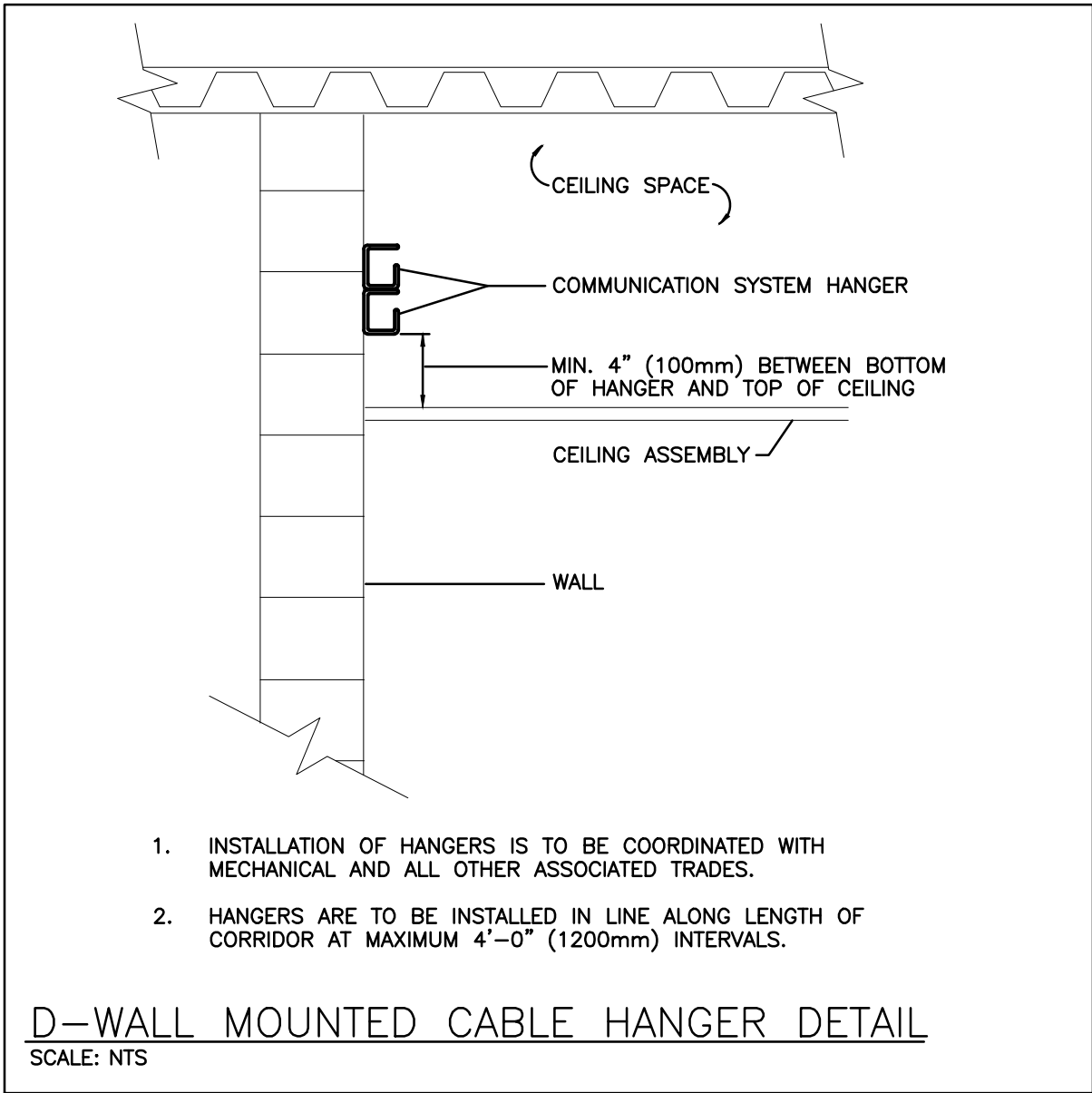
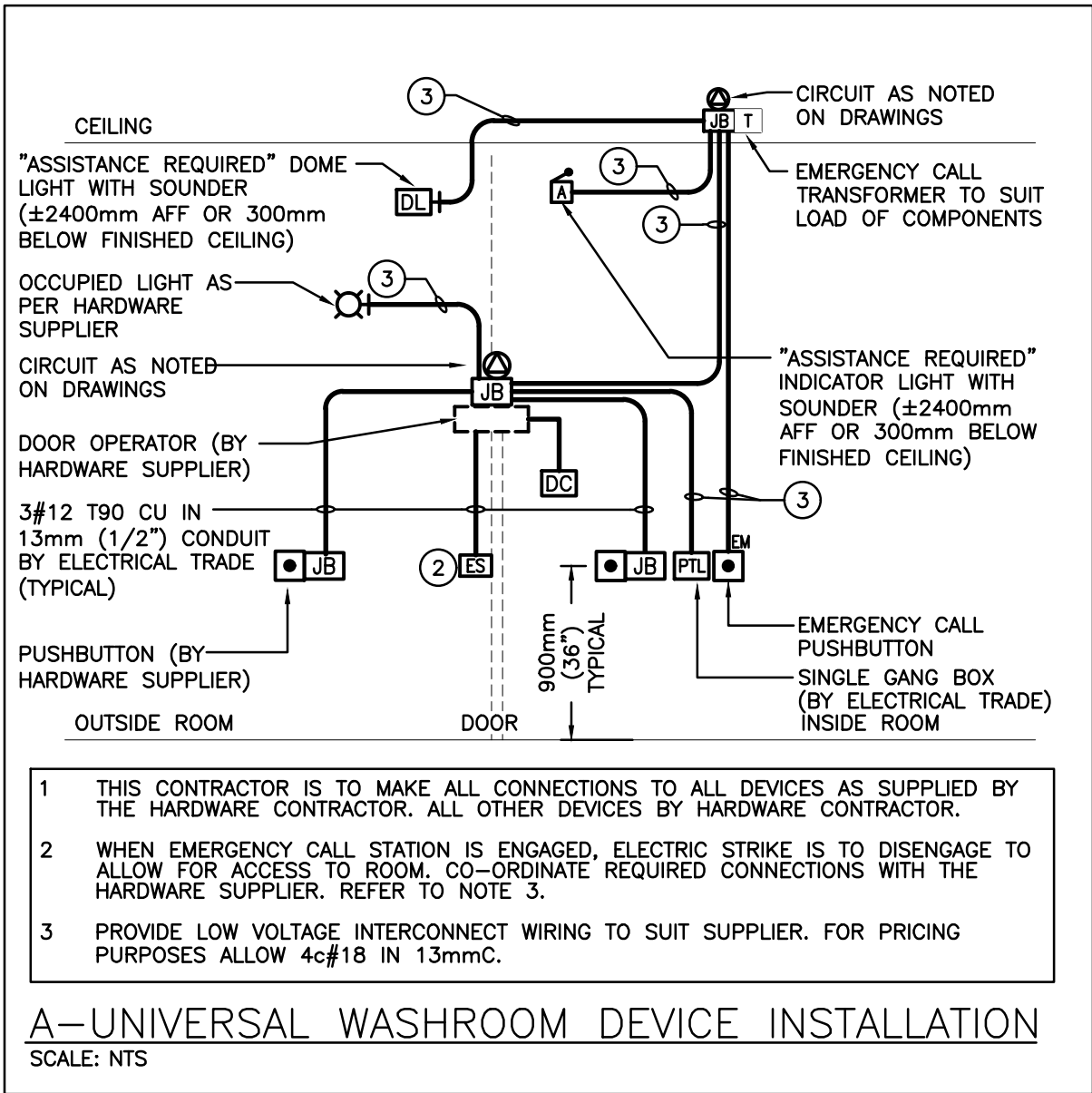
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DRAWING NO:

E103

PARTIAL SITE PLAN-RENOVATION
SCALE: 1:150



ELECTRICAL SYMBOLS		NOTE: ALL SYMBOLS MAY NOT BE USED	
LIGHTING		POWER	
	LIGHT FIXTURE TYPE AS INDICATED		WALL MOUNTED RECEPTACLE (15A-120V)
	COMBINATION EMERGENCY/EXIT TYPE AS INDICATED (EM-X INDICATES BATTERY UNIT TYPE, DC-X INDICATES DC CIRCUIT, AND X-X INDICATES AC SOURCE CIRCUIT)		WALL MOUNTED T-SLOT RECEPTACLE (20A-120V)
	CEILING OR WALL MOUNTED LIGHT FIXTURE TYPE AS INDICATED		T-SLOT RECEPTACLE MTD. ABOVE COUNTER (20A-120V)
	POLE MOUNTED LIGHT FIXTURE		RECEPTACLE MTD. ABOVE COUNTER S=SPLIT (15A-120V)
	WALL MOUNTED EXIT LIGHT SHADING INDICATES FACE		SPECIAL RECEPTACLE
	CEILING MOUNTED EXIT LIGHT ARROWS DENOTE DIRECTION SHADING INDICATES FACE		DIRECT CONNECTION
	SINGLE OR TWIN EMERGENCY LIGHTING FIXTURE		FLOOR BOX C/W DEVICES AS NOTED (REFER TO SPECIFICATIONS)
	BATTERY UNIT WITH INTEGRAL EMERGENCY FIXTURE (EM-X INDICATES BATTERY UNIT TYPE, DC-X INDICATES DC CIRCUIT, AND X-X INDICATES AC SOURCE CIRCUIT)		JUNCTION BOX
	SINGLE POLE SWITCH (3=3 WAY, 4=4 WAY, P=PILOT LIGHT, K=KEYED, DM=DIMMER, M=MOTOR RATED)		PANEL AS INDICATED
	OCCUPANCY SENSOR (PASSIVE)		FUSED DISCONNECT
	CEILING MOUNTED MOTION SENSOR		UNFUSED DISCONNECT
	DIGITAL ROOM CONTROLLER		TIME CLOCK
	ANALOG POWER PACK		DESTRATIFICATION FAN
FIRE ALARM			SURFACE RACEWAY C/W DEVICES AS NOTED (REFER TO SPECIFICATIONS)
	HEAT DETECTOR (135 DEGREE RATE OF RISE AND FIXED TEMPERATURE)		HAND DRYER
	SMOKE DETECTOR (RL=RELAY BASE)		PUSH-BUTTON STATION (QUANTITY OF BUTTONS AS PER PLANS)
	PULLSTATION		TRANSFORMER
	ALARM STROBE		ELECTRIC VEHICLE CHARGER ROUGH-IN
	COMBINATION HORN/STROBE		SNOW MELT TERMINATION KIT
	FIRE SMOKE DAMPER		SNOW MELT SNOW SENSOR
COMMUNICATIONS		SECURITY	
	SINGLE WALL MOUNTED TELEPHONE OUTLET ROUGH-IN C/W 3/8" (13mm) C TO CABLE MANAGEMENT SYSTEM.		SECURITY DETECTOR (SURFACE MOUNTED)
	COMBINATION SINGLE VOICE / SINGLE DATA OUTLET ROUGH-IN UNLESS OTHERWISE NOTED C/W 1" (27mm) C TO CABLE MANAGEMENT SYSTEM.		SECURITY KEYPAD (INSTALL 1100mm AFF) C/W 19mmC TO NEAREST SECURITY JUNCTION BOX
	WIRELESS ACCESS POINT ROUGH-IN. PROVIDE 3/4" (21mm) C TO CABLE MANAGEMENT SYSTEM		DOOR CONTACT C/W 19mmC TO NEAREST SECURITY JUNCTION BOX (REFER TO DETAIL)
	SINGLE DATA OUTLET ROUGH-IN C/W 3/4" (21mm) C TO CABLE MANAGEMENT SYSTEM.		CEILING MOUNTED CAMERA
	HANGER SYSTEM (REFER TO DETAILS)	ACCESS CONTROL	
	CEILING MOUNTED SPEAKER		MAG LOCK
	MICROPHONE OUTLET		ELECTRIC STRIKE, CONFIRM ROUGHIN WITH DOOR HARDWARE.
	AUXILIARY ROUGH-IN FOR USE AS NOTED.		"PUSH-TO-LOCK" BUTTON
GENERAL			EMERGENCY PUSH BUTTON STATION
ER	INDICATED EXISTING ITEM TO REMAIN		"ASSISTANCE REQUIRED" DOME LIGHT WITH SOUNDER
D	INDICATES EXISTING ITEM TO BE DELETED		"ASSISTANCE REQUIRED" INDICATOR LIGHT WITH SOUNDER
R	INDICATES EXISTING ITEM TO BE RELOCATED/IN RELOCATED POSITION	ELECTRIC HEAT	
WG	WIREGUARD		BASEBOARD ELECTRIC HEATER (TYPE AS INDICATED)
GF	GROUND FAULT		FAN FORCED ELECTRIC HEATER (TYPE AS INDICATED)
WP	WEATHERPROOF		UNIT HEATER (TYPE AS INDICATED)
TR	TAMPER RESISTANT	STANDARD CIRCUIT LABELING	
CLG	CEILING MOUNTED	POWER PANEL LABEL CIRCUIT INDICATION SWITCH LEG (IF APPLICABLE)	
	NOTE INDICATOR	A-1-1	
	MECHANICAL ITEM NO.		

