

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
 - .1 Start-up testing and verification of systems
 - .2 Check-out demonstration or proper operation of components.
 - .3 On-site operational tests

1.2 RELATED SECTIONS

- .1 The contractor is to ensure that all related work is co-ordinated among all specification sections, as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 78 00 - Closeout Submittals.
- .4 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL (Average Effectiveness Level): ratio between total test period less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
 - .1 Outage of main power supply in excess of back-up power sources, provided that:
 - .1 Automatic initiation of back-up was accomplished.
 - .2 Automatic shut-down and re-start of components was as specified.

- .2 Failure of communications link, provided that:
 - .1 Controller automatically and correctly operated in stand-alone mode.
 - .2 Failure was not due to failure of any specified EMCS equipment.
- .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
 - .1 System recorded said fault.
 - .2 Equipment defaulted to fail-safe mode.
 - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

1.4 DESIGN REQUIREMENTS

- .1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Final Report: submit report to Departmental Representative.
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor
 - .3 Report format to be approved by Departmental Representative before commissioning is started.
 - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
 - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide documentation, O&M Manuals, and training materials of O&M personnel for review by Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals and Section 25 05 03 – EMCS: Project Record Documents.

1.7 COMMISSIONING

- .1 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative and Commissioning Co-ordinator.
- .2 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:
 - .1 Location and part of system to be tested or commissioned.
 - .2 Testing/commissioning procedures, anticipated results.
 - .3 Names of testing/commissioning personnel.
- .3 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .4 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .5 Load system with project software. Install software for access to EMCS via dial up modem at Owner's designated site and at Transportation and Works Office in St. John's for use during commissioning and for their use afterwards. Where high speed internet is available, use web browser software, compatible with Windows Vista with access via Internet Explorer (latest edition).
- .6 Perform tests as required.

1.8 COMPLETION OF COMMISSIONING

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and Commissioning Co-ordinator.

1.9 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 Products

2.1 EQUIPMENT

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

Part 3 Execution

3.1 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Commissioning Co-ordinator and/or Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by Commissioning Co-ordinator and/or Departmental Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

- .1 Pre-Installation Testing.
 - .1 General: consists of field tests of equipment just prior to installation.
 - .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.

- .3 Configure major components to be tested in same architecture as designed system. Include all required network and control components.
- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Additional instruments to include:
 - .1 DP transmitters.
 - .2 VAV supply duct SP transmitters.
 - .3 DP switches used for dirty filter indication and fan status.
- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source.
- .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
- .8 Departmental Representative to mark instruments tracking within 0.5 % in both directions as "approved for installation".
- .9 Transmitters above 0.5 % error will be rejected.
- .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
 - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
 - .2 Include following activities:
 - .1 Test and calibrate field hardware including stand-alone capability of each controller.
 - .2 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.

- .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
 - .7 Test operating software.
 - .8 Test application software and provide samples of logs and commands.
 - .9 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
 - .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and Engineering units. This document will be used in final startup testing.
- .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and Commissioning Co-ordinator and provide:
- .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Departmental Representative's acceptance signature to be on executive and applications programs.
 - .4 Commissioning to commence during final startup testing.
 - .5 O&M personnel to assist in commissioning procedures as part of training.
 - .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
 - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .8 Operate systems as long as necessary to commission entire project.
 - .9 Monitor progress and keep detailed records of activities and results.

- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
 - .1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
 - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
 - .2 Test to last at least 30 consecutive 24 hour days.
 - .3 Tests to include:
 - .1 Demonstration of correct operation of monitored and controlled points.
 - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
 - .4 System will be accepted when:
 - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
 - .2 Requirements of Contract have been met.
 - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
 - .6 Correct defects when they occur and before resuming tests.
- .5 Commissioning Co-ordinator and/or Departmental Representative to verify reported results.

3.3 ADJUSTING

- .1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

- .1 Demonstrate to Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks, and lock-outs.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for training program, instructors, and training materials, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

- .1 CDL - Control Description Logic.
- .2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
 - .1 List name of trainer, and type of visual and audio aids to be used.
 - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within one week after completion of Phase 1 and Phase 2 training program that training has been satisfactorily completed.

1.5 QUALITY ASSURANCE

- .1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Departmental Representative reserves right to approve instructors.

1.6 INSTRUCTIONS

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.

1.7 TIME FOR INSTRUCTION

- .1 Number of days of instruction to be as specified in this section (1 day = 7 hours including two 15 minute breaks and excluding lunch time).

1.8 TRAINING MATERIALS

- .1 Provide equipment, visual and audio aids, and materials for classroom training.
- .2 Supply manual for each trainee, describing in detail data included in each training program.
 - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O&M).

1.9 TRAINING PROGRAM

- .1 To be in 2 phases over 6 month period.
- .2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative.
 - .1 Train O&M personnel in functional operations and procedures to be employed for system operation.
 - .2 Supplement with on-the-job training during 30 day test period.
 - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
 - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
 - .5 Introduction to Direct Digital Controls and BACnet protocol.
 - .6 Identification of Control Components.
 - .7 Review of DDC Network Diagram for building.
 - .8 Review of shop drawings for building.

- .9 Detailed discussion of sequences of operation
- .10 Walk through of mechanical systems.
- .3 Phase 2: 5 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.
 - .1 Provide multiple instructors on pre-arranged schedule. Include at least:
 - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
 - .2 Equipment maintenance training: provide personnel with 2 days training within a 5 day period in maintenance of EMCS components, maintenance and calibration of sensors and controls.
 - .3 Programmers: provide personnel with 2 days training within a 5 day period in following subjects in approximate percentages of total course shown:
 - .1 Software and architecture: 10%
 - .2 Application programs: 15%
 - .3 Controller programming: 50%
 - .4 Trouble shooting and debugging: 10%
 - .5 Colour graphic generation: 15%
 - .6 Display and interpret summaries
 - .7 Command points
 - .8 Modify points and point groups
 - .9 Define trend logs
 - .10 Schedule and print reports

1.10 ADDITIONAL TRAINING

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

1.11 MONITORING OF TRAINING

- .1 Engineer/ Architect to monitor training program and may modify schedule and content.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

1.2 RELATED SECTIONS

- .1 The contractor is to ensure that all related work is co-ordinated among all specification sections, as well as between other Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.
 - .1 Section 01 33 00 – Submittal Procedures.
 - .2 Section 01 35 29.06 – Health and Safety Requirements.
 - .3 Section 09 91 00.08 – Painting for Minor Works.
 - .4 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
 - .5 Section 25 01 12 - EMCS: Training.
 - .6 Section 25 05 02 - EMCS: Submittals and Review Process.
 - .7 Section 25 05 03 - EMCS: Project Record Documents.
 - .8 Section 25 05 54 - EMCS: Identification.
 - .9 Section 25 05 60 - EMCS: Field Installation.
 - .10 Section 25 08 20 - EMCS: Warranty and Maintenance.
 - .11 Section 25 10 01 - EMCS: Local Area Network (LAN).
 - .12 Section 25 10 02 - EMCS: Operator Work Station (OWS).
 - .13 Section 25 30 01 - EMCS: Building Controllers
 - .14 Section 25 30 02 - EMCS: Field Control Devices.
 - .15 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.3 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
 - .1 ANSI/IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE STD 135, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
 - .1 CEA-709.1-B, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Assessment Act (CEAA).
 - .2 Canadian Environmental Protection Act (CEPA).
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .8 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA).
- .9 National Electrical Manufacturers Association (NEMA)

1.4 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

- .1 Acronyms used in EMCS.
 - .1 AEL - Average Effectiveness Level
 - .2 AI - Analog Input

- .3 AO - Analog Output
- .4 BACnet - Building Automation and Control Network
- .5 BC(s) - Building Controller(s)
- .6 BECC - Building Environmental Control Centre
- .7 CAB - Canadian Automated Building (CAB) Protocol
- .8 CAD - Computer Aided Design
- .9 CDL - Control Description Logic
- .10 CDS - Control Design Schematic
- .11 COSV - Change of State or Value
- .12 CPU - Central Processing Unit
- .13 DI - Digital Input
- .14 DO - Digital Output
- .15 DP - Differential Pressure
- .16 ECU - Equipment Control Unit
- .17 EMCS - Energy Monitoring and Control System
- .18 HVAC - Heating, Ventilation, Air Conditioning
- .19 IDE - Interface Device Equipment
- .20 I/O - Input/Output
- .21 ISA - Industry Standard Architecture
- .22 LAN - Local Area Network
- .23 LCU - Local Control Unit
- .24 MCU - Master Control Unit
- .25 NC - Normally Closed
- .26 NO - Normally Open
- .27 OS - Operating System

- .28 O&M - Operation and Maintenance
- .29 OWS - Operator Work Station
- .30 PC - Personal Computer
- .31 PCI - Peripheral Control Interface
- .32 PCMCIA - Personal Computer Micro-Card Interface Adapter
- .33 PID - Proportional, Integral and Derivative.
- .34 RAM - Random Access Memory
- .35 ROM - Read Only Memory
- .36 SP - Static Pressure
- .37 TCU - Terminal Control Unit
- .38 USB - Universal Serial Bus
- .39 UPS - Uninterruptible Power Supply
- .40 WAN- Wide Area Network

1.5 DEFINITIONS

- .1 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
 - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties or providing status conditions of contacts or relays which provide interaction which related equipment (stop, start) and value or damper actuators.
- .2 Point Name: composed of two parts, point identifier, and point expansion.
 - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25-character field for each point identifier. "System" is system that point is located on.
 - .1 Area descriptor: building or part of building where point is located.
 - .2 System descriptor: system that point is located on.

- .3 Point descriptor: physical logical point description. For point identifier “area”, “system” and “point” will be shortforms or acronyms. Database must provide 25-character field for each point identifier.
- .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in “area”, “system”, and “point” descriptors is placed into appropriate point expansion field. Database must provide 32-character field for each point expansion.
- .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
 - .1 System to support use of numbers and readable characters including blanks, periods, or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input)
 - .2 AO (analog output)
 - .3 DI (digital input)
 - .4 DO (digital output)
 - .5 Pulse inputs
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to ANSI/IEEE 260.1.
 - .2 Refer also to Section 25 05 54 - EMCS: Identification.

1.6 SYSTEM DESCRIPTION

- .1 Refer to control schematics, sequences of operation and related Divisions of specifications for system architecture.
- .2 The system shall communicate with the existing Mitsubishi VRF system Direct Digital Control system via BACnet protocol. The proposed system must integrate fully to allow full and complete access to both the Mitsubishi VRF DDC system and facility EMCS using the operator workstation (OWS) software and operating system supplied by this Contractor. It is the intent of this specification to have one integrated network with a common user interface accessible locally at the operator workstation and remotely via web access. Web access shall be supplied by Departmental Representative.
- .3 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

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- .1 Building Controllers.
 - .2 Control devices as listed in I/O point summaries and/or shown on the control drawings.
 - .3 OWS
 - .4 Data communications equipment necessary to affect EMCS data transmission system.
 - .5 Field control devices.
 - .6 Software/Hardware complete with full documentation.
 - .7 Complete operating and maintenance manuals.
 - .8 Training of personnel.
 - .9 Acceptance tests, technical support during commissioning, full documentation.
 - .10 Wiring interface co-ordination of equipment supplied by others.
 - .11 Miscellaneous work as specified in these sections and as indicated.
 - .4 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed prior to installation.
 - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
 - .4 Provide utility and emergency power to EMCS.
 - .5 Metric references: in accordance with CAN/CSA Z234.1.
 - .5 Language Operating Requirements:
 - .1 Provide English interface to system through operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.

- .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
- .6 Include, in English:
 - .1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS. Point name expansions in English.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.
- .7 The network design to be a fully distributed network, with each primary system having its own locally mounted dedicated controller. Any failure in the network shall **not** in any way affect the control of these primary systems. Connecting hardware points from one system to more than one controller is not acceptable. Any points associated with a system are to be connected to one dedicated controller. Each dedicated controller to have a locally mounted control and display device to allow the operator to view and adjust any point on the controller.
- .8 All wiring associated with the EMCS communication network as well as all control wiring and conduit associated with the EMCS at 50 volts or less. Wire and conduit above 50 volts by Electrical Division.
- .9 BACnet compliance: full compliance to the BACnet standard (ANSA/ASHRAE) 135, BACnet – A Data communication Protocol for Building Automation and Control Networks is mandatory. Down to the field device level, the EMCS system must meet BACnet standards for system architecture and administration and use open communication protocols and user-friendly programming and graphics. Install the EMCS installed to communicate at the supervisory layer to the WAN using the BACnet TCP/IP protocol implemented on Ethernet.
- .10 The EMCS system for this facility to be accessible by designated personnel via the WAN for monitoring and programming purposes. The EMCS contractor to provide all the required hardware, software, gateways, etc. needed to permit connection of the EMCS to the WAN. This shall include all hardware, software, programming, start-up and commissioning required. The contractor to supply and install all the required hardware and software on the WAN file server to allow for this remote operation monitoring and programming to take place. The contractor to supply and install all the required hardware and software on the operator workstation(s) located in the Owner's facilities management department. In addition, a remote dial in access directly to the system shall be provided.

1.7 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Submittals and Review Process.
- .2 Submit for review:
 - .1 Equipment list and systems manufacturers within 10 days after award of contract.
- .3 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 – EMCS: Submittals and Review Process. Label or listing of specified organization is acceptable evidence.
 - .4 In lieu of such evidence, submit certificate from testing organization, approved by third party Engineer registered in Canada, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
 - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
 - .6 Permits and fees: in accordance with general conditions of contract.
 - .7 Existing devices intended for re-use: submit test report.

1.8 QUALITY ASSURANCE

- .1 Have local office for at least 5 years staffed by factory trained personnel capable of installing and providing instruction, routine maintenance, and emergency service on systems.
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide 7-year guarantee of availability of spare parts after obsolescence.
- .4 Ensure factory qualified supervisory personnel continuously direct and monitor work and attend site meetings.

- .5 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .6 Be able to provide factory trained personnel on site within 24 hours notice or provide instructions on maintenance and emergency service on system.
- .7 BACnet devices to bear BACnet testing laboratories BTL mark and listed on BACnet manufacturers association web site.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with “Materials Delivery Schedule” within 2 weeks after award of contract.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.
 - .5 Place materials defined as hazardous or toxic in designated containers.
 - .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, Municipal, and Provincial regulations.
 - .7 Label location of salvaged material's storage areas and provide barriers and security devices.
 - .8 Ensure emptied containers are sealed and stored safely.
 - .9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative Departmental Representative.
 - .10 Fold up metal and plastic banding, flatten and place in designated area for recycling

1.10 EXISTING CONDITIONS - CONTROL COMPONENTS

- .1 Utilize existing control wiring and piping as indicated.

- .2 Re-use field control devices that are usable in their original configuration if they conform to applicable codes, standards, and specifications.
 - .1 Do not modify original design of existing devices without written permission from Departmental Representative.
 - .2 Provide for new, properly designed device where re-usability of components is uncertain.
- .3 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
 - .1 Furnish test report to Departmental Representative within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair by Owner.
 - .2 Failure to produce test report will constitute acceptance of existing devices by owner.
- .4 Non-functioning items:
 - .1 Provide with report specification sheets or written functional requirements to support findings.
 - .2 Owner will repair or replace existing items judged defective yet deemed necessary for EMCS.
- .5 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .6 Assume responsibility for existing controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
 - .1 Be responsible for items repaired or replaced by Owner.
 - .2 Be responsible for repair costs due to negligence or abuse of equipment repaired or replaced by Owner.
 - .3 Responsibility for existing devices terminates upon final acceptance of EMCS or applicable portions of EMCS as approved by Departmental Representative.
- .7 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

Part 2 Products

2.1 ACCEPTABLE SYSTEMS, MANUFACTURERS

- .1 Delta and Automated Logic.
- .2 Proposed system to have communication capability utilizing BACnet Protocol.
- .3 Panel to be NEMA rated to suit environmental requirements.
- .4 Panels to have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.
- .5 Wiring within panels to be contained within properly sized rigid PVC slotted wall wire duct. All wiring within the wire duct to be concealed with a non-slip cover.
- .6 Terminations for the connection of power wiring, communication wiring and field mounted devices to be at properly identified terminal blocks mounted within the control panel.
- .7 All control panels to be provided with an internally mounted 120-volt duplex power receptacle.
- .8 All control panels to be identified with permanently mounted Lamecoid tags to identify the control panel and the systems served by the control panel. Submit schedule of labels with shop drawing submission.
- .9 Provide low voltage transformers in panels or elsewhere as required.
- .10 Provide adaptors between metric and imperial components.

Part 3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

- .1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.

3.2 PAINTING

- .1 Painting to be in accordance with NEMA, supplemented as follows:
- .2 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
- .3 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.

- .4 Clean and prime exposed hangers, racks, fastenings, and other support components.
- .5 Paint all unfinished equipment installed indoors to NEMA.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes.

- .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process include review meetings for building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

- .1 The contractor is to ensure that all related work is co-ordinated among all specification sections as well as between all Divisions, and that the tender price includes all related work. The referenced sections below are for guidance only and are not necessarily a complete list of related sections.
 - .1 Section 01 33 00 - Submittal Procedures.
 - .2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
 - .3 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 DESIGN REQUIREMENTS

- .1 Preliminary Design Review: to contain following contractor and systems information.
 - .1 Location of local office.
 - .2 Description and location of installing and servicing technical staff.
 - .3 Location and qualifications of programming design and programming support staff.
 - .4 List of spare parts.
 - .5 Location of spare parts stock.
 - .6 Names of sub-contractors and site-specific key personnel.
 - .7 Sketch of site-specific system architecture.

- .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
- .9 Descriptive brochures.
- .10 Sample CDL and graphics (systems schematics).
- .11 Response time for each type of command and report.
- .12 Item-by-item statement of compliance.
- .13 Proof of demonstrated ability of system to communicate utilizing BACnet protocol.

1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within 30 working days after contract award for review by Departmental Representative.
- .3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.
- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.
- .5 Soft copy to be in AutoCAD - latest version and Microsoft Word latest version format, or PDF structured using menu format for easy loading and retrieval on OWS.
- .6 Submittals shall consist of:
 - .1 Data sheets of all products.
 - .2 Wiring and piping interconnection diagrams including panel and device power, and sources.
 - .3 List of materials of all proposed devices and equipment.
 - .4 Software documentation:
 - .5 Sequence of operation, in text form.
 - .6 Application programs.
 - .7 Point Schedules

- .8 Controls schematics and system diagrams.
 - .9 Project installation schedule.
 - .10 Names of subtrades working for EMCS contractor.
 - .11 Mounting support details for components installed in airflow, waterflow and steam systems.
- .7 Submit shop drawings in a package which contains the various schedules and drawings which completely describe the control system installed. At a minimum the shop drawing package to contain the following items described in Section 1.4.8 to 1.4.28 as follows:
- .8 Network drawing showing the network connection of all network control units, programmable control units, terminal control units and operator workstations to indicate the location of each of these elements.
 - .9 Schematic control diagram for each system being controlled. Where there are typical systems a drawing to be provided for each system. This drawing to be on an AB size sheet (11 x 17) and shall include a title block which includes as a minimum the drawing title, drawing number, project title, contractor's name, contractor's address, contractor's phone and fax numbers, contractor's project number and a section to provide a record for revision information.
 - .10 The schematic control diagram to include a bill of materials which provides a list of all part numbers and descriptions for the control components on the drawing list to include field equipment as well as panel mounted components.
 - .11 The schematic control diagram to include a complete wiring diagram for all electrical connections, including motor starters, heating coils, coiling coils etc.
 - .12 The schematic control diagram to include a layout of the control panels for each system. This layout to show the mounting of all panel equipment, including transformers, power supplies, controllers, transducers, sensors, relays, contactors, and any other panel mounted equipment.
 - .13 The contractor to include with the shop drawing submittal drawings, showing all wiring details for the connections of sensors, transducers, relays, and contactors these details to show terminal numbers and be referenced to the appropriate schedules and drawings.
 - .14 The contractor to supply with the shop drawing package a complete point schedule to show every point connected to the system. This schedule to be in tabular format and provide the point identification, point type, wire tag, termination details reference, referenced drawings, device mounting location and device code numbers.
 - .15 The point schedule to provide at a minimum the following information on the software attributes of the point:

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- .1 Tag name – ex. EPT-1
 - .2 Point type – ex. AO-3
 - .3 System name – ex. A/C-1
 - .4 Object name – H-VLV.
 - .5 Expanded ID- Heating control valve
 - .6 Units of measurement - %.
- .16 The point schedule to provide at a minimum the following information on the digital controller to which the point is connected:
- .1 Controller type – ex. Unitary controller
 - .2 Controller address ex. 256.
 - .3 Cable destination – the termination at the controller, ex. AO-1.
 - .4 Terminal numbers – the termination at the controller.
- .17 The point schedule to provide at minimum the following information on the control panel:
- .1 Panel identification
 - .2 Panel location
 - .3 Reference drawing
- .18 The point schedule to provide at a minimum the following information on any intermediate device which may be associated with the point:
- .1 Type of wiring or tubing used
 - .2 Device part number
 - .3 Location of the device.
 - .4 Reference details.
- .19 The point schedule to provide at a minimum the following information on any field device which may be associated with the point;
- .1 Type of wiring or tubing used
 - .2 Device part number

- .3 Location of the devices
- .4 Reference details
- .20 The contractor to supply with the shop drawing package a complete room schedule, to show the equipment associated with the room controls. Schedule to be in tabular format and provide the room number and location, terminal unit number, part numbers for the terminal unit controller, sensors, and actuators. Included on this schedule terminal unit type, size, minimum flow and maximum flow.
- .21 Sequence of operation for each system controlled. Sequence to be in complete conformance with the sequence of operations included with this specification. Any changes require the approval of the Departmental Representative in writing. Sequence to include all modes of operation including fail safe, emergency and fire modes.
- .22 Valve schedule including design flow, CV, size, type, actuator, pressure drop and maximum shut off pressure differential for each control valve.
- .23 Damper schedule including design air flow, size, type actuator and torque requirements for each control damper.
- .24 Provide one permanent, not fading, as built copy of each control drawing, enclosed by an aluminium frame with glass cover, or sealed by plastic laminate in rigid metal bound frame. To be installed at each respective control panel location.
- .25 Catalogue cut sheets of all equipment used. This includes, but is not limited to DDC panels, peripherals, sensors, actuators, dampers, control air system components, etc.
- .26 Range and scale information for all transmitters and sensors. This sheet to clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.
- .27 Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.
- .28 Software manuals for all applications programs to be provided as a part of the operator workstations, portable operator terminals, programming devices, and so forth for

1.6 PRELIMINARY SHOP DRAWING REVIEW

- .1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
 - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

- .2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment.
- .3 Spare point capacity of each controller by number and type.
- .4 Controller locations.
- .5 Auxiliary control cabinet locations.
- .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
- .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
- .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
- .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.
- .10 Compressor schematic and sizing data.