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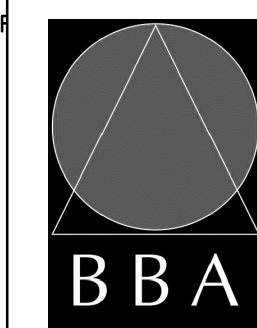
PROJECT:

MILL COURTLAND COMMUNITY CENTRE ADDITION

216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:

DETAILS & LEGEND



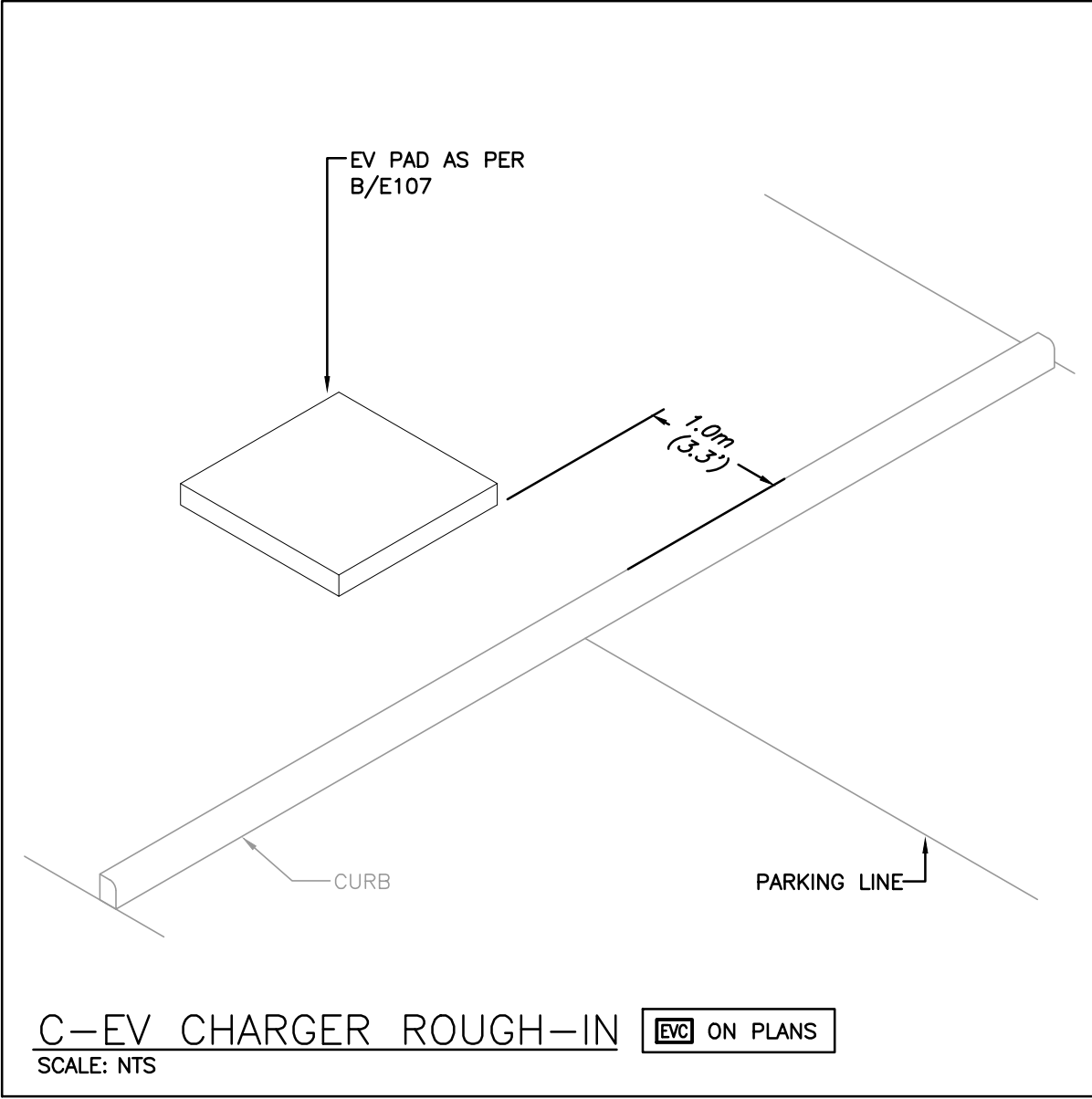
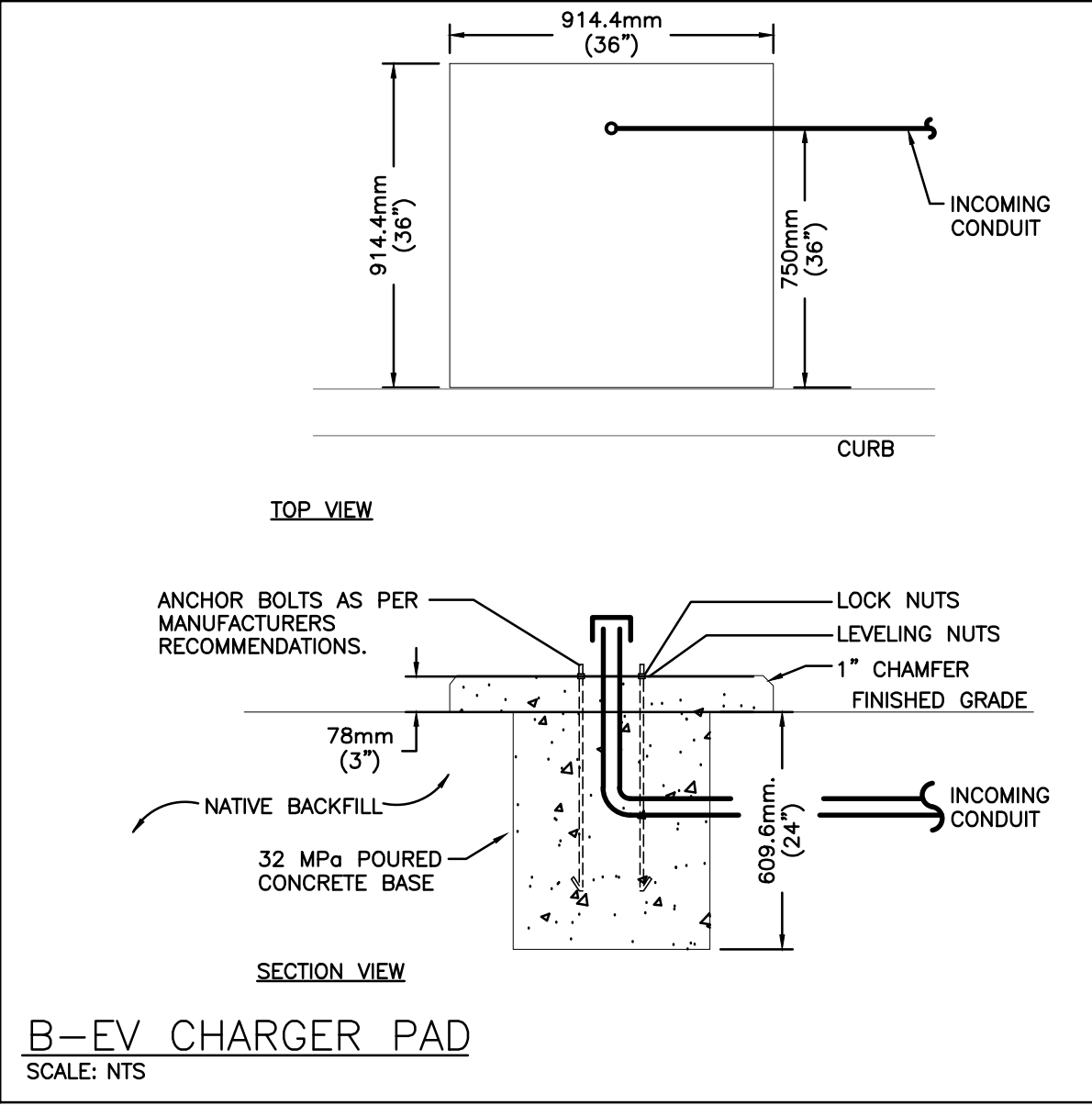
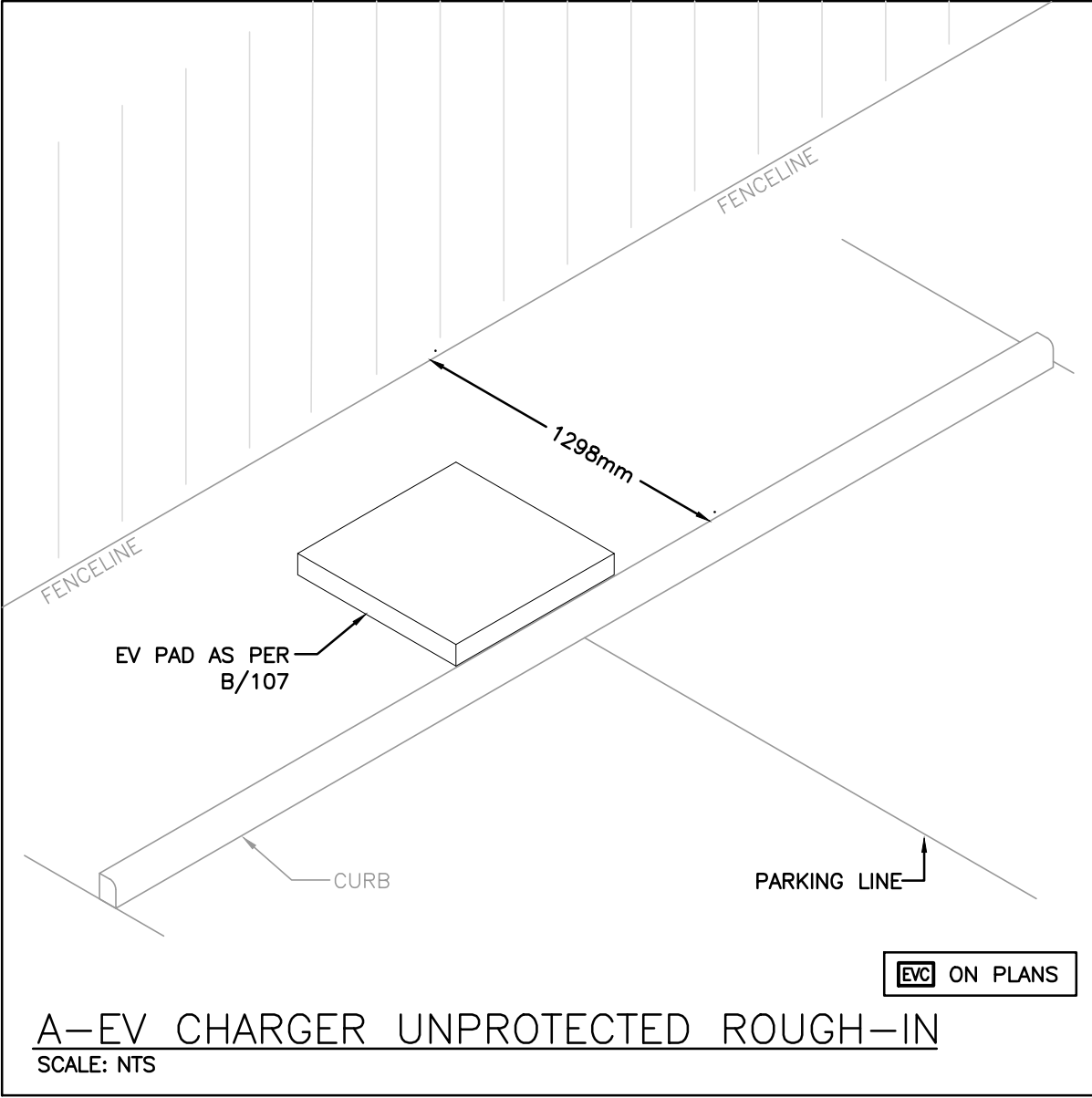
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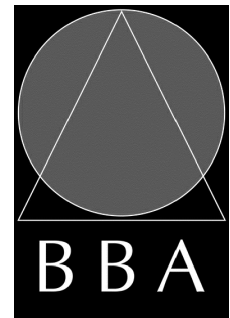
PROJECT:

**MILL COURTLAND
COMMUNITY CENTRE
ADDITION**

216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:

DETAILS

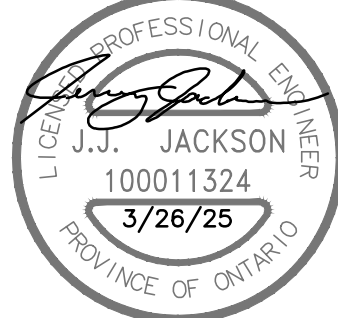


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DESIGN BY:
CM

DOC. CONTROL:
DATE:

DRAWN BY:
DV

% COMPLETE:

CHECKED BY:
JL

INITIAL:

DATE:
MAY 2024

SCALE:
AS NOTED

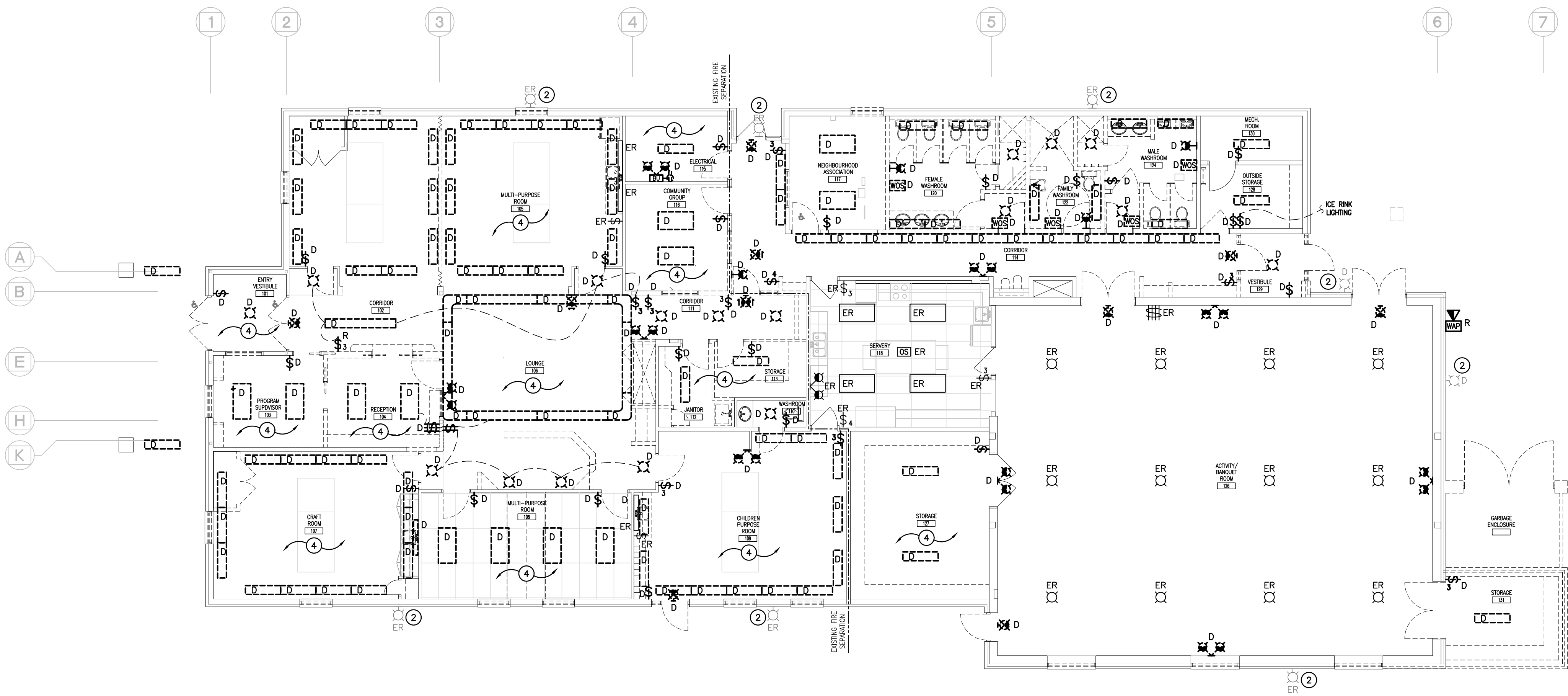
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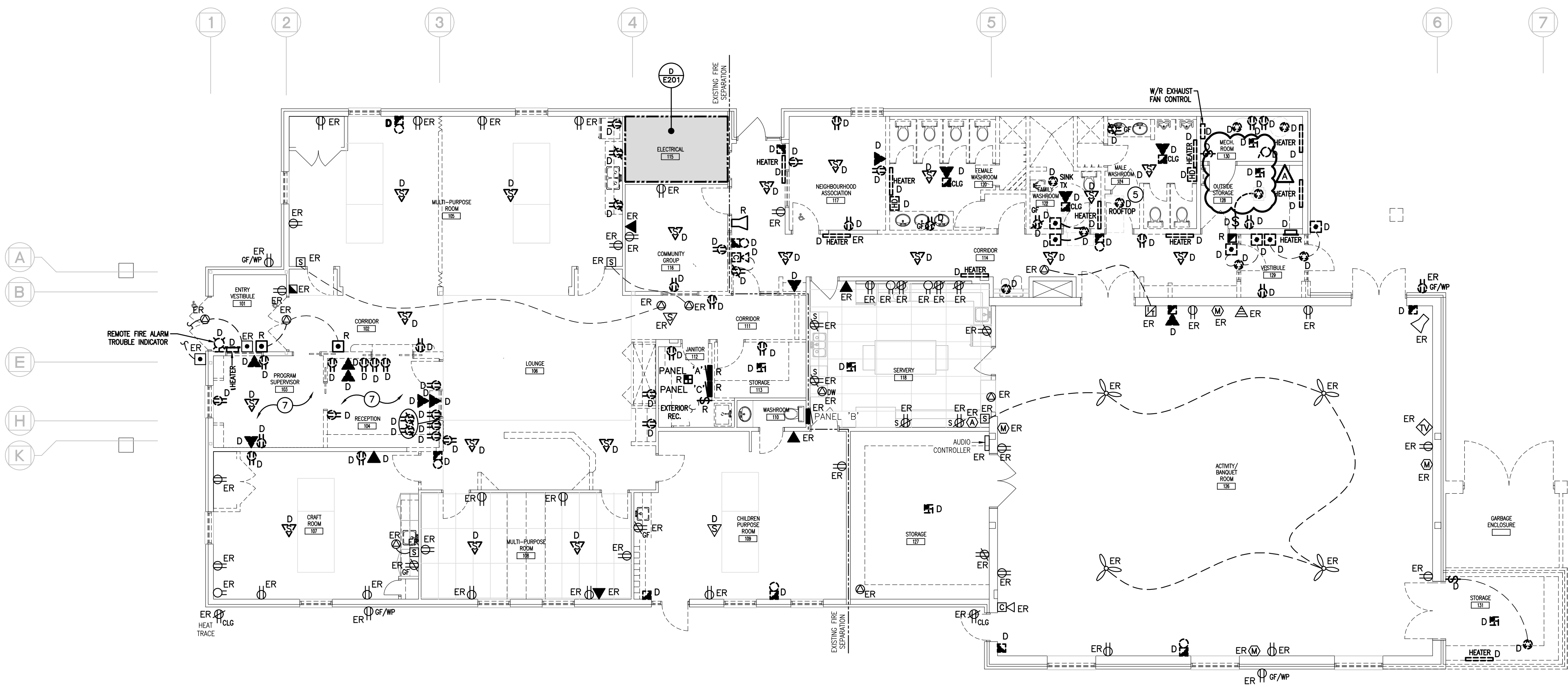
24015

DRAWING NO:

E107



A-GROUND FLOOR PLAN-DEMOLITION-LIGHTING
SCALE: 1:100



B-GROUND FLOOR PLAN-DEMOLITION-POWER & SYSTEMS
SCALE: 1:100

GENERAL DEMOLITION NOTES

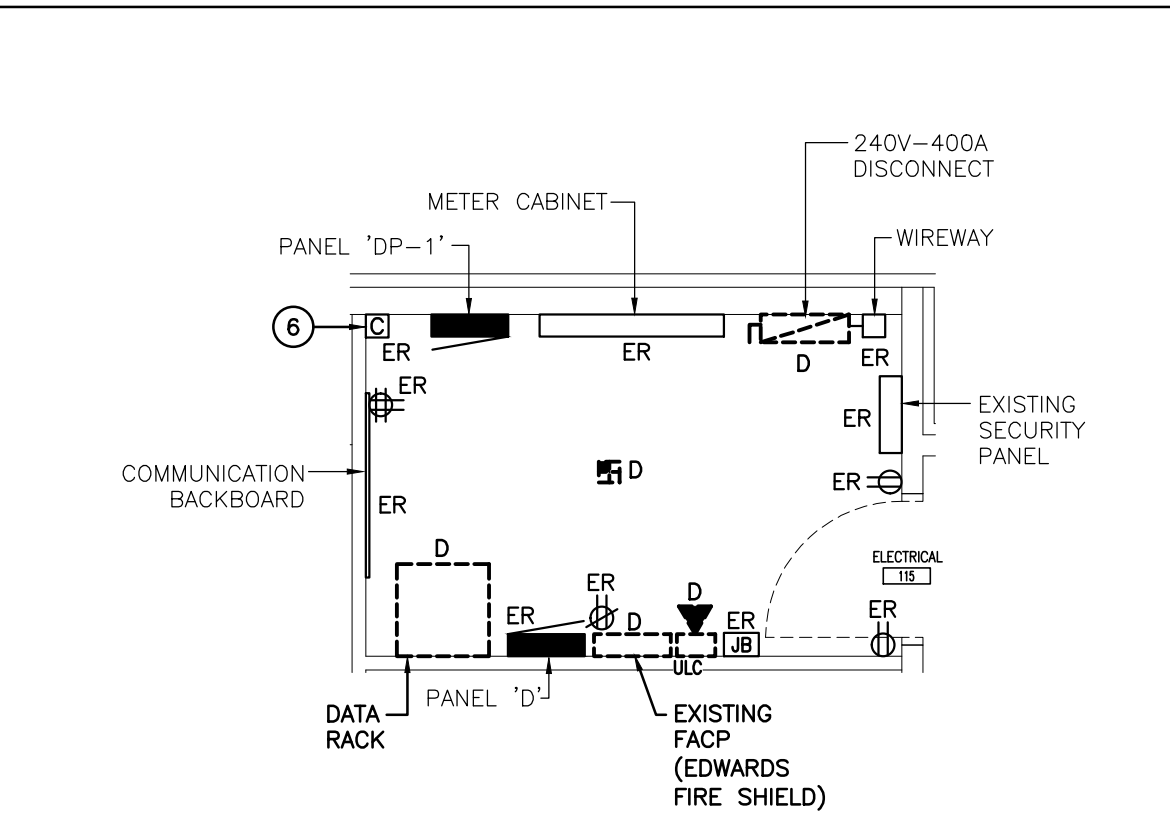
- 'ER' DENOTES EXISTING ITEM TO REMAIN.
- EXISTING ELECTRICAL EQUIPMENT NOT SHOWN SHALL REMAIN UNLESS NOTED OTHERWISE.
- 'R' INDICATES EXISTING ITEM TO BE RELOCATED. REFER TO RENOVATION DRAWINGS AND RELOCATE DEVICE AND WIRING TO SUIT. UNLESS OTHERWISE NOTED.
- 'D' INDICATES EXISTING ITEM TO BE DELETED. UNLESS OTHERWISE NOTED DISCONNECT AND REMOVE NOTED DEVICE AND WIRING BACK TO SOURCE.

SPECIFIC DEMOLITION NOTES

1. THROUGHOUT THE BUILDING, REMOVE ALL P.A. SYSTEM SPEAKERS AND CONTROL DEVICES COMPLETE. PATCH CEILING TO SATISFACTION OF OWNER AND CONSULTANT.
2. REFER TO SITE PLAN FOR EXTERIOR SITE LIGHTING DETAILS.
3. ALL HEAT DETECTORS IN ATTIC SPACE TO BE DEMOLISHED AND REPLACED WITH NEW. CONFIRM EXACT LOCATION OF HEAT DETECTORS IN ATTIC SPACE ON SITE.
4. REMOVE LIGHTING DEVICES IN THIS AREA BUT MAINTAIN BRANCH CIRCUIT WIRING FOR RECONNECTION IN RENOVATION PHASE, UNLESS OTHERWISE NOTED.
5. INDICATES ROOFTOP MECHANICAL UNIT BEING REMOVED BY MECHANICAL CONTRACTOR. THIS CONTRACTOR IS TO DISCONNECT AND REMOVE FEEDER BACK TO SOURCE. DISCONNECT AND REMOVE ALL CONTROL DEVICES. LABEL SOURCE BREAKER AS SPARE.
6. INDICATES EXISTING EXTERIOR LIGHTING CONTROL RELAY TO BE REWORKED TO SUIT NEW EXTERIOR LIGHTING CONTROL SCHEME IN RENOVATION PHASE.
7. REMOVE POWER & SYSTEMS DEVICES IN THIS AREA BUT MAINTAIN BRANCH CIRCUIT WIRING FOR RECONNECTION IN RENOVATION PHASE, UNLESS OTHERWISE NOTED.

C-ATTIC FLOORPLAN

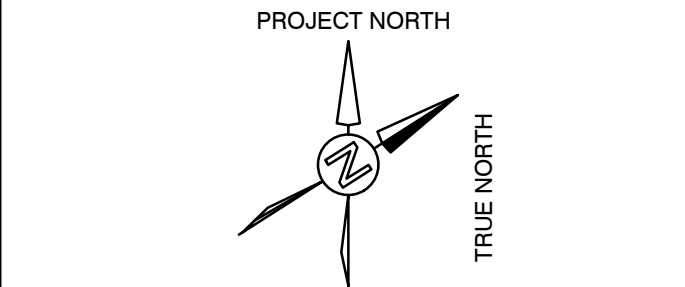
SCALE: 1:400



D-ELEC. RM 115 ENLARGED
SCALE: 1:50

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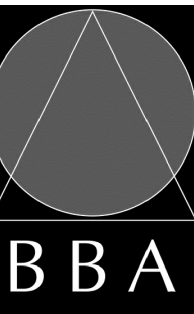


NO.	REVISIONS	DATE	BY
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PROJECT:
**MILL COURTLAND
COMMUNITY CENTRE
ADDITION**
216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:
**GROUND FLOOR PLANS-
DEMOLITION**



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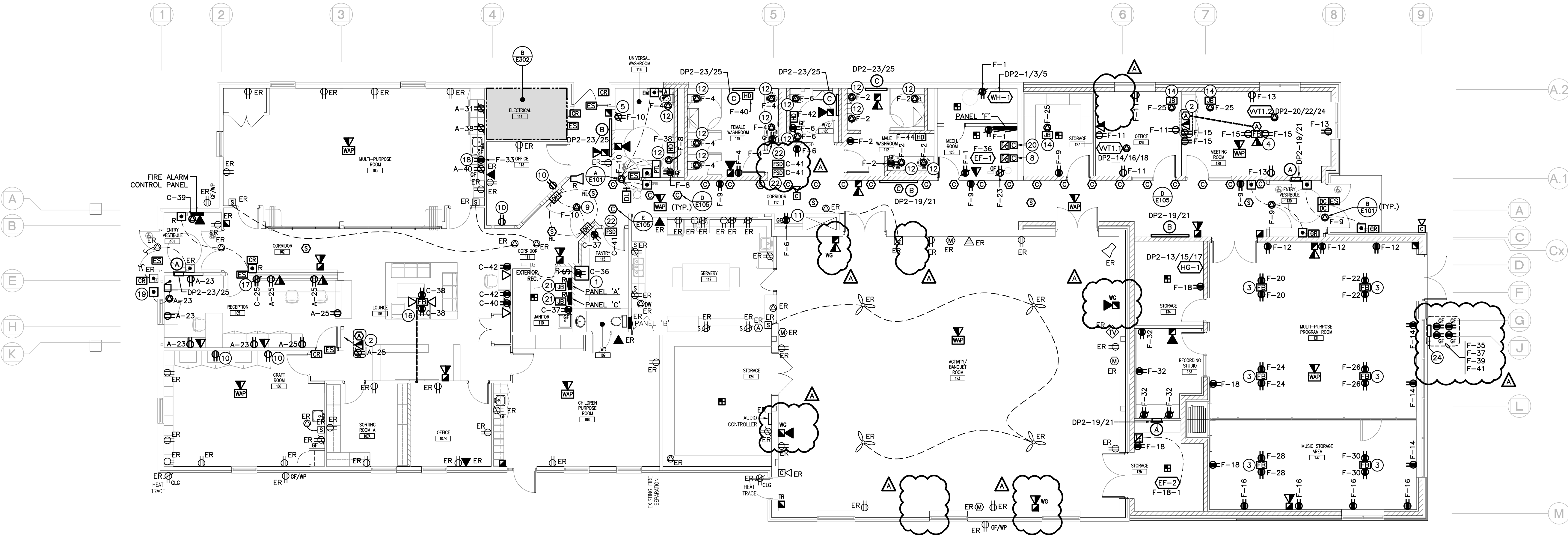
PROJECT NO:
24015
DRAWING NO:
E201