1.7 DETAIL SHOP DRAWING REVIEW

- .1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
 - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
 - .2 Wiring diagrams.
 - .3 Piping diagrams and hook-ups.
 - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
 - .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
 - .1 Sensing element type and location.

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- .2 Transmitter type and range.
 - .3 Associated field wiring schematics, schedules and terminations.
 - .4 Pneumatic schematics and schedules.
 - .5 Complete Point Name Lists.
 - .6 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
 - .7 Software and programming details associated with each point.
 - .8 Manufacturer's recommended installation instructions and procedures.
 - .9 Input and output signal levels or pressures where new systems ties into existing control equipment.
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- .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
 - .7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
 - .8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
 - .9 Listing of and example of specified reports.
 - .10 Listing of time of day schedules.
 - .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
 - .12 Type and size of memory with statement of spare memory capacity.
 - .13 Full description of software programs provided.
 - .14 Sample of "Operating Instructions Manual" to be used for training purposes.
 - .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 – EMCS: Start-up, Verification and Commissioning.

1.8 **QUALITY ASSURANCE**

- .1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:
 - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
 - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
 - .3 Review interface requirements of materials supplied by others.
 - .4 Review "Sequence of Operations".
- .2 Contractor's factory trained programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Owner.

Part 2 **Products**

2.1 **NOT USED**

- .1 Not used.

Part 3 **Execution**

3.1 **NOT USED**

- .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for final control diagrams and operation and maintenance (O&M) manual, for building Energy Monitoring and Control System (EMCS) Work.

1.2 RELATED SECTIONS

- .1 Section 01 78 00 - Closeout Submittals.
- .2 Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .3 Section 25 05 01 - EMCS: General Requirements.
- .4 Section 25 05 02 - EMCS: Submittals and Review Process.

1.3 DEFINITIONS

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 For additional acryonyms and definitions refer to Section 25 05 01 - EMCS: General Requirements

1.4 SUBMITTALS

- .1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.
- .2 Submit Record Documents, As-built drawings, Operation and Maintenance Manual to Departmental Representative in English.
- .3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
 - .1 Binders to be 2/3 maximum full.
 - .2 Provide index to full volume in each binder.
 - .3 Identify contents of each manual on cover and spine.
 - .4 Provide Table of Contents in each manual.

- .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

1.5 AS-BUILTS

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
 - .1 Changes to contract documents as well as addenda and contract extras.
 - .2 Changes to interface wiring.
 - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
 - .4 Locations of obscure devices to be indicated on drawings.
 - .5 Listing of alarm messages.
 - .6 Panel/circuit breaker number for sources of normal/emergency power.
 - .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
 - .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
 - .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.
- .3 Provide before acceptance 4 hard and 1 soft copy incorporating changes made during final review.

1.6 O&M MANUALS

- .1 Custom design O&M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests.
- .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics, or in-depth control theory.

- .4 Functional description to include:
 - .1 Functional description of theory of operation.
 - .2 Design philosophy.
 - .3 Specific functions of design philosophy and system.
 - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
 - .5 Explicit description of hardware and software functions, interfaces, and requirements for components in functions and operating modes.
 - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.
- .5 System operation to include:
 - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
 - .2 Operation of computer peripherals, input and output formats.
 - .3 Emergency, alarm, and failure recovery.
 - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including keystrokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .6 Software to include:
 - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
 - .2 Detailed descriptions of program requirements and capabilities.
 - .3 Data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
 - .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

- .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
- .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair, or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller, and interface firmware, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
 - .1 Provisions and procedures for planning, implementing, and recording hardware and software modifications required during operating lifetime of system.
 - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor, or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for identification of devices, sensors, wiring, tubing, conduit, and equipment for building Energy Monitoring and Control System (EMCS) Work and nameplates, materials, colours, and lettering sizes.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

1.4 DEFINITIONS

- .1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.5 SYSTEM DESCRIPTION

- .1 Language Operating Requirements: provide identification for control items in English.

1.6 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process supplemented and modified by requirements of this Section.
- .2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

Part 2 Products

2.1 NAMEPLATES FOR PANELS

- .1 Identify by plastic laminate, 3 mm thick melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core, mechanically attached with self-tapping screws.
- .2 Sizes: 25 x 67 mm minimum.

- .3 Lettering: minimum 7 mm high, black.
- .4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

- .1 Identify by plastic encased cards attached by plastic tie.
- .2 Sizes: 50 x 100 mm minimum.
- .3 Lettering: minimum 5 mm high produced from laser printer in black.
- .4 Data to include: point name and point address, make, model number.
- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

- .1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative.

2.5 WIRING

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets, and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 PNEUMATIC TUBING

- .1 Numbered tape markings on tubing to provide uninterrupted tracing capability.

2.7 CONDUIT

- .1 Colour code EMCS conduit.

- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".

Part 3 Execution

3.1 NAMEPLATES AND LABELS

- .1 Ensure that manufacturer's nameplates, CSA labels, and identification nameplates are always visible and legible.

3.2 EXISTING PANELS

- .1 Correct existing nameplates and legends to reflect changes made during work.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 73 00 - Execution
- .2 Section 23 05 15 – Common Installation Requirements for HVAC Pipework.
- .3 Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.
- .4 Section 23 07 19 – HVAC Piping Insulation.
- .5 Section 23 23 00 - Refrigerant Piping.
- .6 Section 25 05 54 - EMCS: Identification.
- .7 Section 25 08 20 - EMCS: Warranty and Maintenance.
- .8 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
 - .1 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
 - .2 ANSI C2-1990, National Electrical Safety Code.
 - .3 ANSI/NFPA 70-1990, National Electrical Code.
- .2 CSA Group (CSA)
 - .1 CSA C22.1-12,
 - .2 CAN/CSA-C22.3 No. 7-10, Underground Systems.
 - .3 CAN/CSA C22.2 No. 45.1-07(R2012), Electrical Rigid Metal Conduit.
 - .4 CAN/CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .5 CAN/CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.
 - .6 CAN/CSA-C22.3 No. 1-10, Overhead Systems.

1.3 SYSTEM DESCRIPTION

- .1 Electrical:
 - .1 Provide power wiring from existing power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
 - .2 Hard wiring between field control devices and EMCS field panels.
 - .3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
 - .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

- .5 Refer to wiring diagrams included as part of flow diagrams. Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by engineer before commencing work.
- .2 Mechanical:
 - .1 Pipe Taps Required for EMCS equipment will be supplied and installed by Division 23.
 - .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 23.
 - .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.
- .3 Structural:
 - .1 Special steelwork as required for installation of work.

1.4 PERSONNEL QUALIFICATIONS

- .1 Qualified supervisory personnel to:
 - .1 Continuously direct and monitor all work.
 - .2 Attend site meetings.

1.5 EXISTING CONDITIONS

- .1 Cutting and Patching: refer to Section 01 73 00 - Execution supplemented as specified herein.
- .2 Repair all surfaces damaged during execution of work.
- .3 Turn over to Departmental Representative existing materials removed from work not identified for re-use.

Part 2 Products

2.1 PIPING

- .1 Hot water heating, chilled water: refer to Section 23 05 15 – Common Installation Requirements for HVAC Pipework.
- .2 Hangers and supports: refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.
- .3 Insulation: refer to Section 23 07 19 – HVAC Piping Insulation.
- .4 Refrigeration: refer to Section 23 23 00 - Refrigerant Piping.

2.2 SPECIAL SUPPORTS

- .1 Structural grade steel, primed and painted after construction and before installation.

2.3 WIRING

- .1 As per requirements of Division 26.
- .2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
- .3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
- .4 Terminations:
 - .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.4 CONDUIT

- .1 As per requirements of Division 26.
- .2 Electrical metallic tubing to CAN/CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CAN/CSA C22.2 No. 56. Rigid steel threaded conduit to CAN/CSA C22.2 No. 45.1.
- .3 Junction and pull boxes: welded steel.
 - .1 Surface mounting cast FS: screw-on flat covers.
 - .2 Flush mounting: covers with 25 mm minimum extension all round.
- .4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
- .5 Outlet boxes: 100 mm minimum, square.
- .6 Conduit boxes, fittings:
 - .1 Bushings and connectors: with nylon insulated throats.
 - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for rigid conduit:
 - .1 Couplings and fittings: threaded type steel.
 - .2 Double locknuts and insulated bushings: use on sheet metal boxes.
 - .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
- .8 Fittings for thin wall conduit:
 - .1 Connectors and couplings: steel, set screw type.

2.5 WIRING DEVICES, COVER PLATES

- .1 Conform to CSA.
- .2 Receptacles:
 - .1 Duplex: CSA type 5-15R.
 - .2 Single: CSA type 5-15R.

- .3 Cover plates and blank plates: finish to match other plates in area.

2.6 STARTERS, CONTROL DEVICES

- .1 Across-the-line magnetic starters:
 - .1 Enclosures: CSA Type 1, except where otherwise specified.
 - .2 Size, type, and rating: to suit motors.
- .2 Starter diagrams:
 - .1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.
- .3 Auxiliary Control Devices:
 - .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
 - .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
 - .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
 - .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.
- .4 Finish for starters:
 - .1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .2 Interior: white.

2.7 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

- .1 Solid masonry, tile, and plastic surfaces: lead anchors or nylon shields.
 - .1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.
- .2 Exposed conduits or cables:
 - .1 50 mm diameter and smaller: one-hole steel straps.
 - .2 Larger than 50 mm diameter: two-hole steel straps.
- .3 Suspended support systems:
 - .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
 - .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

Part 3 Execution

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

3.2 PIPING

- .1 Hot water heating, chilled water: refer to Section 23 05 15 – Common Installation Requirements for HVAC Pipework.
- .2 Hangers and supports: refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.
- .3 Insulation: refer to Section 23 07 19 – HVAC Piping Insulation.
- .4 Refrigeration: refer to Section 23 23 00 - Refrigerant Piping.

3.3 MECHANICAL PIPING

- .1 Install piping straight, parallel, and close to building structure with required grades for drainage and venting.
- .2 Ream ends of pipes before assembly.
- .3 Copper tubing not to come into contact with dissimilar metal.
- .4 Use non-corrosive lubricant or Teflon tape on male screwed threads.
- .5 Clean ends of pipes, tubing, and recesses of fittings to be brazed or soldered. Assemble joints without binding.
- .6 Install di-electric couplings where dissimilar metals joined.
- .7 Sleeves:
 - .1 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint.
 - .2 Caulking:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere: provide space for fire stopping by Section [07 84 00 - Fire Stopping]. Maintain the fire-resistance rating integrity of the fire separation.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.
- .8 Pressure tests:
 - .1 Pressure test all piping systems modified under this contract to 1 1/2 times maximum working pressure or 860 kPa (whichever is greater) for 4 hours without loss of pressure.
 - .2 Isolate equipment, components, not designed to withstand test pressure.
- .9 Introduce system pressure carefully into new piping.

3.4 SUPPORTS

- .1 Install special supports as required and as indicated.

3.5 ELECTRICAL GENERAL

- .1 Do complete installation in accordance with requirements of:
 - .1 Division 26, this specification.
 - .2 CSA 22.1 Canadian Electrical Code.
 - .3 ANSI/NFPA 70.
 - .4 ANSI C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling, and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over neatly and closely to building structure to minimize furring.

3.6 CONDUIT SYSTEM

- .1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
- .3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

- .4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
- .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
- .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .7 Limit conduit length between pull boxes to less than 30 m.
- .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
- .9 Fastenings and supports for conduits, cables, and equipment:
 - .1 Provide metal brackets, frames, hangers, clamps, and related types of support structures as indicated and as required to support cable and conduit runs.
 - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
 - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
- .10 Install polypropylene fish cord in empty conduits for future use.
- .11 Where conduits become blocked, remove, and replace blocked sections.
- .12 Pass conduits through structural members only after receipt of Departmental Representative's written approval.
- .13 Conduits may be run in flanged portion of structural steel.
- .14 Group conduits wherever possible on suspended or surface channels.
- .15 Pull boxes:
 - .1 Install in inconspicuous but accessible locations.
 - .2 Support boxes independently of connecting conduits.
 - .3 Fill boxes with paper or foam to prevent entry of construction material.
 - .4 Provide correct size of openings. Reducing washers not permitted.
 - .5 Mark location of pull boxes on record drawings.
 - .6 Identify AC power junction boxes, by panel and circuit breaker.
- .16 Install terminal blocks or strips indicated in cabinets.
- .17 Install bonding conductor for 120 volt and above in conduit.

3.7 WIRING

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:
 - .1 Circuits are continuous, free from shorts, unspecified grounds.
 - .2 Resistance to ground of all circuits is greater than 50 Megohms.

- .5 Provide Departmental Representative with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.8 WIRING DEVICES, COVER PLATES

- .1 Receptacles:
 - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
- .2 Cover plates:
 - .1 Install suitable common cover plate where wiring devices are grouped.
 - .2 Use flush type cover plates only on flush type outlet boxes.

3.9 STARTERS, CONTROL DEVICES

- .1 Install and make power and control connections as indicated.
- .2 Install correct over-current devices.
- .3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.
- .4 Performance Verification:
 - .1 Operate switches and controls to verify functioning.
 - .2 Perform start and stop sequences of contactors and relays.
 - .3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

3.10 GROUNDING

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors, and accessories.
- .2 Install separate grounding conductors in conduit within building.
- .3 Install ground wire in all PVC ducts and in tunnel conduit systems.
- .4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.11 TESTS

- .1 General:
 - .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
 - .2 Give 14 days written notice of intention to test.
 - .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
 - .4 Conceal work only after tests satisfactorily completed.
 - .5 Report results of tests to Departmental Representative in writing.
 - .6 Preliminary tests:
 - .1 Conduct as directed to verify compliance with specified requirements.
 - .2 Make needed changes, adjustments, replacements.
 - .3 Insulation resistance tests:

3.12 IDENTIFICATION

- .1 Refer to Section 25 05 54 - EMCS: Identification.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCES

- .1 Canada Labour Code (R.S., c. L-2)/Part I - Industrial Relations.
- .2 Canadian Standards Association (CSA)
 - .1 CSA Z204 – Guidelines for Managing Indoor Quality in Buildings

1.4 DEFINITIONS

- .1 OWS - Operator Work Station.
- .2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.5 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
 - .1 Point name and location.
 - .2 Device type and range.

- .3 Measured value.
- .4 System displayed value.
- .5 Calibration detail
- .6 Indication if adjustment required,
- .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Maintain records and logs of each maintenance task on site.
 - .2 Organize cumulative records for each major component and for entire EMCS chronologically.
 - .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments, and modifications to EMCS made during warranty period.

1.6 MAINTENANCE SERVICE DURING WARRANTY PERIOD

- .1 Provide services, materials, and equipment to maintain EMCS for warranty period of two (2) years after date of substantial completion. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
 - .1 Initiate service calls when EMCS is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
 - .4 Service personnel to be on site ready to service EMCS after receiving request for service.
 - .5 Perform work continuously until EMCS restored to reliable operating condition.

- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
 - .1 Serial number identifying component involved.
 - .2 Location, date and time call received.
 - .3 Nature of trouble.
 - .4 Names of personnel assigned.
 - .5 Instructions of work to be done.
 - .6 Amount and nature of materials used.
 - .7 Time and date work started.
 - .8 Time and date of completion.
- .5 Provide system modifications in writing.
 - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

1.7 SERVICE CONTRACTS

- .1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures. Service contracts duration is for the warranty period.
- .2 Service Contracts to include:
 - .1 Annual verification of field points for operation and calibration.
 - .2 4 visits per year.
 - .3 2 responses to emergency calls during day, per year.
 - .4 2 responses to emergency calls during silent hours, per year.
 - .5 Silent hours defined as 1630 h – 0800 h and on weekends and statutory holidays.
 - .6 Complete inventory of installed system.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 FIELD QUALITY CONTROL

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Engineer/ Architect as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
 - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
 - .2 Check and calibrate random sample of 10% field input/output devices in accordance with Canada Labour Code - Part I and CSA Z204.
 - .3 Provide dated, maintenance task lists, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
 - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
 - .2 Check equipment cooling fans as required.
 - .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
 - .4 Review system performance with Operations Supervisor and/or Engineer/ Architect to discuss suggested or required changes.
- .5 Major inspections to include, but not limited to:
 - .1 Minor inspection.
 - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

- .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
- .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required (as per 3.1. 3.2).
- .5 Provide mechanical adjustments, and necessary maintenance on printers.
- .6 Run system software diagnostics as required.
- .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
- .1 Perform network analysis and provide report as described in Submittal article.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
- .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).
- .2 Related Sections:
 - .1 Section 25 05 01 – EMCS: General Requirements.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
 - .2 CSA T530, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA – 569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information Technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements.
 - .1 IEEE Std 802.3TM, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA).
 - .1 TIA/EIA-568, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements, Part 2 Balanced Twisted- Pair Cabling Components, Part 3 Optical Fiber Cabling Components Standard.
 - .2 TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.
- .4 Treasury Board Information Technology Standard (TBITS).
 - .1 TBITS 6.9, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings-Technical Specifications.

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 – EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

- .1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-568, CSA T530 and TIA/EIA-569-A.
 - .1 Provide reliable and secure connectivity of adequate performance between different sections segments of network.

- .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .2 Data communication network to included, but not limited to:
 - .1 EMCS-LAN.
 - .2 Modems.
 - .3 Network interface cards.
 - .4 Network management hardware and software.
 - .5 Network components necessary for complete network.

1.5 DESIGN REQUIREMENTS

- .1 EMCS Local Area Network (EMCS-LAN).
 - .1 High Speed, high performance, local area network over MS/TP with MCUs and OWSs communicate with each other directly on peer-to-peer basis in accordance with IEEE 802.3/Ethernet Standard.
 - .2 EMCS-LAN to be: BACnet Protocol
 - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
 - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
 - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
 - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
 - .7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
 - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely to access point status and application report data or execute control functions for other devices via LAN.
 - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
 - .1 Network medium: twisted cable, shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings.

Part 2 Products
2.1 NOT USED
 .1 Not used.

Part 3 Execution
3.1 NOT USED
 .1 Not used.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section includes:

- .1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

- .1 Section 25 05 01 – EMCS: General Requirements.
- .2 Section 25 05 02 – EMCS: Submittals and Review Process.
- .3 Section 25 05 03 – EMCS: Project Record Documents.
- .4 Section 25 30 01 – EMCS: Building Controllers.
- .5 Section 25 90 01 – EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.3 DEFINITIONS

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.
- .2 Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

1.4 OWS SYSTEM DESCRIPTION

- .1 Consists of commercial personal computer (must be in current production) with sufficient memory and processor capacity to perform all functions specified.

1.5 SUBMITTALS

- .1 In accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

1.6 ENVIRONMENTAL CONDITIONS

- .1 OWS to operate in conditions of 10 °C to 32 °C and 20 % to 90 % non-condensing RH.

1.7 MAINTENANCE

- .1 In accordance with Section 25 08 20 – EMCS: Warranty and Maintenance and Section 25 05 03 - EMCS: Project Records Documents.

PART 2 PRODUCTS

2.1 OWS HARDWARE

- .1 Existing PC for existing OWS shall be re-used.
- .2 Include UPS to provide 30 minutes minimum operation of PC, CRT and communication and peripheral devices. This shall apply to fixed (non portable) OWS and peripherals.

2.2 OWS PC COMPONENTS

- .1 Existing PC for existing OWS shall be re-used.

2.3 PRINTERS

- .1 Print to file.