GENERAL RENOVATION NOTES

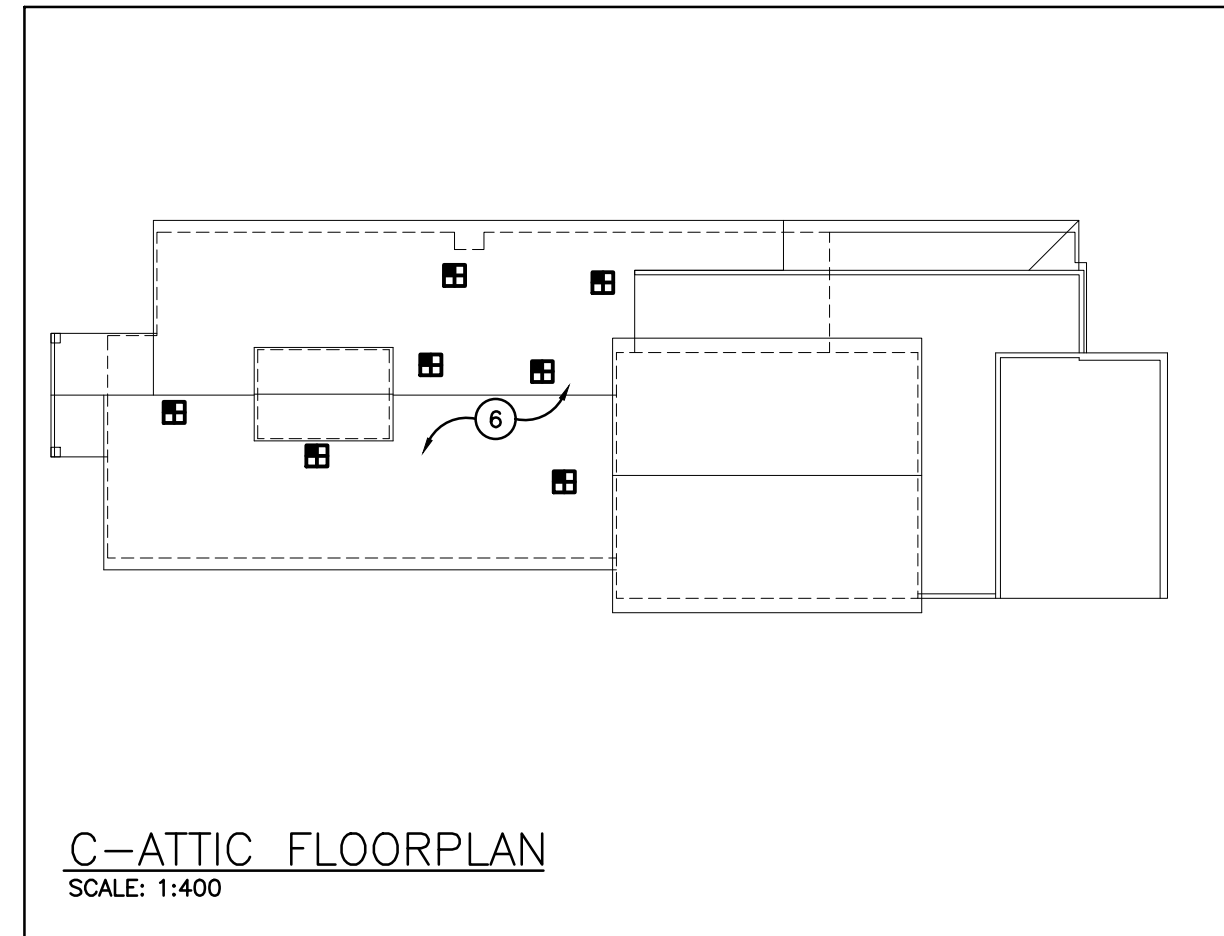
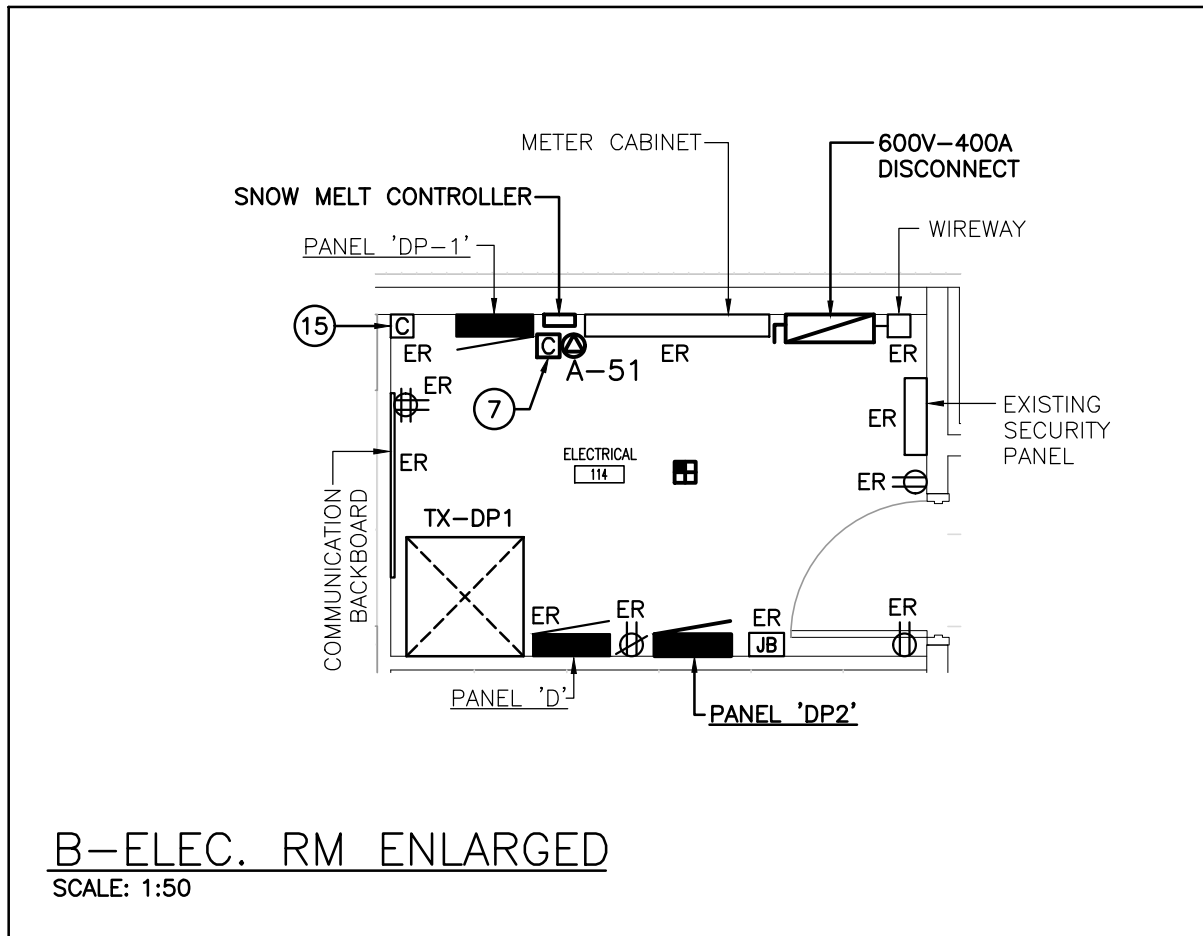
- 'ER' INDICATES EXISTING ITEM TO REMAIN.
- 'R' INDICATES EXISTING ITEM IN RELOCATED POSITION.
- ALL DEVICES SHOWN ARE NEW UNLESS OTHERWISE NOTED.
- EXISTING ELECTRICAL EQUIPMENT NOT SHOWN SHALL REMAIN UNLESS OTHERWISE NOTED.
- MAINTAIN SERVICE TO ALL EXISTING DEVICES TO REMAIN.
- REVISE PANEL DIRECTORIES TO SUIT CHANGES (TYPED).

SPECIFIC RENOVATION NOTES

- 1 INDICATES NEW DATA RACK AND RECEPTACLE MOUNTED HIGH ON THE WALL.
- 2 INDICATES APPROXIMATE LOCATION FOR TV AND A/V AUXILIARY OUTLET AND ASSOCIATED POWER RECEPTACLE. COORDINATE FINAL LOCATION AND HEIGHT WITH ARCHITECT PRIOR TO ROUGH-IN.
- 3 INDICATES MULTIGANG FLOOR BOX CONTAINING TWO (2) RECEPTACLES. PROVIDE 1-21mmC FOR BRANCH CIRCUIT WIRING.
- 4 INDICATES MULTIGANG FLOOR BOX CONTAINING RECEPTACLE, DATA, AND AUXILIARY PORT. PROVIDE 1-21mmC FOR BRANCH CIRCUIT WIRING. PROVIDE 1-21mmC TO NEAREST CABLE MANAGEMENT SYSTEM FOR DATA ROUGH-INS. PROVIDE 1-35mmC FROM FLOORBOX TO BOTTOM OF AUXILIARY PORT ROUGH-IN AT LOCAL MEDIA WALL. CONFIRM EXACT LOCATION WITH ARCHITECT PRIOR TO ROUGH-IN.
- 5 INDICATES RECEPTACLE DEDICATED TO CHANGE TABLE. COORDINATE EXACT LOCATION WITH ARCHITECTURAL DRAWINGS PRIOR TO ROUGH-IN.
- 6 ALL HEAT DETECTORS IN ATTIC SPACE TO BE DEMOLISHED AND REPLACED WITH NEW. CONFIRM EXACT LOCATION OF HEAT DETECTORS IN ATTIC SPACE ON SITE.
- 7 INDICATES SNOW MELT CONTROLLER AND ASSOCIATED CONTACTOR. REFER TO DETAIL H/E105 FOR DETAILS.
- 8 INDICATES 20A-1P CONTACTOR CONTROLLING F-31 EXTERIOR BACK-LIGHTING. CONTACTOR IS TO BE C/W 24V INTEGRAL TRANSFORMER CONTROL, HAND/OFF/AUTO SELECTOR SWITCH, AND RED PILOT LIGHT. PROVIDE TIMECLOCK FOR AUTOMATIC CONTROL. PROVIDE LAMACOID AND LABEL "BACKLOT LIGHT". REFER TO DISTRIBUTION RISER AND SITE PLAN FOR DETAILS. COORDINATE FINAL LOCATION ON SITE.
- 9 WITHIN CEILING SPACE PROVIDE STEPDOWN TRANSFORMER (120-24V). REFER TO WIRING SCHEMATIC DETAIL C/E105 AND RUN NOTED CIRCUIT THROUGH TRANSFORMER. THEN RUN 24V CIRCUIT THROUGH AUXILIARY CONTACTS IN FIRE ALARM CONTROL PANEL THEN ONTO RELAY BASE OF SMOKE DETECTOR THEN TO ALL DOOR HOLDERS.
- 10 CONNECT NEW RECEPTACLES TO EXISTING LOCAL RECEPTACLE BRANCH CIRCUITS MAINTAINED FROM DEMOLITION PHASE. EXTEND EXISTING CONDUIT AND WIRING TO SUIT NEW LOCATIONS AS REQUIRED.
- 11 INDICATED RECEPTACLE SHALL BE MOUNTED WITHIN SHROUD OF WATER FILL STATION. COORDINATE EXACT LOCATION AND MOUNTING HEIGHT ON SITE PRIOR TO ROUGH-IN.
- 12 INDICATES 120V CONNECTION TO 24VDC STEP-DOWN TRANSFORMER MOUNTED ABOVE CEILING OR AT HIGH LEVEL FOR AUTOMATIC FUTURE(S). COORDINATE WITH MECHANICAL CONTRACTOR. CONNECT UPSTREAM OF LOCAL GROUND FAULT STYLE RECEPTACLE CIRCUIT.
- 13 INDICATES RECEPTACLE DEDICATED TO R.O. WATER SYSTEM. COORDINATE LOCATION WITH MECHANICAL CONTRACTOR PRIOR TO ROUGH-IN.
- 14 INDICATES 120V POWER CAPPED IN JUNCTION BOX FOR MECHANICAL VLT'S. COORDINATE LOCATION WITH MECHANICAL TRADE PRIOR TO ROUGH-IN.
- 15 INDICATES EXISTING EXTERIOR LIGHTING CONTROL RELAY TO BE REWORKED TO SUIT NEW EXTERIOR LIGHTING CONTROL SCHEME IN RENOVATION PHASE.
- 16 INDICATES MULTI-GANG FLOORBOX CONTAINING TWO RECEPTACLES AND TWO DATA OUTLETS. PROVIDE 1-21mm CONDUIT FOR BRANCH CIRCUIT WIRING. STUB UP 1-21mmC IN FURRED PARTITION WALL FOR DATA ROUGH-INS AS SHOWN. CONFIRM EXACT LOCATION OF FLOORBOX WITH ARCHITECT PRIOR TO ROUGH-IN.
- 17 INDICATES RECEPTACLE AT HIGH LEVEL FOR FUTURE SECURITY MONITOR. COORDINATE EXACT LOCATION AND HEIGHT WITH ARCHITECTURAL DRAWINGS.
- 18 INDICATED RECEPTACLE TO BE MOUNTED BENEATH COUNTERTOP FOR FUTURE MICROWAVE.
- 19 INDICATES 120V CONNECTION TO STEP-DOWN TRANSFORMER MOUNTED ABOVE CEILING OR AT HIGH LEVEL FOR DOORBELL SYSTEM. COORDINATE SECONDARY VOLTAGE WITH SHOP DRAWINGS PRIOR TO ORDERING.
- 20 INDICATES 20A-1P CONTACTOR CONTROLLING F-29 RINK LIGHTING. CONTACTOR IS TO BE C/W 24V INTEGRAL TRANSFORMER CONTROL, HAND/OFF/AUTO SELECTOR SWITCH, AND RED PILOT LIGHT. PROVIDE TIMECLOCK FOR AUTOMATIC CONTROL. PROVIDE LAMACOID AND LABEL "RINK LGT". REFER TO DISTRIBUTION RISER AND SITE PLAN FOR DETAILS. COORDINATE FINAL LOCATION ON SITE.
- 21 INDICATES RELOCATED PANEL. PROVIDE JUNCTION BOX TO EXTEND BRANCH CIRCUIT WIRING TO NEW PANEL LOCATION. PROVIDE TERMINAL STRIPS. BRANCH CIRCUIT WIRING SHALL BE EXTENDED AND MATCHED TO EXISTING WIRING SIZES.
- 22 PROVIDE 120V POWER AND FIRE ALARM CONNECTIONS TO SMOKE/FIRE DAMPER WITH INTEGRAL SMOKE DETECTOR. REFER TO FIRE ALARM SPECIFICATIONS. COORDINATE EXACT LOCATION/CONNECTION REQUIREMENTS WITH MECHANICAL CONTRACTOR. SMOKE/FIRE DAMPER AND ASSOCIATED INTEGRAL SMOKE DETECTOR TO BE PROVIDED AND INSTALLED BY MECHANICAL CONTRACTOR. PROVIDE MONITORING MODULE(S) PER SMOKE/FIRE DAMPER TO 120V POWER SUPPLY CONNECTION TO THE DAMPER ACTUATOR, AND INTEGRAL SMOKE DETECTOR ALARM AS SIGNAL. A TROUBLE CONDITION SHALL BE ACTIVATED DUE TO THE LOSS OF AC POWER AT THE MAIN CONTROL PANEL, CONSISTING OF AUDIBLE AND VISUAL TROUBLE SIGNAL AND ALARM BY OPERATOR.
- 23 INDICATES 16"x16"x8" VEVOR STAINLESS STEEL LOCKABLE WEATHER PROOF BOX (OR APPROVED EQUIVALENT) C/W FOUR (4) RECEPTACLES MOUNTED WITHIN. BOX SHALL BE EQUIPPED WITH HINGED DOOR.