2.4 CONTROL DESK CONSOLE

- .1 Existing Control Desk Console used for existing OWS shall be re-used.

2.5 OPERATING SYSTEM (OS) OR EXECUTIVE

- .1 To manage software operation of OWS.
 - .1 OS to support complement of hardware terminals and software programs specified.
- .2 OS to be true multitasking operating environment. MS DOS or PC DOS based software platforms not permitted.
- .3 OWS Software to operate in a "Windows" based operating environment. Software to be Windows Vista™, Business Edition.

2.6 OPERATOR'S CONTROL SOFTWARE

- .1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer-to-peer communication occurring at MCU to MCU device level.
- .2 Time Synchronization Module.
 - .1 System to provide Time Synchronization of real-time clocks in controllers.
 - .2 System to perform this feature on regular scheduled basis and on operator request.

- .3 User Display Interface Module.
 - .1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.
 - .2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems, refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.
- .4 General Event Log Module: to record system activities occurring at OWS or elsewhere in the system including:
 - .1 Operator Log-in from any user interface device.
 - .2 Communication messages - errors, failures and recovery.
 - .3 Event notifications and Alarms by category.
 - .4 Record of Operator initiated commands.
- .5 The General Event Log:
 - .1 Able to be archived as necessary to prevent loss of information. Archiving to occur automatically.
 - .2 Hold minimum of 4 months' information and be readily accessible to operator.
- .6 Operator Control Software Module: To support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user: dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:
 - .1 Automatic logging of digital alarms and change of status messages.
 - .2 Automatic logging of analog alarms.
 - .3 System changes: alarm limits, set-points, alarm lockouts.

-
- .4 Display specific point values, states as selected.
 - .5 Provide reports as requested and on scheduled basis when required.
 - .6 Display graphics as requested, and on alarm receptions (user's option).
 - .7 Display list of points within system.
 - .8 Display list of systems within building.
 - .9 Direct output of information to selected peripheral device.
 - .10 On-line changes:
 - .1 Alarm limits.
 - .2 Setpoints.
 - .3 Deadbands.
 - .4 Control and change of state changes.
 - .5 Time, day, month, year.
 - .6 Control loop configuration changes for controller-based CDLs.
 - .7 Control loop tuning changes.
 - .8 Schedule changes.
 - .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.
 - .11 According to assigned user privileges (password definition) the following functions to be supported:
 - .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by the operator.
 - .2 Requests for status, analog, graphic displays, logs, controls to be through user interface screens.
 - .12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.
- .7 Message Handling Module - and Error Messages: Message Handling Module to provide message handling for the following conditions:

- .1 Message and alarm buffering to be provided to prevent any loss of information.
- .2 Error detection correction and retransmission to be included to guarantee data integrity.
- .3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands, and failure of communications between EMCS devices.
- .8 Access Control to Field Equipment
 - .1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. The following is preferred format of progression of password levels:
 - .1 Guest: No password data access and display only.
 - .2 Operator Level: Full operational commands including automatic override.
 - .3 Technician: Data base modifications.
 - .4 Programmer: Data base generation.
 - .5 Highest Level : System Administration - Password assignment, addition, modification.
 - .2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.
- .9 Trend Data Module: Includes Historical data collection utility, Trend data utility, Control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.
 - .1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.
 - .2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of the following point object types - DI, DO, AI, AO, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on

- minimum 96 h basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.
- .3 Control Loop Plot Utility: For AO Points provide for the concurrent plotting of the measured value input - present value, present value of the output, and AO setpoint. The operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as the plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.
 - .4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or up to 6 trend points concurrently or 1 control loop plot. For display output of active trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.
 - .5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.
- .10 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.
- .1 Reports to include time, day, month, year, report title, operator's initials.
 - .2 Software to provide capability to:
 - .1 Generate and format reports for graphical and numerical display from real time and stored data.
 - .2 Print and store reports as selected by operator.
 - .3 Select and assign points used in such reports.
 - .4 Sort output by area, system, as minimum.
 - .3 Periodic/automatic report:
 - .1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.

.2 Reports to include:

- .1 Power demand and duty cycle summary: see application program for same.
- .2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.
- .3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.
- .4 Summary of run time alarms: include point name, run time to date, alarm limit.
- .5 Summary of start/stop schedules: include start/stop times and days, point name.
- .6 Motor status summary.

.4 Report types:

- .1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:

- .1 Points inaccessible from this OWS (total connected for this location), multiple "areas".
- .2 Area (points and systems in Area).
- .3 Area, system (points in system).
- .4 System (points by system type).
- .5 System point (points by system and point object type).
- .6 Area point (points by system and point object type).
- .7 Point (points by point object type).

- .5 Summary report: printout or display of point object data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.

- .6 Include preformatted reports as listed in Event/Alarm Module.
- .11 Graphics Display Module: Graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
 - .1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.
 - .2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). To include capability to call up and cancel display of any graphic picture.
 - .3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.
 - .4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:
 - .1 Modify portion of graphic picture/schematic background.
 - .2 Delete graphic picture.
 - .3 Call up and cancel display of graphic picture.
 - .4 Define symbols.
 - .5 Position and size symbols.
 - .6 Define background screens.
 - .7 Define connecting lines, curves.
 - .8 Locate, orient, size descriptive text.
 - .9 Define, display colours of all elements.
 - .10 Establish co-relation between symbols or text and associated system points or other graphic displays.
 - .5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent any logical grouping of system points or calculated data based upon building function, mechanical

- system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.
- .6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.
 - .7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress.
 - .8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01- EMCS: Site Requirements, Applications and Systems Sequences of Operation, and as directed by Owner's Representative. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and, flow sensor. Diagram to be single line schematic of ductwork as well as any associated heating coil or radiation valve. Owner's Representative to provide CAD. Provide display of TCU -VAV's in table form, include the following values as minimum; Space Temp, Setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Table to be organized by rooms and floor groupings.
 - .9 Provide complete directory of system graphics, including other pertinent information. Utilize mouse or pointing device to "point and click" to activate selected graphic.
 - .10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English language.
- .12 Event/Alarm Module: displays in window alarms as received and stored in General Event Log.
- .1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.
 - .2 Presentation of alarms to include features identified under applicable report definitions of report module paragraph.
 - .3 Alarm reports:
 - .1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.

- .2 Analog alarm limit summary: include point name, alarm limits, deviation limits.
- .3 Summary of alarm messages: include associated point name, alarm description.
- .4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.
- .5 EMCS to notify operator of occurrence of alarms originating at any field device within the following time periods of detection:
 - .1 Critical - 5 seconds.
 - .2 Cautionary - 10 seconds.
 - .3 Maintenance - 10 seconds.
- .6 Display alarm messages in English.
- .7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.
- .8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device acknowledgement. Steady state to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of any type of alarm not to impede notification of subsequent alarms or the function of Controller's/CDL. Random occurrence of alarms must not cause loss of any alarm or over-burden system. Acknowledgement of one alarm not to be considered as acknowledgement of any other alarms.
- .9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
 - .1 Controller not responding - where possible delineate between controller and communication line failure.
 - .2 Controller responding - return to normal.
 - .3 Controller communications bad - high error rate.
 - .4 Controller communications normal - return to normal.

- .10 Digital/alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.
- .13 Archiving and Restoration Module.
 - .1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.
 - .2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.
 - .3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.
- .14 CDL Generator and Modifier Module.
 - .1 CDL Generator module to permit generation and modification of CDLs.
 - .2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
 - .3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.
 - .4 Module to permit testing of code before downloading to building controllers.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

- .1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment.
 - .1 Install tamper locks on breakers of circuit panels.
 - .2 Refer to UPS requirements stated under OWS Hardware in PART 2.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for building automation controllers including:
 - .1 Master Control Unit (MCU).
 - .2 Local Control Unit (LCU)
 - .3 Equipment Control Unit (ECU).
 - .4 Terminal Control Unit (TCU).

1.2 RELATED SECTIONS

- .1 Section 25 05 01 - EMCS: General Requirements.
- .2 Section 25 05 02 - EMCS: Submittals and Review Process.
- .3 Section 25 05 03 - EMCS: Project Records Documents.
- .4 Section 25 30 02 - EMCS: Field Control Devices.
- .5 Section 25 90 01 – EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.3 REFERENCES

- .1 American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE, Applications Handbook, SI Edition.
 - .2 ASHRAE Standard 135 – BAC net – A Data Communications Protocol for Building Automation and Control Networks.
 - .3 ASHRAE Standard 135.1 Method of Test Conformance to BAC net.
- .2 Canadian Standards Association (CSA)
 - .1 C22.2 No.205, Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE)
 - .1 IEEE C37.90.1, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

1.4 DEFINITIONS

- .1 Acronyms used in this section include: see Section 25 05 01 - EMCS: General Requirements.

1.5 SYSTEM DESCRIPTION

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
 - .1 Provide sufficient controllers to meet intents and requirements of this section.
 - .2 Controllers' quantity and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units:
 - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
 - .2 Incorporate communication interface ports for communication LANs to exchange information with other Controllers.
 - .3 Capable of interfacing with operator interface device.
 - .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.6 DESIGN REQUIREMENTS

- .1 To include:
 - .1 Scanning of AI and DI connected inputs for detection of change of value and processing the detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including the resulting required states generated through programmable logic output.
 - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
 - .4 Control of systems as described in sequence of operations.
 - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least 25% of each point type distributed throughout the MCUs and LCUs.

- .3 Field Termination and Interface Devices.
 - .1 To conform to CSA C22.2 No. 205.
 - .2 Electronically interface sensors and control devices to processor unit.
 - .3 Include, but not be limited to, following:
 - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
 - .2 Power supplies for operation of logic devices and associated field equipment.
 - .3 Lockable wall cabinet.
 - .4 Required communications equipment and wiring.
 - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
 - .6 Input/Output interface to accept as minimum AI, AO, DI, DO functions as specified.
 - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
 - .4 AI interface equipment to:
 - .1 Convert analog signals to digital format with 12 bit analog-to-digital resolution.
 - .2 Provide for following input signal types and ranges:
 - .1 4 - 20 mA;
 - .2 0-10V DC
 - .3 10 K ohm.
 - .3 Meet IEEE C37.90.1 surge withstand capability.
 - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
 - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

- .5 AO interface equipment:
 - .1 Convert digital data from controller processor to acceptable analog output signals using 12 bit digital-to-analog resolution.
 - .2 Provide for following output signal types and ranges:
 - .1 4 - 20 mA.
 - .2 0 - 10 V DC.
 - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
 - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
 - .2 Meet IEEE C37.90.1 surge withstand capability.
 - .3 Accept pulsed inputs up to 2 kHz.
- .7 DO interface equipment:
 - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
 - .2 Switch up to 5 amps at 220 V AC using optional interface relay.
- .4 Controller's and associated hardware and software: operate in conditions of 0°C to 44°C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
 - .1 Provide for conduit entrance from top, bottom or sides of panel.
 - .2 ECUs to be mounted in equipment enclosures or separate enclosures.
 - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

1.7 SUBMITTALS

- .1 Make Submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 25 05 02 – EMCS: Submittals and Review Process.
 - .1 Submit product data sheets for each product item proposed for this project.

1.8 MAINTENANCE PROCEDURES

- .1 Provided manufacturers recommended maintenance procedures for insertion in Section 25 05 03 – EMCS: Project Record Documents.

Part 2 Products

2.1 MASTER CONTROL UNIT (MCU)

- .1 Primary function of MCU is to provide co-ordination and supervision of subordinate devices. Supervisory role shall include coordination of subordinate devices in the execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices. Include support for Open System Protocols, BACnet.
- .3 MCU shall have local I/O capacity as follows;
 - .1 To have at least 16 I/O points of which minimum to be 2AO, 6AI, 4DI, 4DO.
 - .2 LCU's to be added to support system functions as indicated in I/O Summary List.
- .4 Central Processor Unit (CPU)
 - .1 Processor to consist of at minimum a 16 bit microprocessor capable of supporting software to meet specified requirements.
 - .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
 - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least all performance and technical specifications. Memory to include:
 - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
 - .2 Battery backed (72 hr minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) RAM to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints,

alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS, CAB-Gateway, or locally installed floppy disk.

- .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving month/day/hour/minute/second, with rechargeable batteries for minimum 72 hr operation in event of power failure.
- .5 Local Operator Terminal (OT)
 - .1 OT to:
 - .1 Have integral access/display panel where immediate access to OWS is not available.
 - .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs additions and modifications.
 - .3 Simultaneously display minimum of 16 points with full English identification to allow operator to view single screen dynamic displays depicting entire mechanical systems.
 - .2 Functions to include, but not be limited to, following:
 - .1 Start and stop points.
 - .2 Modify setpoints.
 - .3 Modify PID loop setpoints.
 - .4 Override PID control.
 - .5 Change time/date.
 - .6 Add/modify/start/stop weekly scheduling.
 - .7 Add/modify setpoint weekly scheduling.
 - .8 Enter temporary override schedules.
 - .9 Define holiday schedules.
 - .10 View analog limits.
 - .11 Enter/modify analog warning limits.
 - .12 Enter/modify analog alarm limits.
 - .13 Enter/modify analog differentials.

- .3 OT to provide access to real and calculated points in controller to which it is connected or to any other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and any other controller in network.
- .4 Operator access to OTs to the same as OWS user password. Password changes to automatically be downloaded to controllers on network.
- .5 OT to provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
- .6 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

- .1 Provide multiple control functions for typical built-up and package HVAC, hydronic and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points of one Building System to be connected to one controller as listed in I/O Summary designations.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements. As per MCU requirements (section 2.3.4) above with the following additions:
 - .1 Include as minimum 2 interface ports for connection to local computer terminal.
 - .2 Design so that shorts, opens or grounds on any input or output will not interfere with other input or output signals.
 - .3 Physically separate line voltage (50V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
 - .4 Include power supplies for operation of LCU and associated field equipment.
 - .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
 - .6 Provide conveniently located screw type or spade lug terminals for field wiring.
 - .7 LCU to have 25 % spare input and 25 % output point capacity without addition of cards, terminals, etc.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
 - .1 The TCU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 VAV Terminal Controller
 - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
 - .2 Controller to support point definition; in accordance with section 25 05 01 – EMCS: General Requirements.
 - .3 Controller to operate independent of network in case of communication failure.
 - .4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.4 SOFTWARE

- .1 General:
 - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
 - .2 To include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
 - .3 Include initial programming of all Controllers, for entire system.
- .2 Program and data storage:
 - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
 - .2 Maintain CDL and operating data such as setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

- .3 Programming languages:
 - .1 Control Description Logic software to be programmed using English like or graphical, high level, general control language.
 - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed.
- .4 Operator terminal interface:
 - .1 MCU to perform operating and control functions specified Section 25 10 02 - EMCS: Operator Work Stations (OWS), including:
 - .1 Multi-level password access protection to allow user/manager to limit workstation control.
 - .2 Alarm management: processing and messages.
 - .3 Operator commands.
 - .4 Reports.
 - .5 Displays.
 - .2 Point identification.
- .5 Pseudo or calculated points:
 - .1 Software to have access to any value or status in controller or other networked controller so as to define and calculate pseudo point from other values/status of controller. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
 - .2 Inputs and outputs for any process to be able to include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to any number of other processes (eg. cascading).
- .6 Control Description Logic (CDL):
 - .1 Capable of generating on-line project-specific control loop algorithms (CDLs). CDLs to be software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
 - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (eg. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS or BC(s) and to tune control loops.

- .3 Perform changes to CDL on-line.
- .4 Control logic to have access to values or status of all points available to controller including global or common values, allowing cascading or inter-locking control.
- .5 Energy optimization routines such as enthalpy control, supply temperature reset, etc. to be LCU or MCU resident functions and form part of CDL.
- .6 MCU to be able to perform following pre-tested control algorithms:
 - .1 Two position control.
 - .2 Proportional Integral and Derivative (PID) control.
 - .3 Automatic control loop tuning.
- .7 Control software to provide the ability to define the time between successive starts for each piece of equipment to reduce cycling of motors.
- .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- .9 Power Fail Restart: Upon detection of power failure system to verify availability of emergency power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .7 Event and Alarm management: The system to use a management by exception concept for Alarm Reporting. This is a system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as a direct result of the primary event to be suppressed by the system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. The exception is, when an air handler which is supposed to stop or start fails to do so under the event condition.
- .8 Energy management programs: The following programs shall include specific summarizing reports, to include the date stamp indicating sensor details which activated and or terminated the feature.
 - .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
 - .1 Time of day scheduling.

- .2 Calendar based scheduling.
 - .3 Holiday scheduling.
 - .4 Temporary schedule overrides.
 - .5 Optimal start stop.
 - .6 Night setback control.
 - .7 Enthalpy (economizer) switchover.
 - .8 Peak demand limiting.
 - .9 Temperature compensated load rolling.
 - .10 Fan speed/flow rate control.
 - .11 Hot deck reset.
 - .12 Hot water reset.
 - .13 Night purge.
- .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
- .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.
- .9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.
- .1 MCUs to accumulate and store automatically run-time for binary input and output points.
 - .2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.
 - .3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.
 - .4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.
 - .5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWh, litres, tonnes, etc.).

- .6 Store event totalization records with minimum of 9,999,999 events before reset.
- .7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
 - .1 Display analog values digitally to 1 place of decimals with negative sign as required.
 - .2 Update displayed analog values and status when new values received.
 - .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
 - .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

- .1 Controllers (MCU, LCU) to support point naming convention as defined in Section 25 05 01 – EMCS: General Requirements.

Part 3 Execution

3.1 LOCATION

- .1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

- .1 Install Controllers in secure enclosures as indicated.
- .2 Provide necessary power from local 120 V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use Uninterruptible Power Supply (UPS) and emergency power when equipment must operate in an emergency and co-ordinating mode.

END OF SECTION

PART 1 General

1.1 RELATED SECTIONS

- .1 Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Section 25 05 03 - EMCS: Project Records Documents.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI C12.7, Requirements for Watthour Meter Sockets.
 - .2 ANSI/IEEE C57.13, Requirements for Instrument Transformers.
- .2 Canadian Standards Association
 - .1 CSA Type 1 Enclosure
 - .2 CSA Type 4X Enclosures
 - .3 CSA Type 12 Enclosures

1.3 SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Include:
 - .1 Information as specified for each device.
 - .2 Manufacturer's detailed installation instructions.
- .3 Pre-Installation Tests
 - .1 Submit samples at random from equipment shipped, as requested by Owner's Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .4 Manufacturer's Instructions
 - .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with Section 25 05 03 - EMCS: Project Records Documents.

PART 2 Products

2.1 GENERAL

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.
- .3 Operating conditions: 0 - 32 °C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters to be unaffected by external transmitters (eg. walkie talkies).
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in CSA 4X enclosures.
- .8 Devices to be installed in user occupied space must not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 TEMPERATURE SENSORS

- .1 General:
 - .1 Thermistors 10 K ohm, $\pm 0.2^{\circ}\text{C}$ accuracy, less than 0.1°C drift over 10 year span. Power supply 5 V dc, 10-35 Vdc, 24 Vac..
 - .2 RTD's: 1000 ohm at 0 °C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm°C.
 - .3 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.
- .2 Sensors:
 - .1 Adjustable room type: wall mounting, LCD display °C or °F. Setpoint adjustment, local indication, push button override for night set back function.
 - .2 Non-adjustable room type: wall mounting, stainless steel plate, sensing only.

- .3 General purpose duct type: suitable for insertion into ducts at any angle, insertion length 460 mm.
- .4 Averaging duct type: continuous filament with minimum immersion length 6000 mm. Bend probe at field installation time to 100 mm radius at any point along probe without degradation of performance.
- .5 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in CSA 4X enclosure.
- .6 Immersion type: spring loaded probe, NPT ½ fitting insertion to suit pipe size.

2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:
 - .1 Input circuit: to accept 3-lead, 100 ohm at 0 deg C, platinum resistance detector type sensors.
 - .2 Power supply: 575 ohms at 24 V DC into load of 575 ohms. Power supply effect less than 0.01 deg C per volt change.
 - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .4 Input and output short circuit and open circuit protection.
 - .5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
 - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
 - .7 Maximum current to 100 ohm RTD sensor: not to exceed 22.5 mA.
 - .8 Integral zero and span adjustments.
 - .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 °C.
 - .10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.
 - .11 Transmitter ranges: Select narrowest range to suit application from following:
 - .1 Minus 50 °C to plus 50 °C, plus or minus 0.5 °C.
 - .2 0 to 100 °C, plus or minus 0.5 °C.
 - .3 0 to 50 °C, plus or minus 0.25 °C.
 - .4 0 to 25 °C, plus or minus 0.1 °C.

.5 10 to 35 °C, plus or minus 0.25°C.

2.4 HUMIDITY SENSORS

.1 Requirements:

- .1 Range: 5 - 95 % RH minimum.
- .2 Operating temperature range: -40°C to 85°C.
- .3 Absolute accuracy:
 - .1 Duct sensors: plus or minus 5 %.
 - .2 Room sensors: plus or minus 2 % .
- .4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
- .5 Maintenance: by simple field method such as washing with solvent or mild detergent solution so as to remove anticipated airborne contaminants.
- .6 Maximum sensor non-linearity: plus or minus 0.5% RH with defined curves.
- .7 Room sensors: wall mounted as indicated.
- .8 Duct mounted sensors: locate so that sensing element is between 1/3 and 2/3 distance across any duct dimension.
- .9 Sensors to be unaffected by external transmitters such as walkie-talkies. Demonstrate to Owner's Representative.
- .10 Power supply: 18-35 Vdc, 18-32 Vac with temperature sensor.

2.5 HUMIDITY TRANSMITTERS

.1 Requirements:

- .1 Input signal: from 1000 ohm RTD.
- .2 Output signal: 4 - 20 mA into 1000 ohm maximum load, 0-5 Vdc, 0-10 Vdc.
- .3 Input and output short circuit and open circuit protection.
- .4 Output accuracy: not to exceed 0.1 % of full span.
- .5 Output linearity error: plus or minus 1.0 % maximum of full scale output.
- .6 Integral zero and span adjustment.
- .7 Temperature range: 0-70°C, -40°C to 85°C for outside air.

- .8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.6 PRESSURE/CURRENT (P/I) TRANSMITTERS

.1 Requirements:

- .1 Range: as indicated in I/O summaries.
 - .1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.
 - .2 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
- .2 Output signal: 4 - 20 mA, 0-5V, 0-10V.
- .3 Output variations: ± 1 % full scale for supply voltage variations of plus or minus 10 %.
- .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 1% of full scale output over entire range.
- .5 Integral zero and span adjustment.
- .6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 °C.
- .7 Over-pressure input protection to at least twice rated input pressure.
- .8 Output short circuit and open circuit protection.
- .9 Pressure ranges: see I/O Summaries.
- .10 Accuracy: plus or minus 1 % of full scale.
- .11 LCD Display.

2.7 DIFFERENTIAL PRESSURE (KPA) TRANSMITTERS

.1 Requirements:

- .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
- .2 Output signal: 4 - 20 mA, 0-5V, 0-10V.
- .3 Output variations: ± 1 % full scale for supply voltage variations of plus or minus 10 %.
- .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 1 % of full scale output over entire range.
- .5 Integral zero and span adjustment.

- .6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 °C.
- .7 Over-pressure input protection to at least twice rated input pressure.
- .8 Output short circuit and open circuit protection.
- .9 The unit to have a NPT connections. The enclosure shall be an integral part of the unit.
- .10 LCD Display.

2.8 DIFFERENTIAL PRESSURE (PA) TRANSMITTERS

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA in 400 ohms, 0-5V into 5K ohms minimum, 0-10 V into 10K ohms minimum.
 - .2 Output variations: $\pm 1\%$ full scale for supply voltage variations of plus or minus 10%.
 - .3 Integral zero and span adjustment.
 - .4 Temperature effects: not to exceed plus or minus 3% full scale/ 50 C.
 - .5 Output short circuit and open circuit protection.
 - .6 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.
 - .7 Pressure ranges: see I/O Summaries.
 - .8 LCD Display.

2.9 FAN SYSTEM STATIC PRESSURE SENSORS

- .1 As per 2.10

2.10 FAN SYSTEM STATIC PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Output signal: 4 - 20 mA in 400 ohms, 0-5V into 5K ohms minimum, 0-10 V into 10K ohms minimum.
 - .2 Output variations: $\pm 1\%$ full scale for supply voltage variations of plus or minus 10%.
 - .3 Integral zero and span adjustment.
 - .4 Temperature effects: not to exceed plus or minus 3% full scale/ 50 C.

- .5 Output short circuit and open circuit protection.
- .6 The unit to have a NPT ½ conduit connection. The enclosure shall be an integral part of the unit.
- .7 Pressure ranges: see I/O Summaries.
- .8 LCD Display.

2.11 PRESSURE AND DIFFERENTIAL PRESSURE SENSORS AND SWITCHES

- .1 Requirements:
 - .1 Range: as indicated in I/O summaries.
 - .1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.
 - .2 Adjustable setpoint and differential.
 - .3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC.
 - .4 Sensor assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
 - .5 Accuracy: within 2% repetitive switching.
 - .6 Provide sensor pressure and accuracy ratings:
 - .1 Chilled and condenser water: 860 kPa.
 - .2 Hot water: 860 kPa.
 - .3 Low pressure steam, compressed air: 1050 kPa. Range: 0 to 200 kPa. Accuracy: plus or minus 3 kPa.
 - .4 Medium pressure steam, compressed air: 1050 kPa. Range: 0 to 700 kPa. Accuracy: plus or minus 7 kPa.
 - .5 High pressure steam: 2100 kPa. Range: 0 to 2100 kPa. Accuracy: plus or minus 14 kPa.
 - .6 High temperature water: 2700 kPa. Range: 0-2700 kPa. Accuracy: plus or minus 25 kPa.
 - .7 For fan operation: Range: 0 to 3000 Pa. Adjustable differential: 10 to 300 Pa.
 - .7 Provide sensors with isolation valve and snubber between sensor and pressure source on liquid service.

- .8 Sensors on steam and high temperature hot water service: provide pigtail syphon.

2.12 TEMPERATURE SWITCHES

.1 Requirements:

- .1 Range: see I/O summaries.
- .2 Temperature sensor: liquid, vapour or bimetallic type. Operate automatically. Reset automatically, except as follows:
 - .1 Freeze protection: manual reset. Optional if software does not auto restart.
 - .2 Fire detection: manual reset. Optional if software does not auto restart.
 - .3 Duct Heater: high limit manual reset in addition to automatic reset.
- .3 Adjustable setpoint and differential.
- .4 Accuracy: plus or minus 1 °C.
- .5 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
- .6 Type as follows:
 - .1 Room: for wall mounting on standard electrical box with or without protective guard as indicated.
 - .2 Duct, general purpose: insertion length = 460 mm.
 - .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
 - .4 Freeze detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 300 mm length.
 - .5 Strap-on: with helical screw stainless steel clamp.

2.13 CURRENT/PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:

- .1 Input range: 4 to 20 mA.
- .2 Output range: proportional 20-104 kPa.
- .3 Housing: dustproof or panel mounted.

- .4 Internal materials: suitable for continuous contact with industrial standard instrument air.
- .5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2 % of full scale over entire range.
- .6 Integral zero and span adjustment.
- .7 Temperature effect: plus or minus 2.0 % full scale/ 50 °C or less.
- .8 Regulated supply pressure: 206 kPa maximum.
- .9 Air consumption: 16.5 ml/s maximum.
- .10 Integral gauge manifold c/w gauge (0-206 kPa).

2.14 AIR PRESSURE GAUGES

- .1 Diameter: 38 mm minimum.
- .2 Range: zero to two times operating pressure of measured pressure media to nearest standard range.

2.15 ELECTRICAL RELAYS

- .1 Requirements:
 - .1 Double voltage, DPDT, plug-in type with termination base.
 - .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
 - .3 Contacts: rated at 5 amps at 120 V AC.
 - .4 Relay to have visual status indication

2.16 SOLID STATE RELAYS

- .1 Requirements:
 - .1 CSA approved.
 - .2 Suitable to the application as recommended by manufacturer.
 - .3 Voltage range: 75-265 VAC
 - .4 Panel mounting.
 - .5 Suitable for AC or DC loads.
 - .6 Output surge absorbing element for inductive on/off loads.

- .7 Input capacitor/resistor circuit for pulse noise absorption.
- .8 For input inductive noise use twisted-pair wires for electromagnetic noise and shielded cable for static noise.

2.17 CURRENT TRANSDUCERS

- .1 Requirements:
 - .1 Range: in accordance with Equipment Schedules.
 - .2 Purpose: measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-5 volt DC.
 - .3 0-10 volts DC.
 - .4 2-10 volts DC.
 - .3 Frequency insensitive from 10 - 80 hz.
 - .4 Accuracy to 0.5% full scale.
 - .5 Zero and span adjustments. Field adjustable range to suit motor applications.
 - .6 Adjustable mounting bracket to allow for secure/safe mounting inside the MCC or starter enclosure.

2.18 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Complete with metering transformer ranged to match load, plug-in base and shorting shunt to protect current transformer when relay is removed from socket.
 - .2 Suitable for single or 3 phase metering into single relay.
 - .3 To have adjustable latch level, adjustable delay on latch and minimum differential of 10 % of latch setting between latch level and release level.
 - .4 3-Phase application: provide for discrimination between phases.
 - .5 To have adjustable latch level to allow detection of worst case selection. To be powered from control circuit of motor starter being metered. Relay and base to be mounted in adjacent auxiliary cabinet only if control circuit power to be brought into auxiliary cabinet. Adjustments to be acceptable from auxiliary cabinet.
 - .6 Relay contacts: capable of handling 10 amps at 240 V AC.

2.19 CONTROL DAMPERS

- .1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 2438 mm high. Multiple sections to have stiffening mullions and jack shafts.
- .2 Materials
 - .1 Frame: 2.3 mm minimum thickness galvanized steel.
 - .2 Blades: galvanized steel with two sheets 0.5 mm thick or otherwise reinforced to ensure specified low leakage when fully closed.
 - .3 Bearings: oil impregnated sintered bronze. Provide thrust bearings for vertical blades.
 - .4 Linkage and shafts: zinc plated steel.
 - .5 Seals: replaceable neoprene or stainless steel spring on sides, top, bottom of frame, along all blade edges and blade ends.
- .3 Performance:
 - .1 Capacity: refer to I/O Summaries.
 - .2 0.02 L/s.m² maximum allowable leakage against 1000 Pa static pressure.
 - .3 Temperature range: minus 50°C to plus 100°C.
 - .4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

2.20 ELECTRONIC CONTROL DAMPER OPERATORS

- .1 Requirements
 - .1 Push-pull proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
 - .3 Operator: size so as to control dampers against maximum pressure or dynamic closing pressure (whichever is greater).
 - .4 Power requirements: 5 VA maximum at 24 V AC.
 - .5 Operating range: 4-20 mA. 0-10 V DC, 2-10 V DC.

2.21 CONTROL VALVES

.1 Requirements:

- .1 NPS 2 and under: bronze with screwed ends.
- .2 NPS 2 1/2 and over: cast iron with flanged ends.
- .3 Trim: type 316 stainless steel.
- .4 Leakage: 0.5 % of rated flow maximum.
- .5 Two or three port as indicated. Normally Open or Normally Closed, as indicated.
- .6 Flow characteristics: linear or equal percentage as indicated.
- .7 Rangeability: 50:1 minimum.
- .8 Performance: Capacity refer to I/O Summaries and Valve Schedule.

2.22 ELECTRONIC/ELECTRIC VALVE ACTUATORS

.1 Requirements:

- .1 Construction: steel, cast iron, aluminum.
- .2 Control voltage: 0-5, 0-10, 2-10V DC, or 4-20 mA.
- .3 Positioning time: to suit application, 90 sec maximum.
- .4 Spring return to normal position as indicated.

2.23 PANELS

- .1 Either free-standing or wall mounted enameled steel cabinets with hinged and key-locked front door.
- .2 To be modular multiple panels as required to handle requirements with additional space to accommodate future capacity as required by Owner's Representative without adding additional cabinets.
- .3 Panels to be lockable with same key.

PART 3 Execution

3.1 INSTALLATION

- .1 Install field control devices, conduit, and wire in accordance with manufacturers recommended methods, procedures, and instructions. Wiring and conduit above 50 volts by electrical Division. Coordinate requirements with Electrical Contactor.
- .2 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in CSA 2 enclosures or as required for specific applications. Provide for electrolytic isolation in all cases when dissimilar metals make contact.
- .3 Support field-mounted transmitters, sensors on pipe stands or channel brackets.
- .4 Install wall mounted devices on plywood panel properly attached to wall.

3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by stainless steel shields.
 - .2 Install in CSA 4X enclosures.
- .4 Duct installations
 - .1 Do not mount in dead air space.
 - .2 Location to be within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor used to sense average temperature.
 - .4 Thermally isolate elements from brackets and supports so as to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors:
 - .1 Sensor length to be not less than 1000 mm per square metre of duct cross-sectional area.
 - .2 Use multiple sensors where single sensor does not meet minimum length ratio. Wire multiple sensors in series for freeze protection applications.

- .3 Wire multiple sensors separately for temperature measurement.
- .4 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.
- .6 Thermowells: install for piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.

3.3 PANELS

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).
- .3 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .4 Identify wiring and conduit clearly.

3.4 MAGNEHELIC PRESSURE INDICATORS

- .1 Install adjacent to fan system static pressure sensor and duct system velocity pressure sensors (as approved by the Owner's Representative).
- .2 Locations to be as indicated or specified.

3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

- .1 Install isolation valve and snubber on sensors between sensor and pressure source. In addition, protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

3.6 I/P TRANSDUCERS

- .1 Install air pressure gauge on outlet.

3.7 PRESSURE GAUGES

- .1 Install on pneumatic systems only.
- .2 Install pressure gauges on pneumatic devices, I/P, pilot positioners, motor operators, switches, relays, valves, damper operators, valve actuators.
- .3 Install pressure gauge on output of controller and auxiliary cabinet pneumatic devices.

3.8 AIR PRESSURE GAUGES

- .1 Install on pneumatic systems only.

- .2 Install on pneumatic devices including I/P's, pilot positioners, motor operators.

3.9 IDENTIFICATION

- .1 Identify field devices properly.
- .2 Refer to Section 25 05 54 - EMCS: Identification.

3.10 TESTING

- .1 Calibrate and test field devices for accuracy and performance. Submit report detailing tests performed, results obtained to Owner's Representative for approval. Owner's Representative will verify results at random. Provide testing equipment and manpower necessary for this verification.

3.11 COMMISSIONING

- .1 Refer to Section 25 08 20 - EMCS: Warranty and Maintenance.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
 - .1 Control Description Logic (CDL) for each system.
 - .2 Input/Output Point Summary Tables for each system.
 - .3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2 REFERENCES

- .1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.
 - .1 MD13800, Energy Management and Control Systems (EMCS) Design Manual.
English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.3 SEQUENCING

- .1 Present sequencing of operations for system, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.
- .2 There is currently an existing Automated Logic controls system installed in this facility. Refer to Appendix A for existing EMCS Shop Drawings.
- .3 Sequencing of operations for system as follows:
 - .1 Occupied/Unoccupied Schedule
 - .1 EMCS shall have an operator-adjustable occupied/unoccupied time of day schedule, which will be utilized by various HVAC systems. The initial schedule shall be coordinated with the owner.
 - .2 Boiler/Hydronic Heating System Control
 - .1 The boiler/hydronic heating system shall operate in either seasonal or manual mode, selectable by the operator.
 - .2 When operating in seasonal mode:
 - .1 EMCS shall have an operator-adjustable setpoint (day) in the spring to disable the electric boiler and associated pumps, control valves, etc.
 - .2 EMCS shall have an operator-adjustable setpoint (day) in the fall to enable the electric boiler and associated pumps, control valves, etc.
 - .3 EMCS shall have an operator-adjustable outdoor air temperature

- automatic override setpoint. Below this setpoint, the electric boiler and associated pumps, control valves, etc. shall be automatically enabled. Initial setpoint 10 degrees C.
- .3 When operating in manual mode:
- .1 EMCS shall allow the operator to enable/disable the electric boiler and associated pumps, control valves, etc.
- .2 EMCS shall have an operator-adjustable outdoor air temperature automatic override setpoint. Below this setpoint, the electric boiler and associated pumps, control valves, etc. shall be automatically enabled. Initial setpoint 10 degrees C.
- .3 Existing Energy Recovery Ventilators (ERV-1/2)
- .1 ERV systems shall operate continuously during the occupied period to provide outdoor air to the spaces served by VRF evaporators.
- .2 Upon system start, the outdoor air intake dampers shall open. Outdoor air dampers shall remain closed during the unoccupied period.
- .3 When the damper position limit switch verifies the open position, EMCS shall start the ERV and display the damper switch open/closed position.
- .4 EMCS shall display supply and exhaust air status based on the duct-mounted flow proving switch and generate alarm if the airflow fails. If failure alarm is generated, shut off the ERV.
- .5 EMCS shall display and trend the following temperatures:
- .1 Outdoor air intake temperature
- .2 ERV supply air temperature (upstream of heating coil)
- .3 ERV supply air temperature (downstream heating coil)
- .4 Exhaust air temperature entering ERV
- .5 Exhaust air temperature leaving ERV
- .6 When the outdoor air temperature is below 10 degrees C, EMCS shall modulate the ERV supply air SCR heating coil to maintain an ERV supply air temperature of 21 degrees C. When the outdoor air temperature is above 10 degrees C, the ERV heating coil control shall be off.
- .7 EMCS shall generate alarms (at OWS and via email) if the ERV supply air temperature rises above 25 degrees C or falls below 8 degrees C for 5 minutes.
- .8 EMCS shall display and trend the relative humidity of the exhaust air from the space.
- .9 ERV shall shut down on signal from the fire alarm panel.
- .10 Return duct smoke detector shall send signal to fire alarm panel in the event of smoke in the return duct.
- .4 VRF System Heating/Cooling Mode Control (EVAP-1 to EVAP-5 & COND-1)
- .1 EMCS shall have an operator-adjustable outdoor air temperature setpoint where the VRF system switches between cooling mode (OAT > setpoint) and heating mode (OAT < setpoint).
- .2 When the building is unoccupied, VRF system cooling mode shall be disabled.

- .3 EMCS shall have a manual override which allows the operator to lock the VRF system in heating or cooling mode for an operator-adjustable period of time.
- .4 EMCS shall have an operator-adjustable outdoor air temperature automatic override setpoint. If, during the time the system is manually placed in cooling mode, the outdoor air temperature falls below this setpoint, the VRF system shall automatically switch to heating mode. This setpoint must be a minimum of 2 degrees C below the cooling/heating mode switch setpoint in sentence 1.
- .5 All automatic switches between heating and cooling mode shall start a timer of operator-adjustable length. Until this timer expires, the system shall not switch modes unless via manual override. The minimum timer length shall be determined and verified by the engineer and VRF equipment supplier.

.5 VRF EVAP-1 - Zone Control

- .1 Spaces Served: Room 201, Room 205/207
- .2 When the VRF system is in occupied mode, the evaporator fan shall operate continuously at low speed to distribute outdoor air from ERV-1, and the zone control dampers shall open 100%. The fan speed may increase, and zone control dampers may close to minimum position as part of the cooling and heating control sequences.
Note: Zone control damper minimum positions to be set during air balancing.
- .3 When the VRF system is in unoccupied mode, the evaporator fan shall operate only on a call for heating in the spaces served. When the fan is off, the zone control dampers shall be fully closed.
- .4 EMCS shall display the occupant-adjustable room temperature setpoint(s). Temperature setpoint min and max shall be operator adjustable via EMCS.
- .5 EMCS shall display and trend the actual room temperature.
- .6 When the VRF system is operating in Heating mode:
 - .1 Stage 1 Heating
 - .1 EMCS shall energize the evaporator heat pump heating cycle on a call for heat from any of the spaces served by the evaporator and start the evaporator fan (if in unoccupied mode). The fan and heating cycle shall run for a minimum of 15 minutes (Operator-adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position.
Note: Room 205/207 has two zone control dampers. These dampers shall modulate simultaneously in parallel

- positions.*
 - .5 Once all zone heating setpoints are met:
 - .1 De-energize heating cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
- .2 Stage 2 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 1 heating at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 205/207 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone heating setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
- .3 Stage 3 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 2 heating at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 205/207 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone heating setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Stage 4 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 3 heating at high fan speed and with a fully open zone control damper, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s) if the boiler/hydronic heating system is enabled.
 - .2 If one zone's heating setpoint is met without auxiliary heat being used, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 205/207 has two zone control dampers. These

- dampers shall modulate simultaneously in parallel positions.*
- .3 Once all zone heating setpoints are met, disable Stage 4 auxiliary heating for the area served and return to Stage 3.
 - .5 Each space shall have an overheat evaporator heating override mode that can be enabled or disabled by the operator. If this override is enabled and the space high temperature alarm is initiated while the system is in occupied mode:
 - .1 Verify that the boiler/hydronic heating system is enabled.
 - .2 The evaporator heating cycle shall be disabled for 1 hour (operator-adjustable duration).
 - .3 During this time, the spaces served shall be heated by the boiler/hydronic heating system by initiating a call for auxiliary heat and opening the associated hydronic heating temperature control valve(s).
 - .4 Zone control dampers shall return to fully open position, and fans shall operate in ventilation mode (if the zone is in occupied mode).
 - .5 After the override time expires, the system shall return to Stage 1 heating by the VRF.
 - .7 When the VRF system is operating in Cooling mode.
 - .1 Stage 1 Cooling:
 - .1 EMCS shall energize the evaporator heat pump cooling cycle on a call for cooling from any of the spaces served by the evaporator. The cooling cycle shall run for a minimum of 15 minutes (operator adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position.