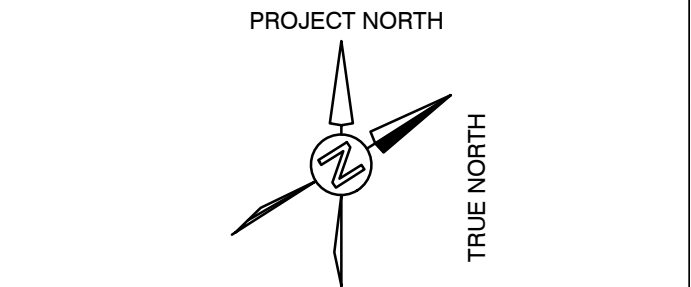


A-GROUND FLOOR PLAN-RENOVATION-POWER & SYSTEMS
SCALE: 1:100



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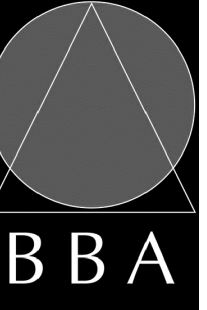


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PROJECT:
**MILL COURTLAND
COMMUNITY CENTRE
ADDENDUM**
216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:
**GROUND FLOOR PLANS-
RENOVATION-
POWER & SYSTEMS**



**BARRY BRYAN
ASSOCIATES**
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Project Managers
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CM
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DV
CHECKED BY:
JL
DATE:
MAY 2024
SCALE:
AS NOTED
FILE:

DOC. CONTROL:
DATE:
% COMPLETE:
INITIAL:

PROJECT NO:
24015

DRAWING NO:
E302

GENERAL DEMOLITION NOTES

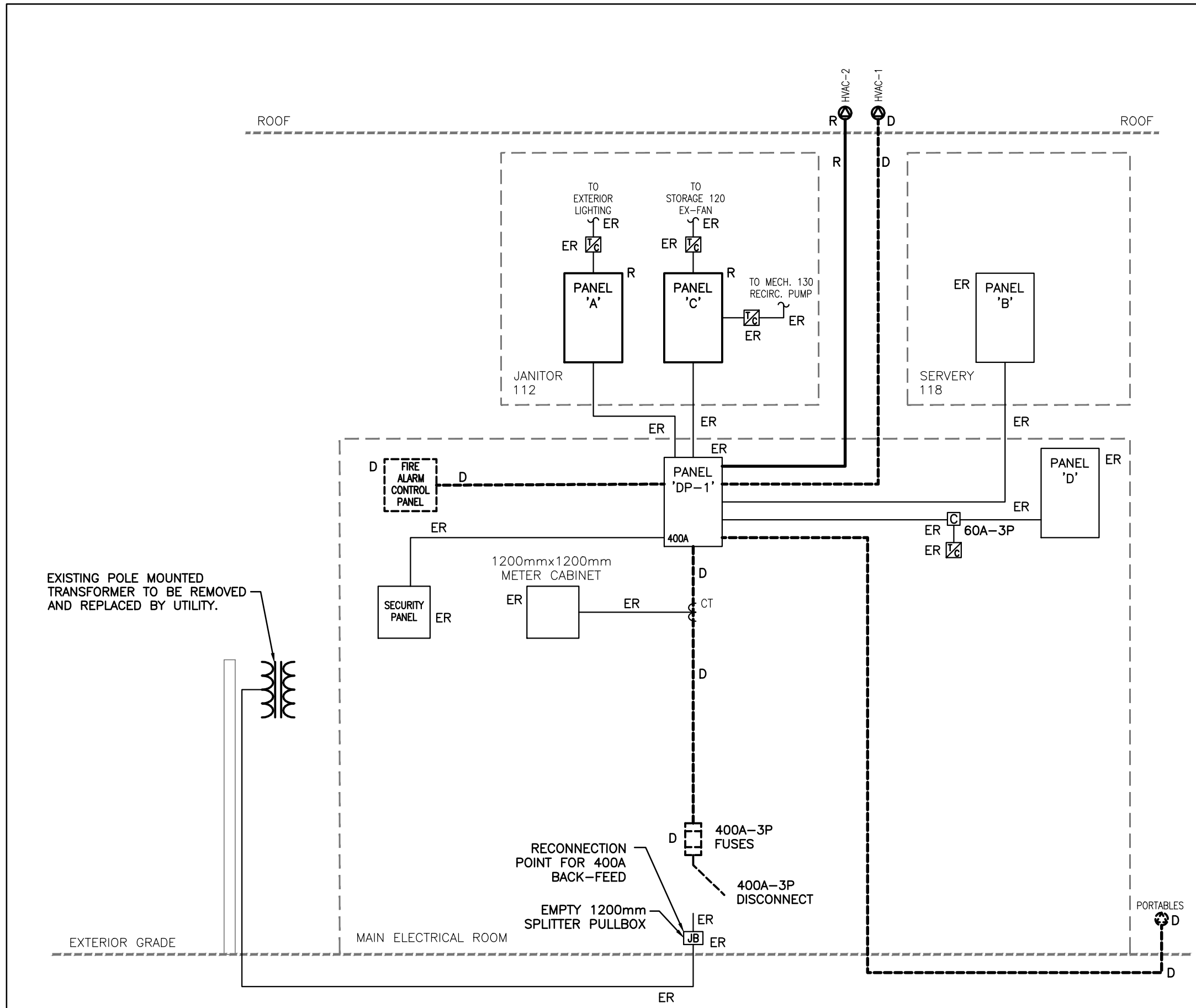
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- 'R' INDICATES EXISTING ITEM TO BE RELOCATED, REFER TO RENOVATION DRAWINGS AND RELOCATE DEVICE AND WIRING TO SUIT, UNLESS OTHERWISE NOTED.
- 'D' INDICATES EXISTING ITEM TO BE DELETED, UNLESS OTHERWISE NOTED DISCONNECT AND REMOVE NOTED DEVICE AND WIRING BACK TO SOURCE.