Note: Room 205/207 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .5 Once all zone cooling setpoints are met:
 - .1 De-energize cooling cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
 - .2 Stage 2 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at low fan speed and with a fully open zone control damper, increase evaporator fan to

- mid speed.
- .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
Note: Room 205/207 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
- .3 Once all zone cooling setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
- .3 Stage 3 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
Note: Room 205/207 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone cooling setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Each zone shall have an overcooled space setpoint, set below the space cooling setpoint but above the space low temperature alarm setpoint. If the space temperature falls below this setpoint:
 - .1 Ensure the associated zone control damper is at minimum position.
 - .2 Ensure the boiler/hydronic heating system is enabled.
 - .3 Initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
- .8 EMCS shall generate an alarm (at OWS and via email) upon failure of any evaporator.
- .9 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .10 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .11 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .12 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.
- .6 VRF EVAP-2 - Zone Control
 - .1 Spaces Served: Room 202, Room 300, Room 301

- .2 When the VRF system is in occupied mode, the evaporator fan shall operate continuously at low speed to distribute outdoor air from ERV-1, and the zone control dampers shall open 100%. The fan speed may increase and zone control dampers may close to minimum position as part of the cooling and heating control sequences.
Note: Zone control damper minimum positions to be set during air balancing.
- .3 When the VRF system is in unoccupied mode, the evaporator fan shall operate only on a call for heating in the spaces served. When the fan is off, the zone control dampers shall be fully closed.
- .4 EMCS shall display the occupant-adjustable room temperature setpoint(s). Temperature setpoint min and max shall be operator adjustable via EMCS.
- .5 EMCS shall display and trend the actual room temperature.
- .6 When the VRF system is operating in Heating mode:
 - .1 Stage 1 Heating
 - .1 EMCS shall energize the evaporator heat pump heating cycle on a call for heat from any of the spaces served by the evaporator and start the evaporator fan (if in unoccupied mode). The fan and heating cycle shall run for a minimum of 15 minutes (Operator-adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position.
 - .5 Once all zone heating setpoints are met:
 - .1 De-energize heating cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
 - .2 Stage 2 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 1 heating at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
 - .3 Once all zone heating setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
 - .3 Stage 3 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 2 heating at mid fan speed and with a

- fully open zone control damper, increase evaporator fan to high speed.
- .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
- .3 Once all zone heating setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Stage 4 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 3 heating at high fan speed and with a fully open zone control damper, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s) if the boiler/hydronic heating system is enabled.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
 - .3 Once all zone heating setpoints are met, disable Stage 4 auxiliary heating for the area served and return to Stage 3.
- .5 Each space shall have an overheat evaporator heating override mode that can be enabled or disabled by the operator. If this override is enabled and the space high temperature alarm is initiated while the system is in occupied mode:
 - .1 Verify that the boiler/hydronic heating system is enabled.
 - .2 The evaporator heating cycle shall be disabled for 1 hour (operator-adjustable duration).
 - .3 During this time, the spaces served shall be heated by the boiler/hydronic heating system by initiating a call for auxiliary heat and opening the associated hydronic heating temperature control valve(s).
 - .4 Zone control dampers shall return to fully open position, and fans shall operate in ventilation mode (if the zone is in occupied mode).
 - .5 After the override time expires, the system shall return to Stage 1 heating by the VRF.
- .7 When the VRF system is operating in Cooling mode.
 - .1 Stage 1 Cooling:
 - .1 EMCS shall energize the evaporator heat pump cooling cycle on a call for cooling from any of the spaces served by the evaporator. The cooling cycle shall run for a minimum of 15 minutes (operator adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum

- position.
- .5 Once all zone cooling setpoints are met:
 - .1 De-energize cooling cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
- .2 Stage 2 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
 - .3 Once all zone cooling setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
- .3 Stage 3 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
 - .3 Once all zone cooling setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Each zone shall have an overcooled space setpoint, set below the space cooling setpoint but above the space low temperature alarm setpoint. If the space temperature falls below this setpoint:
 - .1 Ensure the associated zone control damper is at minimum position.
 - .2 Ensure the boiler/hydronic heating system is enabled.
 - .3 Initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
- .8 EMCS shall generate an alarm (at OWS and via email) upon failure of any evaporator.
- .9 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .10 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .11 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.

- .12 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.7 VRF EVAP-3 - Zone Control

- .1 Spaces Served: Room 104, Room 106, Room 115, Room 208, Room 209
- .2 When the VRF system is in occupied mode, the evaporator fan shall operate continuously at low speed to distribute outdoor air from ERV-1, and the zone control dampers shall open 100%. The fan speed may increase and zone control dampers may close to minimum position as part of the cooling and heating control sequences.
Note: Zone control damper minimum positions to be set during air balancing.
- .3 When the VRF system is in unoccupied mode, the evaporator fan shall operate only on a call for heating in the spaces served. When the fan is off, the zone control dampers shall be closed.
- .4 EMCS shall display the occupant-adjustable room temperature setpoint(s). Temperature setpoint min and max shall be operator adjustable via EMCS.
- .5 EMCS shall display and trend the actual room temperature.
- .6 When the VRF system is operating in Heating mode:
- .1 Stage 1 Heating
- .1 EMCS shall energize the evaporator heat pump heating cycle on a call for heat from any of the spaces served by the evaporator and start the evaporator fan (if in unoccupied mode). The fan and heating cycle shall run for a minimum of 15 minutes (Operator-adjustable) before being eligible to be disabled.
- .2 EMCS shall modulate the zone control dampers 100% open.
- .3 Evaporator fan shall initially operate on low speed.
- .4 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position.
Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
- .5 Once all zone heating setpoints are met:
- .1 De-energize heating cycle.
- .2 Return all zone control dampers to fully open position.
- .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
- .2 Stage 2 Heating
- .1 If any zone heating setpoint is not achieved within 15

- minutes with Stage 1 heating at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
- .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
- .3 Once all zone heating setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
- .3 Stage 3 Heating
- .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 2 heating at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
- .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
- .3 Once all zone heating setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Stage 4 Heating
- .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 3 heating at high fan speed and with a fully open zone control damper, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s) if the boiler/hydronic heating system is enabled.
Note: Room 106 has electric auxiliary heat, and Room 115 does not have any auxiliary heat
- .2 If one zone's heating setpoint is met without auxiliary heat being used, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
- .3 Once all zone heating setpoints are met, disable Stage 4 auxiliary heating for the area served and return to Stage 3.
- .5 Each space shall have an overheat evaporator heating override mode that can be enabled or disabled by the operator. If this override is enabled and the space high temperature alarm is initiated while the system is in occupied mode:
- .1 Verify that the boiler/hydronic heating system is enabled.

- .2 The evaporator heating cycle shall be disabled for 1 hour (operator-adjustable duration).
- .3 During this time, the spaces served shall be heated by the boiler/hydronic heating system by initiating a call for auxiliary heat and opening the associated hydronic heating temperature control valve(s).
- .4 Zone control dampers shall return to fully open position, and fans shall operate in ventilation mode (if the zone is in occupied mode).
- .5 After the override time expires, the system shall return to Stage 1 heating by the VRF.
- .7 When the VRF system is operating in Cooling mode.
 - .1 Stage 1 Cooling:
 - .1 EMCS shall energize the evaporator heat pump cooling cycle on a call for cooling from any of the spaces served by the evaporator. The cooling cycle shall run for a minimum of 15 minutes (operator adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position.

Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .5 Once all zone cooling setpoints are met:
 - .1 De-energize cooling cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
 - .2 Stage 2 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.

Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone cooling setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.

- .3 Stage 3 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
Note: Room 104 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone cooling setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
 - .4 Each zone shall have an overcooled space setpoint, set below the space cooling setpoint but above the space low temperature alarm setpoint. If the space temperature falls below this setpoint:
 - .1 Ensure the associated zone control damper is at minimum position.
 - .2 Ensure the boiler/hydronic heating system is enabled.
 - .3 Initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
Note: Room 106 has electric auxiliary heat, and Room 115 does not have any auxiliary heat.
 - .8 EMCS shall generate an alarm (at OWS and via email) upon failure of any evaporator.
 - .9 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
 - .10 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
 - .11 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
 - .12 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.
- .8 VRF EVAP-4 - Zone Control
- .1 Spaces Served: Room 110, Room 111, Room 217, Room 220, Room 302
Note: Room 111 is an unoccupied LAN room. This room is to have the zone control damper indefinitely closed and the hydronic heating control valve shall remain closed. This room shall not control any aspect of the VRF/evaporator control at this time. The space temperature sensor shall be used for monitoring, trending, and alarming only. See Par. 12 below.
 - .2 When the VRF system is in occupied mode, the evaporator fan shall operate continuously at low speed to distribute outdoor air from ERV-1,

and the zone control dampers shall open 100%. The fan speed may increase and zone control dampers may close to minimum position as part of the cooling and heating control sequences.

Note: Zone control damper minimum positions to be set during air balancing.

- .3 When the VRF system is in unoccupied mode, the evaporator fan shall operate only on a call for heating in the spaces served. When the fan is off, the zone control dampers shall be closed.
- .4 EMCS shall display the occupant-adjustable room temperature setpoint(s). Temperature setpoint min and max shall be operator adjustable via EMCS.
- .5 EMCS shall display and trend the actual room temperature.
- .6 When the VRF system is operating in Heating mode:
 - .1 Stage 1 Heating
 - .1 EMCS shall energize the evaporator heat pump heating cycle on a call for heat from any of the spaces served by the evaporator and start the evaporator fan (if in unoccupied mode). The fan and heating cycle shall run for a minimum of 15 minutes (Operator-adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position.
 - .5 Once all zone heating setpoints are met:
 - .1 De-energize heating cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
 - .2 Stage 2 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 1 heating at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
 - .3 Once all zone heating setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
 - .3 Stage 3 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 2 heating at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.

- .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
- .3 Once all zone heating setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Stage 4 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 3 heating at high fan speed and with a fully open zone control damper, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s) if the boiler/hydronic heating system is enabled.
Note: Room 110 has both hydronic and electric auxiliary heat. Hydronic heat should be used first if boiler system is enabled. Electric heat may be staged on as required to maintain setpoint.
 - .2 If one zone's heating setpoint is met without auxiliary heat being used, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
 - .3 Once all zone heating setpoints are met, disable Stage 4 auxiliary heating for the area served and return to Stage 3.
- .5 Each space shall have an overheat evaporator heating override mode that can be enabled or disabled by the operator. If this override is enabled and the space high temperature alarm is initiated while the system is in occupied mode:
 - .1 Verify that the boiler/hydronic heating system is enabled.
 - .2 The evaporator heating cycle shall be disabled for 1 hour (operator-adjustable duration).
 - .3 During this time, the spaces served shall be heated by the boiler/hydronic heating system by initiating a call for auxiliary heat and opening the associated hydronic heating temperature control valve(s).
 - .4 Zone control dampers shall return to fully open position, and fans shall operate in ventilation mode (if the zone is in occupied mode).
 - .5 After the override time expires, the system shall return to Stage 1 heating by the VRF.
- .7 When the VRF system is operating in Cooling mode.
 - .1 Stage 1 Cooling:
 - .1 EMCS shall energize the evaporator heat pump cooling cycle on a call for cooling from any of the spaces served by the evaporator. The cooling cycle shall run for a minimum of 15 minutes (operator adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.

- .3 Evaporator fan shall initially operate on low speed.
- .4 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position.
- .5 Once all zone cooling setpoints are met:
 - .1 De-energize cooling cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
- .2 Stage 2 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
 - .3 Once all zone cooling setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
- .3 Stage 3 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
 - .3 Once all zone cooling setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Each zone shall have an overcooled space setpoint, set below the space cooling setpoint but above the space low temperature alarm setpoint. If the space temperature falls below this setpoint:
 - .1 Ensure the associated zone control damper is at minimum position.
 - .2 Ensure the boiler/hydronic heating system is enabled.
 - .3 Initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
Note: Room 110 has both hydronic and electric auxiliary heat. Hydronic heat should be used first if boiler system is enabled. Electric heat may be staged on as required to maintain setpoint.
- .8 EMCS shall generate an alarm (at OWS and via email) upon failure of any evaporator.
- .9 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount

- above the space temperature setpoint (ex. setpoint + 5C).
- .10 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
 - .11 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
 - .12 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.9 VRF EVAP-5 - Zone Control

- .1 Spaces Served: Room 112, Room 214, Room 215, Room 218, Room 303
- .2 When the VRF system is in occupied mode, the evaporator fan shall operate continuously at low speed to distribute outdoor air from ERV-1, and the zone control dampers shall open 100%. The fan speed may increase and zone control dampers may close to minimum position as part of the cooling and heating control sequences.
Note: Zone control damper minimum positions to be set during air balancing.
- .3 When the VRF system is in unoccupied mode, the evaporator fan shall operate only on a call for heating in the spaces served. When the fan is off, the zone control dampers shall be closed.
- .4 EMCS shall display the occupant-adjustable room temperature setpoint(s). Temperature setpoint min and max shall be operator adjustable via EMCS.
Note: Room 214 does not have an occupant-adjustable thermostat. The space setpoint shall be adjustable by the operator via EMCS.
- .5 EMCS shall display and trend the actual room temperature.
- .6 When the VRF system is operating in Heating mode:
 - .1 Stage 1 Heating
 - .1 EMCS shall energize the evaporator heat pump heating cycle on a call for heat from any of the spaces served by the evaporator and start the evaporator fan (if in unoccupied mode). The fan and heating cycle shall run for a minimum of 15 minutes (Operator-adjustable) before being eligible to be disabled.
 - .2 EMCS shall modulate the zone control dampers 100% open.
 - .3 Evaporator fan shall initially operate on low speed.
 - .4 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position.
 - .5 Once all zone heating setpoints are met:
 - .1 De-energize heating cycle.
 - .2 Return all zone control dampers to fully open position.

- .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.
- .2 Stage 2 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 1 heating at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 112 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone heating setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
- .3 Stage 3 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 2 heating at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's heating setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 112 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone heating setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
- .4 Stage 4 Heating
 - .1 If any zone heating setpoint is not achieved within 15 minutes with Stage 3 heating at high fan speed and with a fully open zone control damper, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s) if the boiler/hydronic heating system is enabled.
Note: Room 112 does not have any auxiliary heat.
 - .2 If one zone's heating setpoint is met without auxiliary heat being used, the associated zone control damper shall modulate towards minimum position to maintain the space heating setpoint.
Note: Room 112 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone heating setpoints are met, disable Stage 4 auxiliary heating for the area served and return to Stage 3.
- .5 Each space shall have an overheat evaporator heating override

mode that can be enabled or disabled by the operator. If this override is enabled and the space high temperature alarm is initiated while the system is in occupied mode:

- .1 Verify that the boiler/hydronic heating system is enabled.
- .2 The evaporator heating cycle shall be disabled for 1 hour (operator-adjustable duration).
- .3 During this time, the spaces served shall be heated by the boiler/hydronic heating system by initiating a call for auxiliary heat and opening the associated hydronic heating temperature control valve(s).
- .4 Zone control dampers shall return to fully open position, and fans shall operate in ventilation mode (if the zone is in occupied mode).
- .5 After the override time expires, the system shall return to Stage 1 heating by the VRF.

.7 When the VRF system is operating in Cooling mode.

.1 Stage 1 Cooling:

- .1 EMCS shall energize the evaporator heat pump cooling cycle on a call for cooling from any of the spaces served by the evaporator. The cooling cycle shall run for a minimum of 15 minutes (operator adjustable) before being eligible to be disabled.
- .2 EMCS shall modulate the zone control dampers 100% open.
- .3 Evaporator fan shall initially operate on low speed.
- .4 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position.
Note: Room 112 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
- .5 Once all zone cooling setpoints are met:
 - .1 De-energize cooling cycle.
 - .2 Return all zone control dampers to fully open position.
 - .3 Allow evaporator fan to operate on low speed if in occupied mode. If in unoccupied mode, the fan shall shut off.

.2 Stage 2 Cooling

- .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at low fan speed and with a fully open zone control damper, increase evaporator fan to mid speed.
- .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
Note: Room 112 has two zone control dampers. These

- dampers shall modulate simultaneously in parallel positions.*
- .3 Once all zone cooling setpoints are met, disable Stage 2 (return to low fan speed) and return to Stage 1.
 - .3 Stage 3 Cooling
 - .1 If any zone cooling setpoint is not achieved within 15 minutes with Stage 1 cooling at mid fan speed and with a fully open zone control damper, increase evaporator fan to high speed.
 - .2 If one zone's cooling setpoint is met, the associated zone control damper shall modulate towards minimum position to maintain the space cooling setpoint.
Note: Room 112 has two zone control dampers. These dampers shall modulate simultaneously in parallel positions.
 - .3 Once all zone cooling setpoints are met, disable Stage 3 (return to mid fan speed) and return to Stage 2.
 - .4 Each zone shall have an overcooled space setpoint, set below the space cooling setpoint but above the space low temperature alarm setpoint. If the space temperature falls below this setpoint:
 - .1 Ensure the associated zone control damper is at minimum position.
 - .2 Ensure the boiler/hydronic heating system is enabled.
 - .3 Initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
 - .8 EMCS shall generate an alarm (at OWS and via email) upon failure of any evaporator.
 - .9 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
 - .10 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
 - .11 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
 - .12 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.
- .10 Room 100 Baseboard Radiation
- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor.
 - .2 Space temperature setpoint shall be adjustable by the operator via EMCS. EMCS shall display space temperature setpoint.
 - .3 If the boiler/hydronic heating system is enabled and the space temperature falls below the setpoint, initiate a call for auxiliary heat and open the

- associated hydronic heating temperature control valve(s).
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.11 Room 105 Cooling Exhaust Fan

- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor.
- .2 Space temperature setpoint shall be adjustable by the operator via EMCS. EMCS shall display space temperature setpoint.
- .3 If the temperature rises above the space temperature setpoint, EMCS shall initiate the space cooling exhaust fan (EF-1).
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.12 LAN Room 111 A/C

- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor – monitor only.
- .2 On a call from A/C system supplied 7-day programmable space thermostat, cooling cycle shall be energized to maintain occupant-adjustable space setpoint.
- .3 Zone control damper and hydronic heat control valve shall remain closed indefinitely.
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS.
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS.
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via

EMCS.

- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.13 Room 200 Baseboard Radiation

- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor.
- .2 Space temperature setpoint shall be adjustable by the operator via EMCS. EMCS shall display space temperature setpoint.
- .3 If the boiler/hydronic heating system is enabled and the space temperature falls below the setpoint, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.14 Room 206 Force Flow Heater

- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor.
- .2 Space temperature setpoint shall be adjustable by the operator via EMCS. EMCS shall display space temperature setpoint.
- .3 If the boiler/hydronic heating system is enabled and the space temperature falls below the setpoint, initiate a call for auxiliary heat, start the force flow heater fan, and open the associated hydronic heating temperature control valve(s).
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.15 Room 210 Baseboard Radiation

- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor.
- .2 Space temperature setpoint shall be adjustable by the operator via EMCS. EMCS shall display space temperature setpoint.
- .3 If the boiler/hydronic heating system is enabled and the space temperature falls below the setpoint, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.16 Room 211, Room 212, and Room 213 Baseboard Radiation

- .1 EMCS shall display and trend the space temperature, measured by the wall mount temperature sensor.
- .2 Space temperature setpoint shall be adjustable by the operator via EMCS. EMCS shall display space temperature setpoint.
- .3 If the boiler/hydronic heating system is enabled and the space temperature falls below the setpoint, initiate a call for auxiliary heat and open the associated hydronic heating temperature control valve(s).
- .4 Space high temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 25C) or an amount above the space temperature setpoint (ex. setpoint + 5C).
- .5 Space low temperature alarm setpoint shall be operator-adjustable via EMCS. Alarm setpoint may be either fixed value (ex. 15C) or an amount below the space temperature setpoint (ex. setpoint - 5C).
- .6 Temperature alarm setpoint time delay shall be operator-adjustable via EMCS.
- .7 EMCS shall generate an alarm (at OWS and via email) if space temperatures are above/below the high/low temperature alarm setpoints for longer than the temperature alarm setpoint time delay.

.17 Heating Boiler

Refer to Appendix A for existing boiler control shop drawings. This contractor is responsible for integrating all existing EMCS control points into the new controls

system.

Part 2 PRODUCTS

2.1 NOT USED

.1 Not Used.

Part 3 EXECUTION

3.1 NOT USED

.1 Not Used.