DISTRIBUTION RISER NOTES

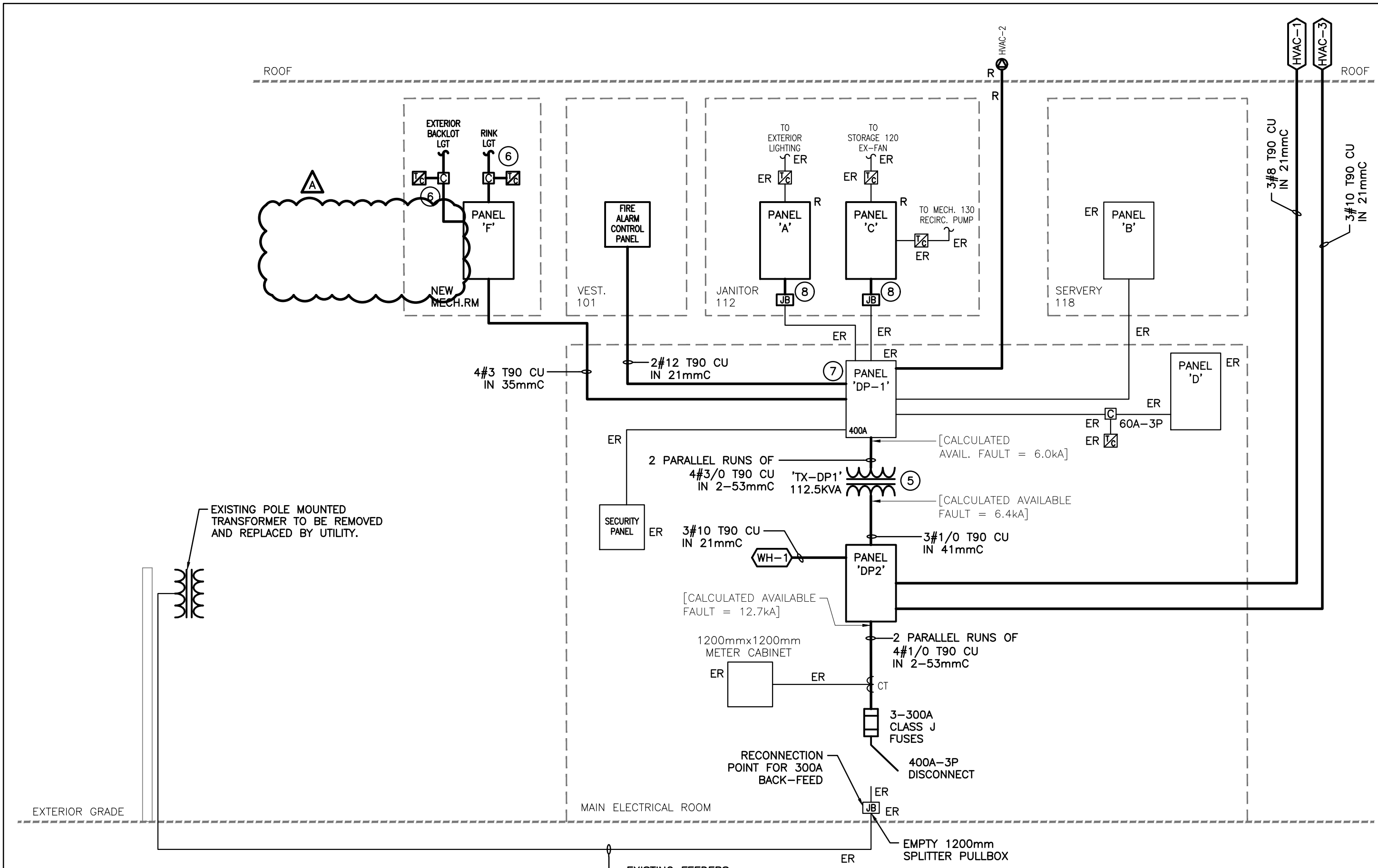
- 1 REFER TO SPECIFICATION FOR INFORMATION REGARDING MOULDED CASE CIRCUIT BREAKERS.
- 2 ALL DISTRIBUTION EQUIPMENT ARE TO BE PROVIDED WITH WARNING LABELS CONFORMING TO THE ONTARIO ELECTRICAL SAFETY CODE RULE #2-308(1),(2)
- 3 INSTALL GROUND WIRE TO SUIT THE ELECTRICAL SAFETY CODE IN ALL CONDUIT.
- 4 ALL LIGHTING CIRCUITS ARE TO BE PROVIDED WITH SEPARATE NEUTRALS. SIZE BRANCH CONDUITS ACCORDINGLY.
- 5 INDICATES TRANSFORMER WITH NAME AND KVA RATING AS NOTED C/W PRIMARY OF 600V 3P 3W, SECONDARY OF 120/208V 3P 4W, K FACTOR OF 1 AND 1/2 MINIMUM OF 3%.
- 6 INDICATES MULTI-POLE CONTACTOR AND TIMELOCK FOR CONTROL OF DEVICES AS INDICATED. REFER TO FLOOR AND SITE PLANS FOR LOCATIONS & DETAILS.
- 7 PAINT INDICATED DEVICE RED TO SUIT THE ELECTRICAL SAFETY CODE.
- 8 INDICATES RELOCATED PANEL, PROVIDE JUNCTION BOX TO EXTEND BRANCH CIRCUIT WIRING TO NEW PANEL LOCATION. PROVIDE TERMINAL STRIPS. BRANCH CIRCUIT WIRING SHALL BE EXTENDED AND MATCHED TO EXISTING WIRING SIZES.

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A-DISTRIBUTION RISER DIAGRAM-DEMOLITION
SCALE: 1:100



B-DISTRIBUTION RISER DIAGRAM-RENOVATION
SCALE: 1:100



PROJECT:
**MILL COURTLAND
COMMUNITY CENTRE
ADDITION**
216 MILL STREET
KITCHENER, ONTARIO
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DRAWING:
**DISTRIBUTION RISER
DIAGRAM-DEMOLITON &
RENOVATION**



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DATE: MAY 2024	
SCALE: AS NOTED	
FILE:	

PROJECT NO:
24015
DRAWING NO:
E401

EXISTING PANEL 'DP-1' SCHEDULE

VOLTAGE: 120/208 VOLTS
PHASE: 3P, 4W
MAINS: 400A
NEUTRAL BUS:
MOUNTING: SURFACE
NOTES: EXISTING SIEMENS TYPE CPD-7

ER	PANEL 'A' 200A	1	2	200A	PANEL 'C'
ER		3P			3P
ER	PANEL 'B' 100A	1	2	60A	BANQUET HALL HVAC-1
ER		3P			3P
ER	PANEL 'D' 70	7	8	50A	HVAC-2
ER		3P			3P
ER	SECURITY CONTROL PANEL	15	14	15A	FIRE ALARM CONTROL PANEL
ER	PORTABLE 100A	15	16		SPACE
ER		3P			3P
ER	SPACE	21	20		SPACE
ER	SPACE	23	24		SPACE

PROPOSED PANEL 'DP-1' SCHEDULE

ER	PANEL 'A' 200A	1	2	200A	PANEL 'C'
ER		3P			3P
ER	PANEL 'B' 100A	1	2	60A	SPARE
ER		3P			3P
ER	PANEL 'D' 70	7	8	50A	HVAC-2
ER		3P			3P
ER	SECURITY CONTROL PANEL	15	14	15A	SPARE
ER	PANEL 'F' 100A	15	16		SPACE
ER		3P			3P
ER	SPACE	21	20		SPACE
ER	SPACE	23	24		SPACE

DESIGNATION

'ER' INDICATES EXISTING SERVICE AND BREAKER THAT SHOULD REMAIN UNTOUCHED
'SP' INDICATES EXISTING BREAKER THAT MAY BECOME SPARE DUE TO DEMOLITION. (CONFIRM ON SITE)
'RW' INDICATES EXISTING BREAKER THAT SHOULD BE REWIRED TO SERVICE DEVICES INDICATED ON PLAN

NOTES: THIS CONTRACTOR IS TO INVESTIGATE BREAKERS AND REVISE PANEL SCHEDULES TO SUIT RENOVATION, NOTING ANY BREAKERS THAT BECOME SPARE DUE TO DEMOLITION. THIS CONTRACTOR IS ALSO TO NOTIFY THE CONSULTANT OF ANY BREAKERS THAT ARE INDICATED TO BE DEMOLISHED OR REUSED, BUT WHICH ARE IN USE BY OTHER DEVICES OR SERVICES.

PANEL 'DP2'

VOLTAGE: 347/600 VOLTS
PHASE: 3P, 4W
MAINS: 400A
NEUTRAL BUS: FULL
MOUNTING: SURFACE
NOTES: C/W SPRINKLER HOOD

WH-1	WATER HEATER	25A	1	2	125A	TX-DP1
		3P				3P
HVAC-1	HVAC-1	35A	7	8	30A	HVAC-3
		3P				3P
HG-1	STEAM HUMIDIFIER	20A	13	14	15A	WT-1.1
		3P				3P
A	ELECTRIC HEATERS WEST	20A	19	20	15A	WT-1.2
		2P				3P
A	ELECTRIC HEATERS EAST	20A	23	24		SPACE
		2P				3P
	SPACE	27	28			SPACE
	SPACE	29	30			SPACE
	SPACE	31	32			SPACE
	SPACE	33	34			SPACE
	SPACE	35	36			SPACE
	SPACE	37	38			SPACE
	SPACE	39	40			SPACE
	SPACE	41	42			SPACE

NOTE: THE INDICATED PANEL ASSEMBLY MUST HAVE AN INTERRUPTING CAPACITY OF 18000A . PROVIDE BY EITHER FULLY RATED BREAKERS OR INTEGRATED EQUIPMENT RATING WITH THE UPSTREAM BREAKER.

EXISTING PANEL 'A' SCHEDULE

VOLTAGE: 120/208 VOLTS
PHASE: 3P, 4W
MAINS: 225A
NEUTRAL BUS:
MOUNTING: SURFACE
NOTES: EXISTING SIEMENS NL48442C

ER	EXIT LGT	15A	1	2	15A	BANQUET RM DOWN LGT
ER	WASHROOM/MSCG OFFICE LGT	15A	3	4	15A	GYM LGT
ER	KITCHEN/SERVERY LGT	15A	5	6	15A	GYM LGT
ER	CHILDRENS' ROOM LGT	15A	7	8	15A	GYM LGT
ER	RECEP./ENTRANCE/STRG. LGT	15A	9	10	40A	RANGE
ER	CRAFT/M.P. RM LGT	15A	11	12	2P	
ER	LOUNGE LIGHTS	15A	13	14	40A	RANGE
ER	MULTI-PURPOSE RM LGT	15A	15	16	2P	
ER	FUTURE SIGN LGT	15A	17	18	20A	EXTERIOR LGT
ER	CRAFT RM REC	15A	19	20	20A	EXTERIOR LGT/FRONT SIGN
ER	CRAFT RM REC	15A	21	22	15A	CHILDRENS RM REC
ER	SUPERVISOR REC	15A	23	24	15A	M.P. RM REC
ER	RECEPTION REC	15A	25	26	15A	M.P. RM REC
ER	M.P. RM/COMPUTER TOY REC	15A	27	28	15A	COPIER REC
ER	M.P. RM/COMPUTER TOY REC	15A	29	30	15A	COFFEE MAKER REC
ER	M.P. RM FRIDGE REC	15A	31	32	20A	REC/STRG/EX.FAN/HS OFFICE REC
ER	COMM. GROUP REC	15A	33	34	15A	CRAFT RM REC
ER	RINK/PIT REC.	15A	35	36	15A	CRAFT RM REC
ER	(RINK) SPARE	15A	37	38	15A	M.P. RM COUNTER REC
ER	RINK LGT	15A	39	40	15A	M.P. RM COUNTER REC
ER	RINK LGT	2P	41	42	15A	CORRIDOR LGT