HVAC Control System Upgrade Ardgowan National Historic Site Charlottetown, PEI R.116036.001	EMCS: Site Requirements, Applications, and System Sequences of Operation	Section 25 90 01 Page 25 2021-11-10
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APPENDIX A

Ardgowan National Historic Site
Existing Automatic Controls As-Built Drawings

MEMCO CONTROLS

Dieppe, NB E1A 1P9

T: 506-854-2496 F: 506-384-8452

Project Name: A911 - HVAC Upgrade - Ardgowan

Project Number: A911

Drawing Designation: Submittal

Drawing Date: 19/07/2017

<u>Page</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Part Description</u>
2	Automated Logic	LGR25	BACnet Router, 25 Point Gateway
4	Automated Logic	SE6104a	Control Module, 6DO, 10UI, 4AO
6	BAPI	ALC/10K-2-O-EU	Outside Air Temp, 10K, Type 2
8	Belimo	NFB24	Dmpr. Act. 90 in-lbs, Spring Return, On/Off, 24 VAC,
10	C3 Controls	W22U-24I-WLR	22mm, RED, Pilot Light, 24VAC/24VDC
11	Cleveland	AFS-222	Differential Pressure Switch, 0-12 in. WC, SPDT, Auto Reset
13	Greystone	CS-650-R1	Current Sensor, 0-5 Volt (0-10/20/50 A - Switch Selectable)
14	Tamco Controls	TI-1/2 BR4	4" Brass Well
16	Veris	FKIT-VMD2B-F24A	Relay Kit 24Vac
18	Veris	X50CAA & X150CAA	120Vac Transformer 50VA and 120Vac Transformer 150VA

E.M.C. Ltd.
569-1650

Job: ARdgowan HVAC Upgrade

Contractor: EMC

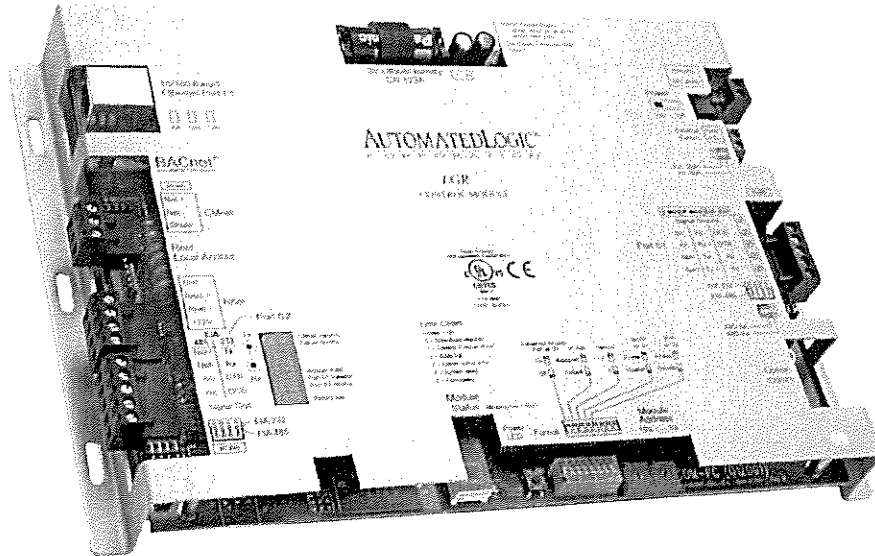
Engineer: MCA

Reviewed: CM

Date: July 20/17

LGR line

High Speed Ethernet Router



The LGR is an extremely powerful, high-speed router/gateway that can connect hundreds of control modules to a BACnet®/IP backbone. Support for BACnet/IP, BACnet-over-Ethernet, ARCNET 156 Kbps, MS/TP, and BACnet PTP communications are standard. A wide range of open and proprietary protocol translator drivers allow the LGR to also serve as a gateway to other manufacturers' equipment. Fully programmable, the LGR can also execute complex control strategies for high-level system integration.

Key Features and Benefits

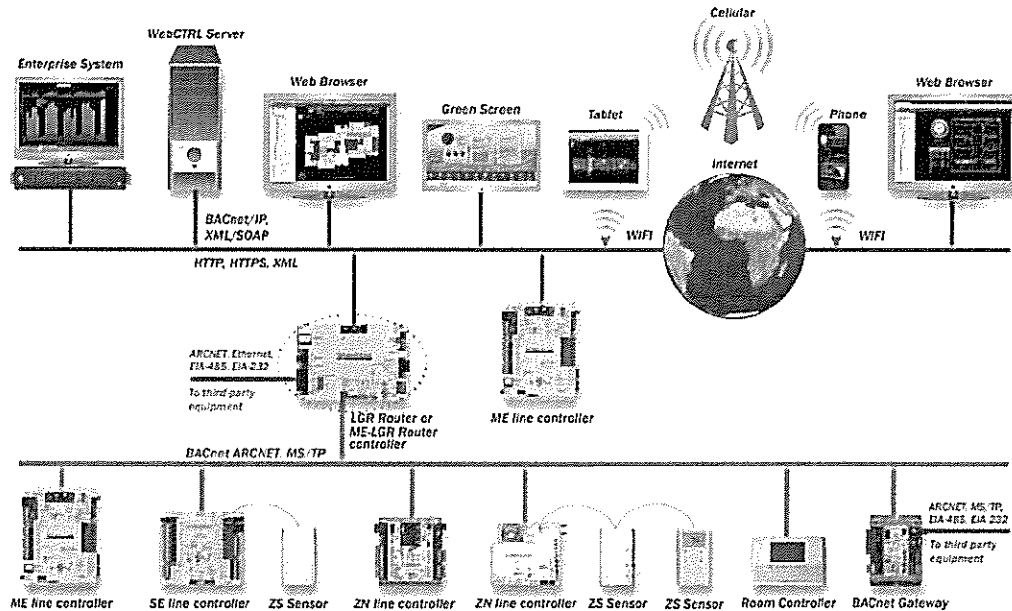
- 10/100Base-T Fast Ethernet allows modules to serve as a BACnet router between BACnet/IP system backbone and field devices subnetwork.
- Native BACnet communications to field devices over a high-speed ARCNET 156 Kbps or BACnet MS/TP network.
- Can route messages from BACnet/IP to BACnet-over-Ethernet, providing compatibility with older BACnet systems.
- A wide range of open and proprietary protocol translator drivers allow the LGR to also serve as a gateway to other manufacturers' equipment.
- Designed with a high-speed true 32-bit microprocessor with cache memory, Fast Ethernet controller, high performance 32-bit serial communications co-processor, and ARCNET communications co-processor, LGR routers have the horsepower to serve the most demanding translation and communications functions.
- Can support hundreds of individual control programs written in ALC's legendary EIKON® LogicBuilder Graphic Programming Language. LGRs can handle the toughest system integration control programs.
- 16 MByte battery-backed SDRAM (32 bit wide), with 12 MBytes available for use, stores application programs, trends and other data when power is lost.
- 8 MByte Flash memory (32 bit wide) for easy field upgrades over the network.
- Battery backed real-time clock provides true standalone capabilities. LGRs recover from power failures providing full continuity of operations, even when communications are disrupted.
- Rnet port supports Automated Logic's line of RS room sensors and BACview local operator interface, and provides local access to the system. Enhanced local access is also available on an EIA-232 port.
- Tough construction delivers superior performance and reliability. Control modules are constructed with a rugged aluminum cover which provides optimum electrical protection and noise immunity.

AUTOMATEDLOGIC
Building Automation Technologies

1150 Roberts Boulevard
 Kennesaw, Georgia 30144
 770-429-3000
 Fax: 770-429-3001
www.automatedlogic.com

LGR line

Specifications



BACnet Support

Conforms to the BACnet Advanced Application Controller (B-AAC) Standard Device as defined in BACnet 135-2001 Annex L - Tested to Protocol Revision 9

Communication:

The following ports are available on the LGR routers:
 Ethernet port* (10/100Mbps) for BACnet over Ethernet or BACnet/IP communications.
 EIA-485 port for ARCNET 156 Kbps or BACnet MS/TP (9600 baud to 76.8 Kbps).
 EIA-232/485*configurable port for BACnet PTP.
 Rnet port for RS room sensors and local BACview⁶ operator displays.
 Xnet (500Kbps) port for MEX I/O expansion modules.
 Local access port.
 *Third-Party integration drivers available through Ethernet and (1) EIA-232/485 configurable port.

Microprocessor:

32-bit Motorola Power PC microprocessor with cache memory, Fast Ethernet controller, high performance 32-bit communication co-processor, ARCNET communication co-processor and I/O expansion CAN co-processor.

Memory:

16 MByte non-volatile battery-backed SDRAM (with 12 MBytes available for use),
 8 MByte Flash memory, 32-bit memory bus. (Shelf life of the battery is 10 years with 720 hours of continuous operation.)

Real-time Clock:

Battery-backed real-time clock.

Status Indicators:

LED status indicators for EIA-232/485 communication, Ethernet port communication, and low battery status. 7-segment status display for running, error, and power status.

Module Addressing:

Rotary dip switches for intuitive network addressing of modules

Protection:

Built-in surge and transient protection circuitry for power and communications

Listed by

UL916 (Canadian Std C22.2 No. 205-M1983), CE, FCC Part 15 - Subpart B - Class A.

Environmental Operating Range:

-20°F to 140°F (-29°C to 60°C); 10 to 90% relative humidity, non-condensing.
 NOTE: Control modules should be installed within the building.

Power Requirements:

24 V-ac \pm 10%, 50 to 60Hz, 24 VA, or 26 V-dc \pm 10%, 10W.
 NOTE: Power consumption will increase when BACview⁶ or other accessories are attached.

Physical

Rugged aluminum cover. Removable screw terminal blocks

Weight:

1.4 lb. (0.635 kg)

Dimensions



Overall

Width: 11-5/16" (287mm)
 Height: 7-1/2" (190mm)
 Depth: 2-3/4" (70mm) min. panel depth

Mounting

Width: 10-13/16" (275mm)
 Height: 5" (127mm)

Automated Logic Corporation, 1150 Roberts Boulevard, Marietta, Georgia 30067, 770/429-3000, Fax 770/429-3001, www.automatedlogic.com

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BACnet is a registered trademark of ASHRAE. All other trademarks are the property of their respective owners. Specifications are subject to change without prior notice. Automated Logic is a part of DDC Controls & Security, a unit of United Technologies Corp.

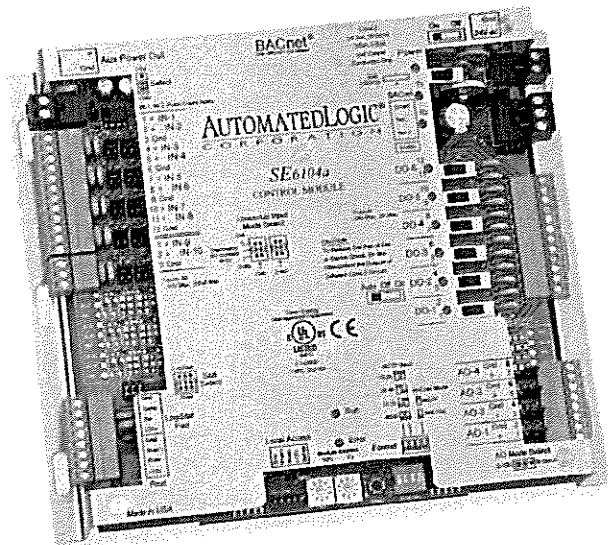
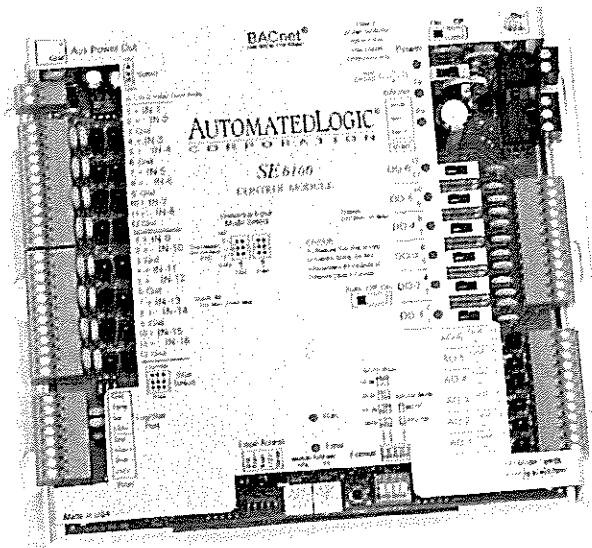
Made in the USA



LGR CS r10

SE6166 /SE6104

Rugged Flexibility for Single Equipment Applications



Automated Logic's powerful SE line provides a rugged solution for single equipment applications. Designed to operate in a wide range of environmental conditions, SE controllers can be used in rooftop units, mechanical rooms, equipment closets, or almost any other weather tight location. Fully programmable using the EIKON®-LogicBuilder graphic programming language, SE controllers use native BACnet communications over either a high-speed ARCNET 156 Kbps network or a medium speed MS/TP network to provide maximum flexibility and interoperability.

Key Features and Benefits

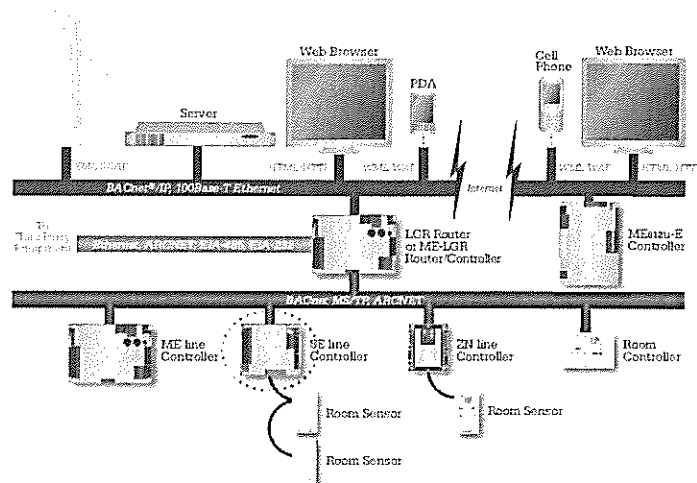
- Native BACnet communications to field devices over a high-speed ARCNET 156 Kbps or BACnet MS/TP network.
- 12-bit Analog to Digital converter provides extreme precision on all inputs. Pulse counting capability up to 40 Hz is available on selected inputs.
- Uses a high-speed microprocessor with 1 MByte Flash memory and 1 MByte of RAM for unparalleled programmability. Firmware upgrades can be downloaded remotely – no chip replacement necessary.
- Battery backed real-time clock provides true stand-alone capabilities. Control modules recover from power failures providing full continuity of scheduled operations, even when communications are disrupted.
- Rnet port supports Automated Logic's line of RS room sensors and BACview[®] local operator interface, and provides local access to the system.
- SE line controllers are fully graphically programmable and offer full peer-to-peer communications with other SE line, ME line or ZN line controllers. Graphical programs are universally understood and provide self-documenting control sequences.
- Tough construction delivers superior performance and reliability. Control modules are constructed with a rugged aluminum cover, which provides optimum electrical protection and noise immunity.

AUTOMATEDLOGIC
CORPORATION

1150 Roberts Boulevard
Kennesaw, Georgia 30144
770/429-3000
Fax 770/429-3001
www.automatedlogic.com

SE6166 /SE6104

Specifications



BACnet Support:	Conforms to the Advanced Application Controller (B-AAC) Standard Device Profile as defined in BACnet 135-2001 Annex L.
Communication:	The following ports are available on the SE control modules: EIA-485 port for ARCNET 156 Kbps or MS/TP (9600 bps – 76.8 kbps). Rnet Port supports: 1. Local access for system start-up and troubleshooting. 2. Local operator interface BACview®. 3. RS Room Sensors - one RS Pro and up to four RS room sensors for averaging or high/low select control.
Binary Outputs:	SE6166 and SE6104 have six binary outputs, relay contact rated at 3A max @ 24 V-ac, configured normally open with hand-off auto switches.
Universal Inputs:	SE6166 - 16 configurable universal inputs, SE6104 - 10 configurable universal inputs, both with 12-bit A/D resolution. Supported input types include: 0-5 V-dc, 0-10 V-dc, 0-20 mA, Thermistor (10k Ohm Type II), 1k Ohm RTD (Platinum, Nickel or Balco), and Dry Contact. NOTE: Inputs 1 and 2 support pulse counting up to 40 cycles per second (40 Hz).
Analog Outputs:	SE6166 - six analog outputs, SE6104 - four analog outputs, both with 0-10 V-dc or 0-20mA selectable with 8-bit resolution.
Microprocessor:	High speed microprocessor with ARCNET communication co-processor.
Memory:	1 MByte non-volatile battery-backed RAM, 1 MByte Flash memory, 16-bit memory bus. (Shelf life of the battery is 10 years with 10,000 hours of continuous operation.)
Real-time Clock:	Battery-backed real-time clock.
Status Indicators:	LED status indicators for EIA-485 communication, running, error, power and all digital outputs.
Module Addressing:	Rotary dip switches for intuitive network addressing of modules.
Protection:	Built-in surge and transient protection circuitry for power, communications, inputs and outputs.
Listed by:	UL916 (Canadian Std C22.2 No. 205-M1983), CE, FCC Part 15 – Subpart B – Class A.
Environmental Operating Range:	-20°F to 140°F (-29°C to 60°C); 10 to 90% relative humidity, non-condensing. NOTE: Control modules should be mounted in protective enclosures.
Power Requirements:	24 V-ac ± 10%, 26 V-dc (25 V min, 30 V max), 50 to 60Hz, 20VA. NOTE: Power consumption will increase when BACview or other accessories are attached.
Physical:	Rugged aluminum cover. Removable screw terminal blocks.
Weight:	0.6 lb. (0.27 kg).

Dimensions:



Overall

Width: 8.3" (211mm)
Height: 7" (178mm)
Depth: 1.5" (38mm) min. panel depth

Mounting

Width: 7.835" (199mm)
Height: 5" (127mm)
5" mounting hole spacing



Features & Options

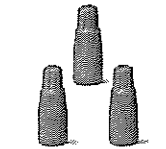
- Quick-Response Sensor
- Etched Teflon Leadwires
- Well-Vented, Light-Colored Sensor Guard
- Weather Tight or Weatherproof Enclosure
- Wide Selection of Temperature Sensing Elements
- Limited Lifetime Warranty



Outside Air Units are designed to be mounted outdoors. The 5 1/4" UV-resistant plastic shield keeps the sensor out of the sunlight and allows for excellent air circulation. They come standard in a Weather Tight (EU) UV-resistant enclosure which carries an IP 66 rating (similar to NEMA 4X) and is light in color to reflect sunlight and minimize reading error. Outside Air Units are also available in a cast aluminum Weatherproof (WP) enclosure which carries a NEMA 3R rating.

All Outside Air Units have etched Teflon leadwires and double encapsulated sensors to create a watertight package that can withstand high humidity and condensation and perform under real world conditions. This is especially important in an outside air application which can be exposed to rain, snow, and large temperature swings.

Sealant Filled Connectors

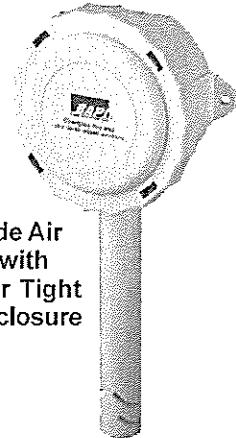


Twist-on (above)
Crimp-on (below)

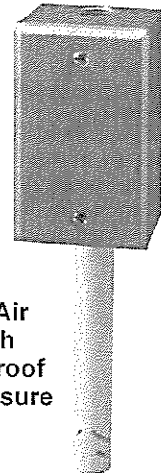
Our Sealant Filled Connectors contain a moisture-excluding sealant which encapsulates the electrical connection and adds an extra layer of protection against moisture and oxidation. For more info, see page E7.

*For detailed specifications
on the individual Sensors
& Transmitters, turn to
Section F.*

Outside Air
Unit with
Weather Tight
(EU) Enclosure



Outside Air
Unit with
Weatherproof
(WP) Enclosure



*Some items may not be CE compliant, call BAPI for additional information.

Specifications

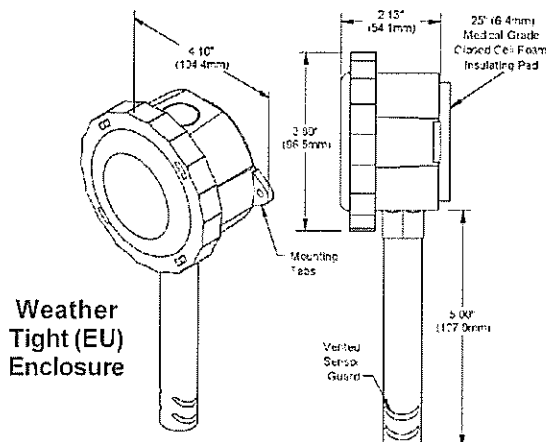
Material: WP Model: Cast Aluminum
EU Model : ABS Plastic

Rating: WP Model: NEMA 3R
EU Model: IP 66

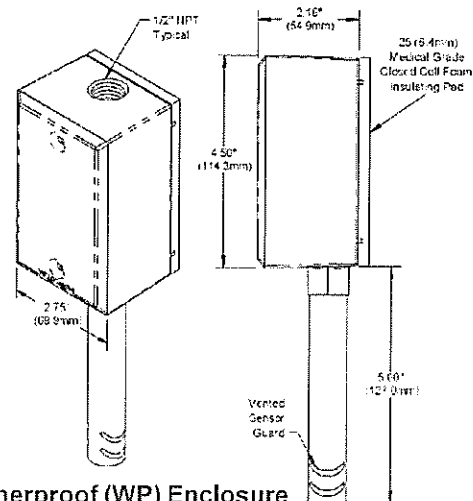
Environmental Specifications:

Temperature: -40 °C to 100 °C)

Humidity: 0 to 100%, non-condensing



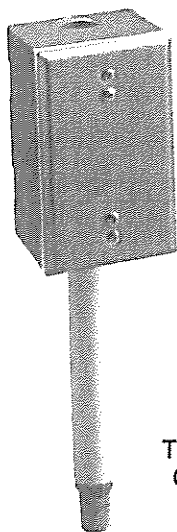
Weather
Tight (EU)
Enclosure



Weatherproof (WP) Enclosure

Ordering Information		Outside Air Units - Temperature	
BA/	Sensor Type	Use the designator number (shown to the left in bold) to indicate the sensor	
		THERMISTORS	RTDs
	1.8K	1.8K Ω @ 25 °C	100 100 Ω Platinum @ 0 °C, .385 Ω /°C temp. coeff.
	2.2K	2.2K Ω @ 25 °C	1K(375) 1K Ω Platinum @ 0 °C, 3.75 Ω /°C temp. coeff.
	3K	3K Ω @ 25 °C	1K 1K Ω Platinum @ 0 °C, 3.85 Ω /°C temp. coeff.
	3.3K	3.3K Ω @ 25 °C	2K 2K Ω Silicon @ 20 °C, 8 Ω /°C temp. coeff.
	→ 10K-2	10K Ω @ 25 °C	
	10K-3	10K Ω @ 25 °C	
	10K-3(11K)	5,238 Ω @ 25 °C	SEMICONDUCTORS
	20K	20K Ω @ 25 °C	334 LM334 Semiconductor
	47K	47K Ω @ 25 °C	592 AD592 Semiconductor, 273 μ A @ 0 °C \pm
	50K	50K Ω @ 25 °C	592-10K AD592 Semiconductor with a 10 k Ω shunt resistor, 2.73 V @ 0 °C
	100K	100K Ω @ 25 °C	
		TEMPERATURE TRANSMITTERS	<i>Must include a "range" figure</i>
	T100(range)	100 Platinum RTD, 100 Ω @ 0 °C with 4 to 20 mA Output	
	T100M(range)	100 Platinum RTD, 100 Ω @ 0 °C with MATCHED* 4 to 20 mA Output	
	T1K(range)	1K Platinum RTD, 1,000 Ω @ 0 °C with 4 to 20 mA Output	
	T1KM(range)	1K Platinum RTD, 1,000 Ω @ 0 °C with MATCHED* 4 to 20 mA Output	
	T10K(range)	10K Thermistor, 10,000 Ω @ 25 °C with 4 to 20 mA Output	
		TEMPERATURE TRANSMITTER RANGES	
		Custom temperature transmitter ranges are available. Common ranges are listed below	
		32 to 122 F	0 to 50 C
		20 to 120 F	-7 to 48 C
		-20 to 120 F	-29 to 48 C
		0 to 150 F	-18 to 66 C
		-30 to 140 F	-34 to 60 C
		-22 to 158 F	-30 to 70 C
		-52 to 152 F	-47 to 67 C
	→	Configuration	
	-O-EU	Weather Tight Enclosure - IP 66 UV-resistant enclosure	
	-O-WP	Weather Proof Enclosure - NEMA 3R rated cast aluminum enclosure	
EXAMPLE			
BA/	10K-2	-O-EU	Outside Air Unit with Weathertight Enclosure and 10K-2 Thermistor
Part Number: BA/10K-2-O-EU			

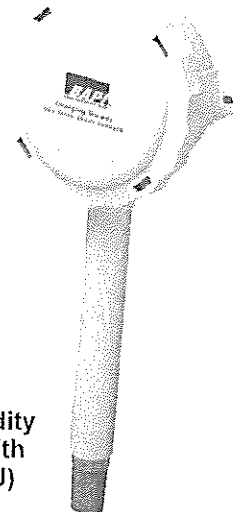
Call BAPI if you have questions about the above ordering grid or the configuration of the product you are ordering.



Combination
Temperature/Humidity
Outside Air Unit with
Weather Tight (WP)
Enclosure

Combination Temperature/Humidity Outside Air Units

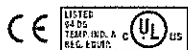
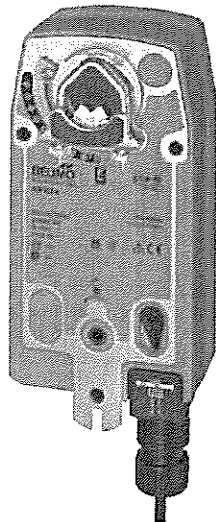
Humidity control is an important aspect of any climate control system. Save time and money by combining your temperature and humidity sensors into one Outside Air Unit. BAPI's microprocessor-based humidity sensors are prescreened for accuracy, eliminating field calibration even when replacing a sensor or probe. For more information on Combination Outside Air Units, turn to page B16.



Combination
Temperature/Humidity
Outside Air Unit with
Weather Tight (EU)
Enclosure

NFB24, NFB24-S, NFX24, NFX24-S

On/Off, Spring Return, 24 V



- Torque min. 90 in-lb, for control of air dampers

Application

For On/Off, fail-safe control of dampers in HVAC systems. Actuator sizing should be done in accordance with the damper manufacturer's specifications. Control is On/Off from an auxiliary contact, or a manual switch.

The actuator is mounted directly to a damper shaft up to 1.05" in diameter by means of its universal clamp. A crank arm and several mounting brackets are available for applications where the actuator cannot be direct coupled to the damper shaft.

Operation

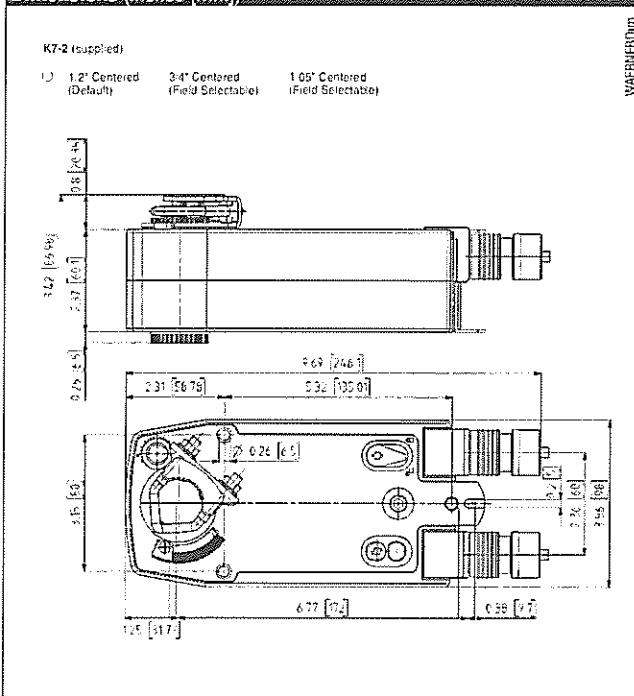
The NFB and NFX series actuators provide true spring return operation for reliable fail-safe application and positive close off on air tight dampers. The spring return system provides constant torque to the damper with, and without, power applied to the actuator.

The NFB and NFX series provides 95° of rotation and is provided with a graduated position indicator showing 0° to 95°.

The actuator may be stalled anywhere in its normal rotation without the need of mechanical end switches.

The NFB24-S and NFX24-S versions are provided with two built-in auxiliary switches. These SPDT switches are provided for safety interfacing or signaling, for example, for fan start-up. The switching function at the fail-safe position is fixed at +10°, the other switch function is adjustable between +10° to +90°. The NFB24, NFB24-S, NFX24 and NFX24-S actuator is shipped at +5° (5° from full fail-safe) to provide automatic compression against damper gaskets for tight shut-off.

Dimensions (Inches (mm))



Technical Data		NFB24, NFB24-S, NFX24, NFX24-S
Power supply		24 VAC \pm 20% 50/60 Hz 24 VDC \pm 20% / -10%
Power consumption	running	6 W
	holding	2.5 W
Transformer sizing		8.5 VA (class 2 power source)
Electrical connection	NFB24...	3 ft, 18 GA appliance cable, 1/2" conduit connector -S models: two 3 ft, 18 gauge appliance cables with 1/2" conduit connectors
	NFX24...	3 ft [1m], 10 ft [3m] or 16 ft [5m] 18 GA appliance or plenum cables, with or without 1/2" conduit connector -S models: two 3 ft [1m], 10 ft [3m] or 16 ft [5m] appliance cables, with or without 1/2" conduit connectors
Overload protection		electronic throughout 0 to 95° rotation
Control		on/off
Torque		90 in-lb [10 Nm] minimum
Direction of rotation	spring	reversible with CW/CCW mounting
Mechanical angle of rotation		95° (adjustable with mechanical end stop, 35° to 95°)
Running time	motor	< 75 seconds
	spring	20 seconds @ -4°F to 122°F [-20°C to 50°C]; < 60 seconds @ -22°F [-30°C]
Position indication		visual indicator, 0° to 95° (0° is full spring return position)
Manual override		5 mm hex crank (3/16" Allen), supplied
Humidity		max. 95% RH non-condensing
Ambient temperature		-22°F to 122°F [-30°C to 50°C]
Storage temperature		-40°F to 176°F [-40°C to 80°C]
Housing		Nema 2, IP54, Enclosure Type2
Housing material		zinc coated metal and plastic casing
Agency listings †		cULus acc. to UL60730-1A/-2-14, CAN/CSA E60730-1:02, CE acc. to 2004/108/EC & 2006/95/EC
Noise level		<50dB(A) motor @ 75 seconds ≤62dB(A) spring return
Servicing		maintenance free
Quality standard		ISO 9001
Weight		4.15 lbs (1.9 kg), 4.4 lbs (2.0 kg) with switches

† Rated Impulse Voltage 800V Type of action 1 AA (1 AA B for -S version), Control Pollution Degree 3.

NFB24-S, NFX24-S

Auxiliary switches 2 x SPDT 3A (0.5A) @ 250 VAC, UL approved
one set at +10°, one adjustable 10° to 90°

M40024 - 05/10 - Subject to change © Belimo Aircontrols (USA), Inc.

Accessories	
AV 8-25	Shaft extension
IND-AFB	Damper position indicator
KH-AFB	Crank arm
K7-2	Universal clamp for up to 1.05" dia jackshafts
TF-CC US	Conduit fitting
Tool-06	8mm and 10 mm wrench
ZG-100	Universal mounting bracket
ZG-101	Universal mounting bracket
ZG-118	Mounting bracket for Barber Colman® MA 3../4.., Honeywell® Mod III or IV or Johnson® Series 100 replacement or new crank arm type installations
ZG-AFB	Crank arm adaptor kit
ZG-AFB118	Crank arm adaptor kit
ZS-100	Weather shield (metal)
ZS-150	Weather shield (polycarbonate)
ZS-260	Explosion-proof housing
ZS-300	NEMA 4X housing

Note: When using NFB24, NFB24-S, NFX24, NFX24-S actuators, only use accessories listed on this page.

For actuator wiring information and diagrams, refer to Belimo Wiring Guide.

Typical Specification

On/Off spring return damper actuators shall be direct coupled type which require no crank arm and linkage and be capable of direct mounting to a jackshaft up to a 1.05" diameter. The actuators must be designed so that they may be used for either clockwise or counterclockwise fail-safe operation. Actuators shall be protected from overload at all angles of rotation. If required, two SPDT auxiliary switch shall be provided having the capability of one being adjustable. Actuators with auxiliary switches must be constructed to meet the requirements for Double Insulation so an electrical ground is not required to meet agency listings. Actuators shall be cULus Approved and have a 5 year warranty, and be manufactured under ISO 9001 International Quality Control Standards. Actuators shall be as manufactured by Belimo.

Wiring Diagrams

INSTALLATION NOTES

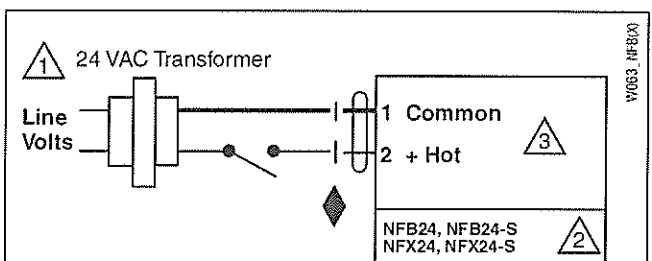
- 1 Provide overload protection and disconnect as required.
- 2 **CAUTION Equipment Damage!**
Actuators may be connected in parallel.
Power consumption and input impedance must be observed.
- 3 Actuators may also be powered by 24 VDC.
- 4 For end position indication, interlock control, fan startup, etc., NFB24-S and NFX24-S incorporates two built-in auxiliary switches: 2 x SPDT, 3A (0.5A) @250 VAC, UL Approved, one switch is fixed at +10°, one is adjustable 10° to 90°.

APPLICATION NOTES

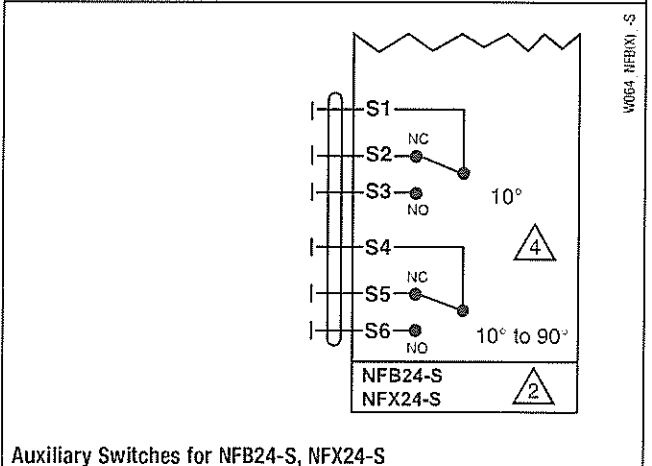
- ◆ Meets cULus requirements without the need of an electrical ground connection.

WARNING Live Electrical Components!

During installation, testing, servicing and troubleshooting of this product, it may be necessary to work with live electrical components. Have a qualified licensed electrician or other individual who has been properly trained in handling live electrical components perform these tasks. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.



On/Off wiring for NFB24, NFX24



Auxiliary Switches for NFB24-S, NFX24-S

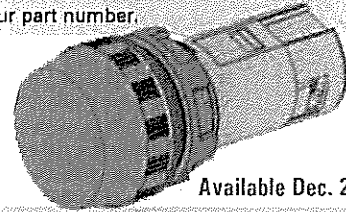
IT'S EASY TO BUILD YOUR OWN PILOT LIGHT

Simply pick the code number from each of the sections below and combine them to build your part number.

Unibody Pilot Lights (Relampable)

W22U - - - -
I II III IV

Example: To build one of our most popular Pilot Lights, the part number would be W22U + II + III + IV or W22U-120LR-WLR



Available Dec. 2012.

I. OPERATOR TYPE		
CODE	DESCRIPTION	PRICE
W22U	Unibody Light Unit	\$ 4.50

II. VOLTAGE	
CODE	DESCRIPTION
FULL VOLTAGE	
6	6V AC/DC
12	12V AC/DC
24	24V AC/DC
120	120V AC/DC

c3controls LED lamp design life is 100,000 hours—that's 11.4 years!

III. LAMP TYPE/COLOR		
CODE	DESCRIPTION	PRICE
LED		
LA	Amber	\$ 7.00
LB	Blue	\$ 7.00
LG	Green	\$ 7.00
LR	Red	\$ 7.00
LW	White	\$ 7.00
INCANDESCENT		
I	Clear	—
F	Clear Flashing Bulb*	\$ 4.00
*NOTE: Incandescent flashing bulbs available for any 6V full voltage application.		
NL	No Lamp	— \$1.00

IV. LENS/COLOR		
CODE	DESCRIPTION	PRICE
WLA	Amber	\$ 1.00
WLB	Blue	\$ 1.00
WLC	Clear	\$ 1.00
WLG	Green	\$ 1.00
WLR	Red	\$ 1.00
WLW	White	\$ 1.00
WLY	Yellow	\$ 1.00

See page 42 for Lamp Replacement Chart and page 43 for Lamp Technical Data.

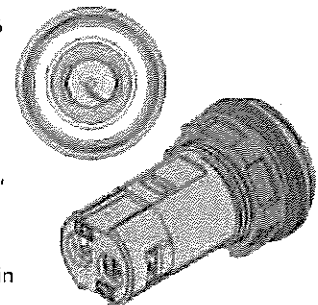
DISCOUNT SCHEDULE **C**

22mm IEC Unibody Relampable Pilot Lights

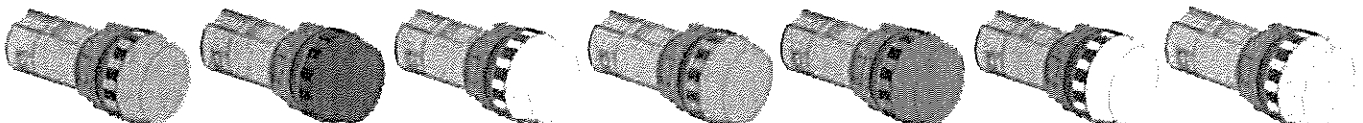
Our 22mm IEC Unibody Pilot Lights were designed with simplicity in function to save you valuable time and money. This full voltage light unit is available in 6, 12, 24 and 120 volts using either Incandescent or our LED lamps with leakage protection. We offer seven different lens color options to add to your flexibility. All c3controls 22mm IEC operators are UL Listed and CE marked and are rated Type 4/4X as standard for watertight and corrosion resistance. In addition, operators are also listed for Type 1, 2, 3, 3R, 12, 13 and IP66 applications, and meet global standards requirements.

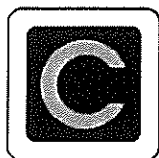
Product features include:

- Vibration resistant compact design.
- Our seal is infused with a coating to eliminate cracking when exposed to harsh conditions such as heat, dryness and sunlight. This seal also acts as a light reflector because it is white which increases light output and improves visibility from all angles.
- Our rugged Lexan™ lenses provide better visibility and can resist high impact for reliable performance in most environments, even in high ambient temperatures.
- Wiring is made easy by utilizing rear access captive mounting screws with side wire entry.
- Polyester construction for superior corrosion resistance, moisture rejection and electrical insulation.
- Operators conveniently mount in a round 22.5mm (7/8") hole that is directly interchangeable with competitors units and eliminates the labor required for notching.



Available Lens Colors for Unibody Pilot Lights





Cleveland Controls
Division of UniControl Inc.

Model
AFS-222

AIR PRESSURE SENSING SWITCH WITH ADJUSTABLE SET POINT RANGE

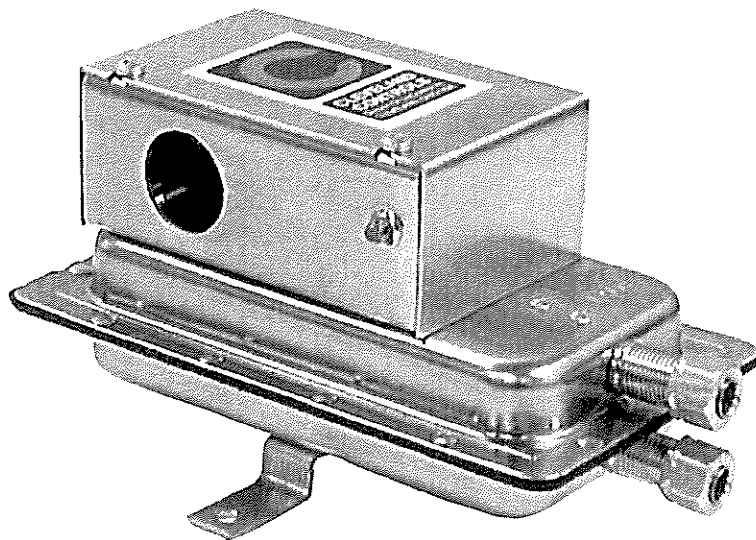
APPLICATION

Model AFS-222 Air Pressure Sensing Switch is a general purpose proving switch designed for HVAC and Energy Management applications. It may be used to sense positive, negative, or differential air pressure.

GENERAL DESCRIPTION & OPERATION

The plated housing contains a diaphragm, a calibration spring and a snap-acting SPDT switch. The sample connections located on each side of the diaphragm accept $\frac{1}{4}$ " OD metallic tubing via the integral compression ferrule and nut.

An enclosure cover guards against accidental contact with the live switch terminal screws and the set point adjusting screw. The enclosure cover will accept a $\frac{1}{2}$ " conduit connection.

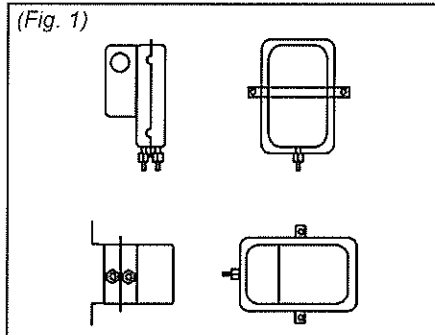


MOUNTING (SEE FIGURE 1)

Select a mounting location which is free from vibration. The AFS-222 must be mounted with the diaphragm in any vertical plane in order to obtain the lowest specified operating set point. Avoid mounting with the sample line connections in the "up" position. Surface mount via the two $\frac{3}{16}$ " diameter holes in the integral mounting bracket. The mounting holes are $3\text{--}7/8$ " apart.

The AFS-222 is designed to accept firm-wall sample lines of $\frac{1}{4}$ " OD tubing by means of

(Fig. 1)



AIR SAMPLING CONNECTION (SEE FIGURE 2)

ferrule and nut compression connections. For sample lines of up to 10 feet, $\frac{1}{4}$ " OD tubing is acceptable. For lines up to 20 feet, use $\frac{1}{4}$ " ID tubing. For lines up to 60 feet, use $\frac{1}{2}$ " ID tubing. A $\frac{1}{4}$ " OD adapter, suitable for slip-on flexible tubing is available: order part number 18311.