PROPOSED PANEL 'A' SCHEDULE

ER	EXIT LGT	15A	1	2	15A	BANQUET RM DOWN LGT
ER	WASHROOM/MSCG OFFICE LGT	15A	3	4	15A	GYM LGT
ER	KITCHEN/SERVERY LGT	15A	5	6	15A	GYM LGT
ER	CHILDRENS' ROOM LGT	15A	7	8	15A	GYM LGT
ER	RECEP./ENTRANCE/STRG. LGT	15A	9	10	40A	RANGE
ER	CRAFT/M.P. RM LGT	15A	11	12	2P	
ER	LOUNGE LIGHTS	15A	13	14	40A	RANGE
ER	MULTI-PURPOSE RM LGT	15A	15	16	2P	
ER	MULTI-PURPOSE RM LGT	15A	17	18	20A	EXTERIOR LGT
ER	FUTURE SIGN LGT	15A	19	20	20A	EXTERIOR LGT/FRONT SIGN
ER	CRAFT RM REC	15A	21	22	15A	CHILDRENS RM REC
ER	CRAFT RM REC	15A	23	24	15A	M.P. RM REC
ER	RECEPTION REC	15A	25	26	15A	M.P. RM REC
ER	M.P. RM/COMPUTER TOY REC	15A	27	28	15A	COPIER REC
ER	M.P. RM/COMPUTER TOY REC	15A	29	30	15A	COFFEE MAKER REC
ER	M.P. RM FRIDGE REC	15A	31	32	20A	REC/STRG/EX.FAN/HS OFFICE REC
ER	COMM. GROUP REC	15A	33	34	15A	CRAFT RM REC
ER	RINK/PIT REC.	15A	35	36	15A	CRAFT RM REC
ER	(RINK) SPARE	15A	37	38	15A	M.P. RM FREEZER REC
ER	RINK LGT	15A	39	40	15A	M.P. RM COUNTER REC
ER	RINK LGT	2P	41	42	15A	CORRIDOR LGT

DESIGNATION

'ER' INDICATES EXISTING SERVICE AND BREAKER THAT SHOULD REMAIN UNTOUCHED
'RW' INDICATES EXISTING BREAKER THAT SHOULD BE REWIRED TO SERVICE DEVICES INDICATED ON PLAN
'SP' INDICATES EXISTING BREAKER THAT MAY BECOME SPARE DUE TO DEMOLITION. (CONFIRM ON SITE)

NOTES: THIS CONTRACTOR IS TO INVESTIGATE BREAKERS AND REVISE PANEL SCHEDULES TO SUIT RENOVATION, NOTING ANY BREAKERS THAT BECOME SPARE DUE TO DEMOLITION. THIS CONTRACTOR IS ALSO TO NOTIFY THE CONSULTANT OF ANY BREAKERS THAT ARE INDICATED TO BE DEMOLISHED OR REUSED, BUT WHICH ARE IN USE BY OTHER DEVICES OR SERVICES.

PANEL 'F'

VOLTAGE: 120/208 VOLTS
PHASE: 3P, 4W
MAINS: 225A
NEUTRAL BUS: FULL
MOUNTING: SURFACE
NOTES: C/W SPRINKLER HOOD

EXIT LGT	15A	1	2	20A	MEN WR REC
WR/CORR./MECH LGT	15A	3	4	20A	WOMEN WR REC
MUSIC RM/OFFICE LGT	15A	5	6	20A	PRIVATE WR REC
MECH RM REC	20A	7	8	20A	UNIV. WR REC
VEST. DOOR OP./CORR. REC	20A	9	10	15A	UNIV WR DOOR OP./CHNG TABLE REC
OFFICE REC	15A	11	12	20A	MULTIPURPOSE RM REC
MEETING RM REC	15A	13	14	20A	MULTIPURPOSE RM REC
MEETING RM FLRBOX/MEDIA REC	15A	15	16	20A	MULTIPURPOSE RM REC
EXTERIOR SHEDS/LGTS REC	20A	17	18	20A	MULTIPURPOSE/STRG RM REC
EXTERIOR SHED REC	20A	19	20	20A	M.P. FLOORBOX REC
SPARE	15A	21	22	20A	M.P. FLOORBOX REC
R.O. WATER REC	15A	23	24	20A	M.P. FLOORBOX REC
VVT SYSTEM	15A	25	26	20A	M.P. FLOORBOX REC
WASHROOM EXHAUST FAN	15A	27	28	20A	M.P. FLOORBOX REC
RINK LGT	20A	29	30	20A	M.P. FLOORBOX REC
EXTERIOR BACKLOT LGT	20A	31	32	20A	RECORDING REC
MULTIPURPOSE ROOM MICROWAVE	20A	33	34	20A	ROOF MAINT. REC
EAST LOT EXT. REC.	20A	35	36	15A	WR EXHAUST FAN
EAST LOT EXT. REC.	20A	37	38	20A	UNIV WR HANDDRYER
EAST LOT EXT. REC.	20A	39	40	20A	FEMALE WR HANDDRYER
EAST LOT EXT. REC.	20A	41	42	20A	WR HANDDRYER

NOTE: THE INDICATED PANEL ASSEMBLY MUST HAVE AN INTERRUPTING CAPACITY OF 10000A . PROVIDE BY EITHER FULLY RATED BREAKERS OR INTEGRATED EQUIPMENT RATING WITH THE UPSTREAM BREAKER.

EXISTING PANEL 'C' SCHEDULE

VOLTAGE: 120/208 VOLTS
PHASE: 3P, 4W
MAINS: 225A
NEUTRAL BUS:
MOUNTING: SURFACE
NOTES: EXISTING SIEMENS NL48442C

ER	DRINKING FOUNTAIN	15A	1	2	15A	HOT WATER CIRC PUMP
ER	EXISTING	15A	3	4	15A	WATER HEATER POWER VENT
ER	B.A.S. TAC	15A	5	6	15A	WASHROOM EXHAUST
ER	EXH. FAN (BANQUET HALL)	15A	7	8	15A	SPARE
ER	SPARE	15A	9	10	15A	DOOR ASSISTER(REAR)
ER	DOOR ASSISTER INTERIOR	15A	11	12	15A	DOOR ASSISTER(REAR)
ER	DOOR ASSISTER EXTERIOR	15A	13	14	15A	OUTSIDE REC
ER	HAND DRYER WOMENS	15A	15	16	15A	BANQUET HALL SOUND SYSTEM
ER	RECEPTION REC	15A	17	18	15A	WASHROOM REC
ER	HAND DRYER MENS	15A	19	20	15A	CORRIDOR REC
ER	RECEPTACLES	15A	21	22	15A	NBRHD ASSOC. REC
ER	TELEPHONE REC	15A	23	24		SPACE
ER	RECEPTION REC	15A	25	26	15A	DOOR OPENER
ER	VIDEO EQUIP REC	15A	27	28	15A	SPARE
ER	SPARE	15A	29	30	15A	EXISTING
ER	ISOLATED GROUND REC	15A	31	32	15A	EXISTING
ER	EXISTING	30A	33	34	15A	EXISTING
ER	EXISTING	30A	35	36		SPACE
ER	SPACE		37	38		SPACE
ER	SPACE		39	40		SPACE
ER	SPACE		41	42		SPACE

PROPOSED PANEL 'C' SCHEDULE

ER	DRINKING FOUNTAIN	15A	1	2	15A	HOT WATER CIRC PUMP
ER	EXISTING	15A	3	4	15A	WATER HEATER POWER VENT
ER	B.A.S. TAC	15A	5	6	15A	WASHROOM EXHAUST
ER	EXH. FAN (BANQUET HALL)	15A	7	8	15A	SPARE
ER	SPARE	15A	9	10	15A	DOOR ASSISTER(REAR)
ER	DOOR ASSISTER INTERIOR	15A	11	12	15A	DOOR ASSISTER(REAR)
ER	DOOR ASSISTER EXTERIOR	15A	13	14	15A	OUTSIDE REC
ER	HAND DRYER WOMENS	15A	15	16	15A	BANQUET HALL SOUND SYSTEM
ER	RECEPTION REC	15A	17	18	15A	WASHROOM REC
ER	HAND DRYER MENS	15A	19	20	15A	CORRIDOR REC
ER	RECEPTACLES	15A	21	22	15A	NBRHD ASSOC. REC
ER	TELEPHONE REC	15A	23	24		SPACE
ER	RECEPTION SECURITY REC	15A	25	26	15A	DOOR OPENER
ER	VIDEO EQUIP REC	15A	27	28	15A	SPARE
ER	SPARE	15A	29	30	15A	EXISTING
ER	ISOLATED GROUND REC	15A	31	32	15A	EXISTING
ER	EXISTING	30A	33	34	15A	EXISTING
ER	EXISTING	30A	35	36	20A	DATA RACK REC
ER	JANITOR/PANTRY REC	20A	37	38	20A	LOUNGE FLOORBOX REC
ER	FIRE ALARM CONTROL PANEL	15A	39	40	20A	LOUNGE PRINTER
ER	FIRE SMOKE DAMPERS	15A	41	42	20A	LOUNGE REC

DESIGNATION

'ER' INDICATES EXISTING SERVICE AND BREAKER THAT SHOULD REMAIN UNTOUCHED
'RW' INDICATES EXISTING BREAKER THAT SHOULD BE REWIRED TO SERVICE DEVICES INDICATED ON PLAN
'NB' INDICATES NEW BREAKER AND WIRING TO SERVICE INDICATED. PROVIDE MOUNTING HARDWARE AS REQUIRED.

NOTES: THIS CONTRACTOR IS TO INVESTIGATE BREAKERS AND REVISE PANEL SCHEDULES TO SUIT RENOVATION, NOTING ANY BREAKERS THAT BECOME SPARE DUE TO DEMOLITION. THIS CONTRACTOR IS ALSO TO NOTIFY THE CONSULTANT OF ANY BREAKERS THAT ARE INDICATED TO BE DEMOLISHED OR REUSED, BUT WHICH ARE IN USE BY OTHER DEVICES OR SERVICES.

The contractor shall verify all dimensions and report all errors and discrepancies to the Consultant before commencement of the work.
The drawings show general arrangement of services. Follow as closely as actual building construction will permit. Obtain approval for relocation of service from Consultant before commencement of the work.
The drawings do not indicate all offsets fitting and accessories which may be required. Provide the same to meet the required conditions.
Drawings and specifications, etc., prepared and issued by the Consultant are the property of the Consultant and must be returned at the completion of the project. These documents are not to be duplicated or copied without the consent of the Consultant.
Do not scale this drawing.
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NO.	ISSUES	DATE	BY
1	ISSUED FOR DESIGN BRIEF	MAY 30 2024	CM
2	ISSUED FOR REVIEW	OCT 02 2024	CM
3	ISSUED FOR 66% REVIEW	OCT 22 2024	CM
4	ISSUED FOR 90% REVIEW	DEC 13 2024	CM
5	ISSUED FOR PERMIT	DEC 16 2024	CM
6	ISSUED FOR TENDER	FEB 27 2025	CM

A	ISSUED FOR ADDENDUM 1	MAR 26 2025	CM
NO.	REVISIONS	DATE	BY



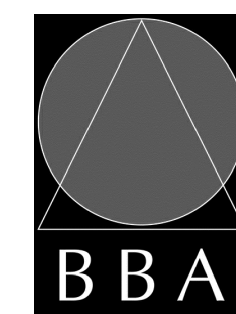
PROJECT:

MILL COURTLAND COMMUNITY CENTRE ADDITION

216 MILL STREET
KITCHENER, ONTARIO
CITY OF KITCHENER

DRAWING:

PANEL SCHEDULES



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DESIGN BY: CM	DOC. CONTROL: DATE:
DRAWN BY: DV	% COMPLETE:
CHECKED BY: JL	INITIAL:
DATE: MAY 2024	SCALE: AS NOTED
FILE:	

PROJECT NO: 24015	DRAWING NO: E602
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