Locate the sampling probe a minimum of 1.5 duct diameters downstream from the air source. Install the sampling probe as close to the center of the airstream as possible. Refer to Figure 2 to identify the high pressure inlet (H) and the low pressure inlet (L). Select one of the five application options listed below, and connect the sample lines as recommended.

POSITIVE PRESSURE ONLY: Connect the sample line to inlet H; inlet L remains open to the atmosphere.

NEGATIVE PRESSURE ONLY: Connect the sample line to inlet L; inlet H remains open to the atmosphere.

TWO NEGATIVE SAMPLES: Connect the higher negative sample to inlet L. Connect the lower negative sample to inlet H.

TWO POSITIVE SAMPLES: Connect the higher positive sample to inlet H. Connect the lower positive sample to inlet L.

ONE POSITIVE AND ONE NEGATIVE SAMPLE: Connect the positive sample to inlet H. Connect the negative sample to inlet L.



Cleveland Controls
DIVISION OF UNICONTROL INC.
1111 Brookpark Rd
Cleveland OH 44109

Tel: 216-398-0330

Fax: 216-398-8558

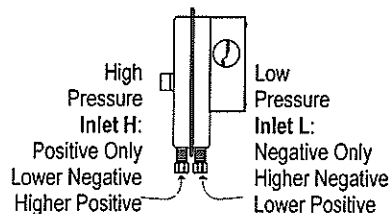
Email: sales@vac@unicontrolinc.com

Web page: <http://www.clevelandcontrols.com>

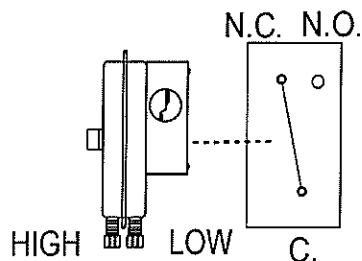
Bulletin AFS-222.07

Are you
reading a FAX
or a COPY of this
bulletin? DOWNLOAD
the full-color PDF ver-
sion of this and other
literature at our
website!

(Figure 2)

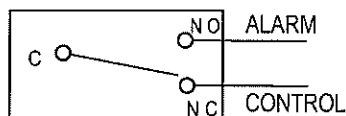


(Figure 3)

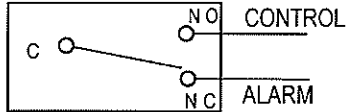


(Figure 4)

To prove excessive air flow or pressure:



To prove insufficient air flow or pressure:



ELECTRICAL CONNECTIONS (SEE FIGURE 3)

Before pressure is applied to the diaphragm, the switch contacts will be in the normally closed (NC) position. The snap switch has screw top terminals with cup washers. Wire alarm and control applications as shown in Figure 4.

FIELD ADJUSTMENT

The adjustment range of an AFS-222 Air Switch is 0.05 ± 0.02 " w.c. to 12.0" w.c. To adjust the set point, turn the adjusting screw counterclockwise until motion has stopped. Next, turn the adjusting screw 4 complete turns in a clockwise direction to engage the spring. From this point, the next ten turns will be used for the actual calibration. Each full turn represents approximately 1.2" w.c.

Please note: To properly calibrate an air switch, a digital manometer or other measuring device should be used to confirm the actual set point.

SPECIFICATIONS

MODEL AFS-222 AIR PRESSURE SENSING SWITCH WITH ADJUSTABLE SET POINT RANGE

Mounting Position:

Mount with the diaphragm in any vertical plane.

Set Point Range:

0.05 ± 0.02 " w.c. to 12.0" w.c.

Field Adjustable "Operate Range":

0.07" w.c. to 12.0" w.c.

Field Adjustable "Release Range":

0.04" w.c. to 11.2" w.c.

Approximate Switching Differential:

Progressive, increasing from 0.02 ± 0.01 " w.c. at minimum set point to approximately 0.8" w.c. at maximum set point.

Measured Media:

Air, or combustion by-products that will not degrade silicone.

Maximum Pressure:

$\frac{1}{2}$ psi (0.03 bar)

Operating Temperature Range:

-40F to 180F (-40 to 82C)

Life:

100,000 cycles minimum at $\frac{1}{2}$ psi maximum pressure each cycle and at maximum rated electrical load.

Electrical Rating:

300 VA pilot duty at 115 to 277 VAC, 15 amps noninductive to 277 VAC, 60Hz.

Contact Arrangement: SPDT.

Electrical Connections:

Screw-type terminals with cup washers.

Conduit Opening:

$\frac{7}{8}$ " diameter opening accepts $\frac{1}{2}$ " conduit.

Sample Line Connectors:

Male, externally threaded $\frac{7}{16}$ " 24 UNS 2A thread, complete with nuts and self-aligning ferrules.

Sample Line Connections:

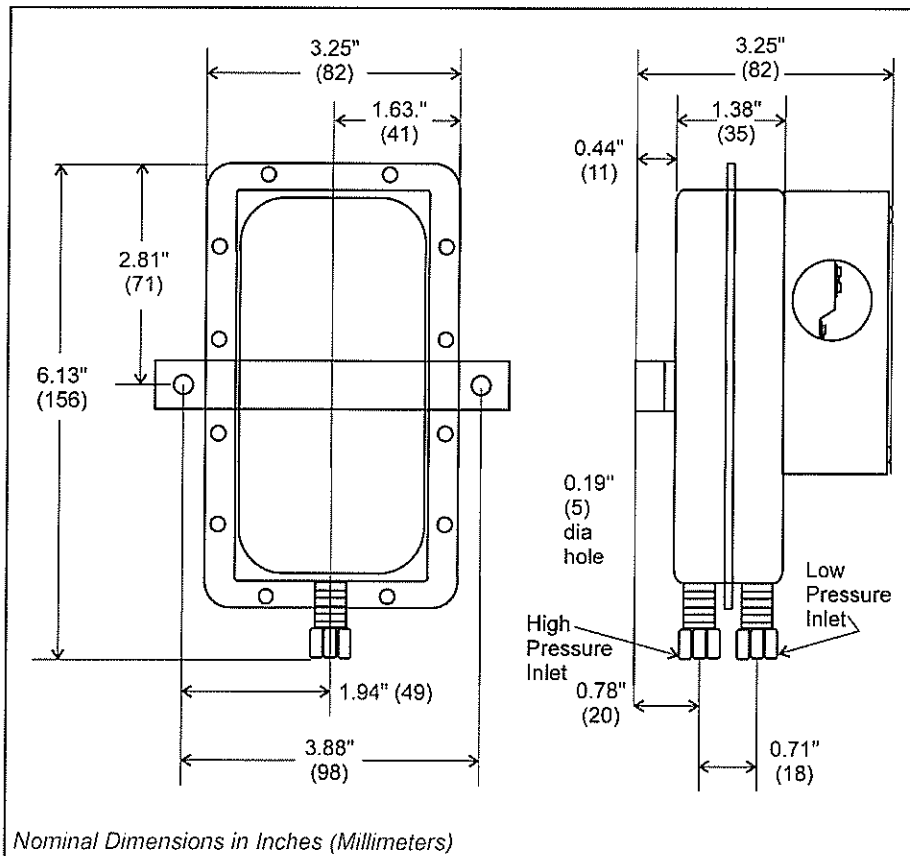
Connectors will accept $\frac{1}{4}$ " OD rigid or semi-rigid tubing.

Approvals: UL, FM, CSA.

Shipping Weight: 1.2 lbs.

Accessories:

- P/N 18311 Slip-on $\frac{1}{4}$ " OD Tubing Adapter, suitable for slipping on flexible plastic tubing.
- Sample line probes.
- Orifice plugs (pulsation dampers).



Nominal Dimensions in Inches (Millimeters)



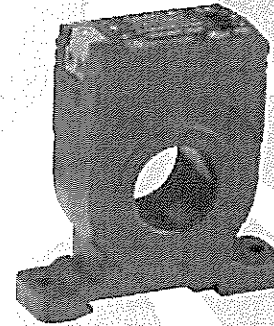
GREYSTONE ENERGY SYSTEMS INC

CURRENT SENSOR CS-650 Series

The CS-650 Series current sensors monitor line current for electrical loads such as pumps, conveyors, machine tools, or fans and output a 0-5 Vdc signal to represent the load current.

The CS-650 require no external power as they are totally powered by induction from the AC line being monitored.

The sensors are typically used to monitor motor operation and can be used to determine motor failure, belt loss, machine feed rates or tool wear.



SPECIFICATION:

Measurement Range.....CS-650-R1: 0-10/20/50 Amps
CS-650-R2: 0-50/100/150 Amps
CS-650-200: 0-200 Amps
Maximum Input Current.....CS-650-R1: 100 Amps Continuous
CS-650-R2: 150 Amps Continuous
CS-650-200: 250 Amps Continuous
Accuracy.....CS-650-R1/R2: $\pm 2\%$ FSO (5-100% of range)
CS-650-200: $\pm 1\%$ FSO (5-100% of range)
Signal Output.....0-5 Vdc
Sensor Power.....Self-powered
Insulation Class.....600 Vac, insulated conductors
Frequency.....50/60 Hz
Response Time.....200 mS Typical, 0-90 %
Output Load.....1 M Ω typical
Loading Error.....add 0.5% error with 100K Ω
Operating Temperature.....-15 to 60°C (5 to 140 °F)
Operating Humidity.....5 to 90% RH non-condensing
Terminal Block.....14 to 22 AWG
Dimensions.....67 x 68.6 x 24.1 mm
(2.65 x 2.7 x 0.95 in)
Sensor Aperture.....20.3 mm (0.8 in)
Enclosure Material.....ABS/PC, UL94 V-0
Agency Approvals.....cULus Listed

PART NUMBER SELECTED

PRODUCT SELECTION INFORMATION:

MODEL	Product Description
CS-650	Solid-core Current Sensor, 0-5 Vdc Output

CODE	Sensing Range	Maximum Input
R1	0-10/20/50 Amps - Switch Selectable	100 Amps Continuous
R2	0-50/100/150 Amps - Switch Selectable	150 Amps Continuous
200	0-200 Amps	250 Amps Continuous

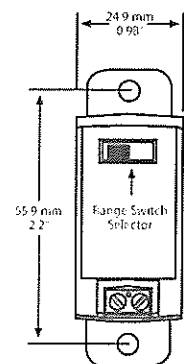
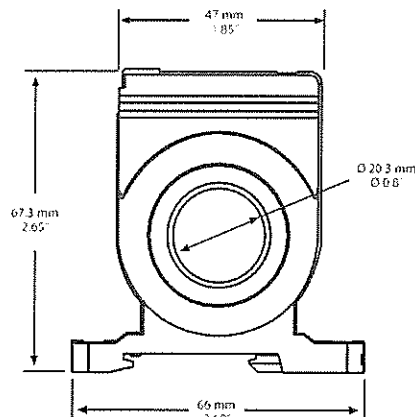
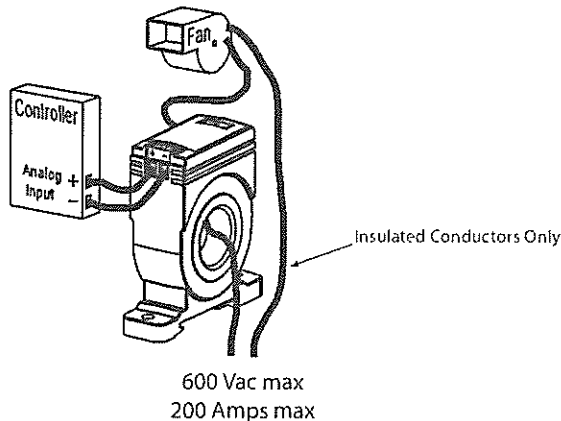
Greystone Energy Systems, Inc. reserves the right to make design modifications without prior notice.

TYPICAL INSTALLATION:

For complete installation and wiring details, please refer to the product installation instructions.

The CS-650 series must be mounted in an electrical enclosure and has an integral mounting tab to allow either screw mount to a surface or spring mount to a DIN rail.

The CS-650 series has a 2 wire connection to the Building Automation System.



Greystone Energy Systems, Inc.
150 English Drive, Moncton, NB
Canada E1E 4G7

(506) 853-3057 Fax: (506) 853-6014
North America: 1-800-561-5611
e-mail: mail@greystoneenergy.com
www.greystoneenergy.com



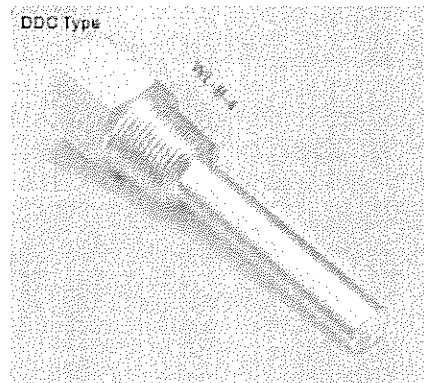
RoHS
COMPLIANT



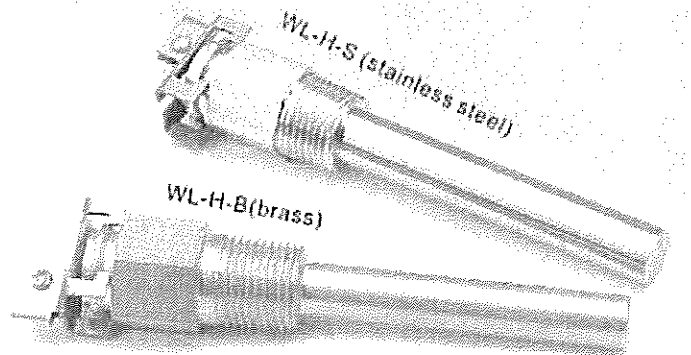
Wells

Descriptions

These thermowells are designed for mounting temperature sensors in pipes and tanks. The thermowells are designed to reduce the stress encountered in flowing fluid installation which produces a constantly oscillating force that can eventually crack a probe unless it is mounted in one of these wells. The wells are designed to handle this stress yet provide good thermal contact with the fluid. They also provide isolation, if the sensor needs to be serviced the system can remain in operation without having to drain down the lines.



Honeywell Type



Features & Options

- Three Lengths: 2", 4" and 8" (Fit standard Immersion Unit lengths)
- Stainless Steel (304 or 316) or Brass
- Two Part (Welded) or Machined Construction
- Other Lengths or Materials Available Upon Request
- Limited Lifetime Warranty

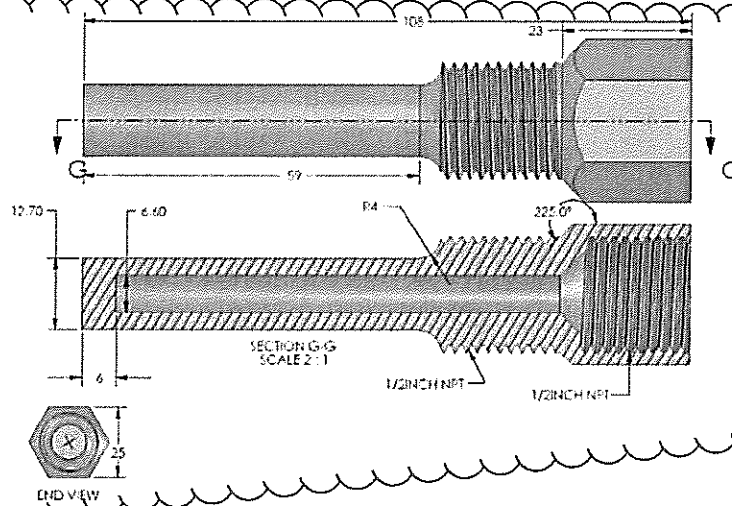
2 Part (Welded) Temcowell Standard Temcowells available from Temco include 304 stainless steel (machined), 316 stainless steel (machined), brass (machined), and two part (welded) stainless steel. These wells are offered in 2", 4" and 8" lengths with 1/2" NPT external and 1/2" NPSM. Other lengths and thread diameters are available upon request. The Thermowell chosen for the installation is governed mainly by the corrosion conditions the well will face. The machined stainless steel wells all come with a mirror polish to provide maximum corrosion resistance. Occasionally, the material consideration is one of strength rather than corrosion. For example, a machined stainless steel well may be required for high pressure water service where otherwise a brass or two part stainless steel well would be satisfactory from a corrosion standpoint. market require.

Well failures, in most cases, are not due to the effects of pressure or temperature on the well. The calculations necessary to provide adequate strength, under given conditions, are familiar enough to permit proper choice of wall thickness and material. The values shown in Table 1 are conservative, and intended primarily as a guide.

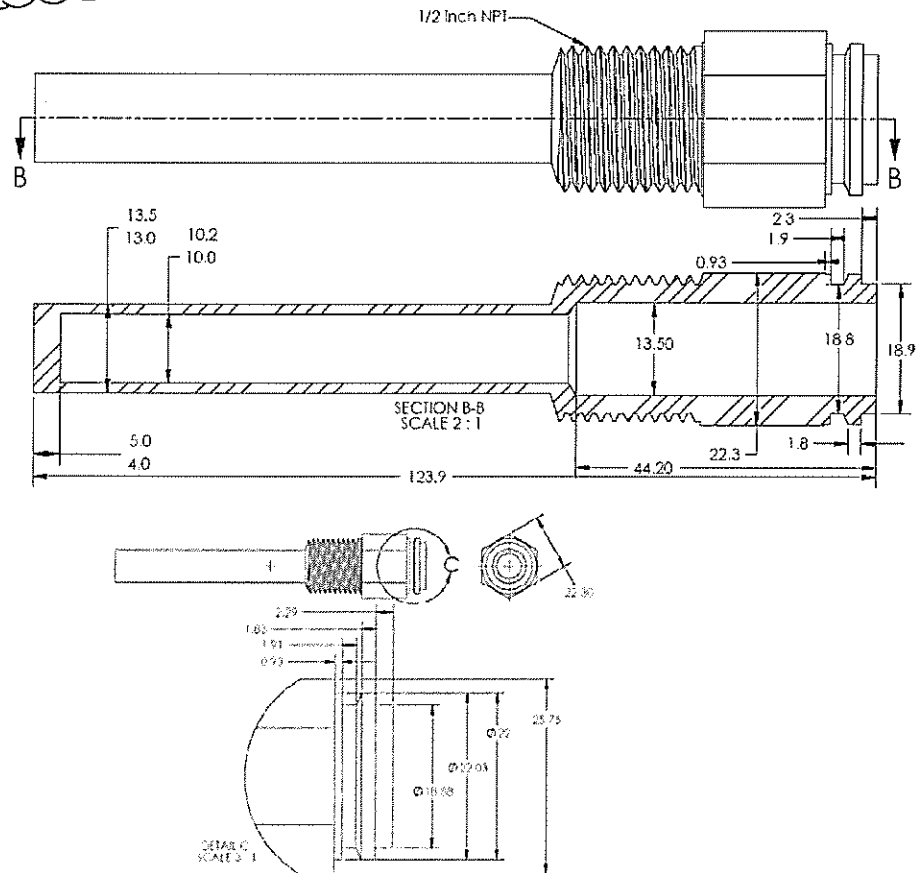
Wells are also safe if the resonant frequency is well below the wake frequency or if the fluid velocity is constantly fluctuating through the critical velocity point. Nevertheless, if the installation is not hampered by the use of a sufficiently stiff well.

Dimensions

DDC Type:



Honeywell Type:



Ordering Information

→ WL-B-4	Brass well, 4" Length, 1/2" NPT thread, fits 6mm dia probes.
WL-B-6	Brass well, 6" Length, 1/2" NPT thread, fits 6mm dia probes.
WL-H-S	Stainless steel well, Honeywell type, 4" Length, 1/2" NPT thread, fits 3/8" dia probes.
WL-H-B	Brass Well, Honeywell type, 4" Length, 1/2" NPT thread, fits 3/8" dia probes.

Socket DPDT Relays

DESCRIPTION

Veris VMD2B Series are DPDT blade-style relays for socket/DIN mounting. Both the full-featured and standard DIN rail sockets are compatible with all VMD2B relays.

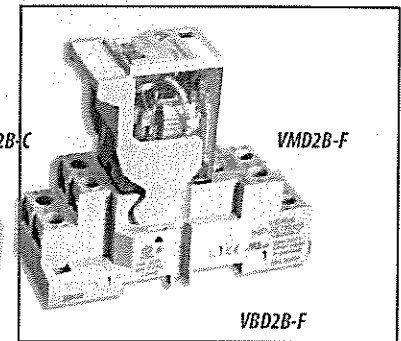
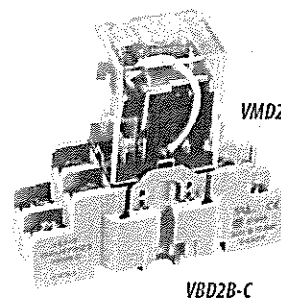
The VMD2B-F is the full-featured model in a slim housing. The LED, the flag indicator, and the test button allow for worry-free operation and easy troubleshooting with minimal downtime. Never wonder where the problem is!

TYPICAL COIL PERFORMANCE

Power Consumption	
AC Coils.....	1.2VA
DC Coils.....	0.9W

CONTACT RATINGS

Standard (F & C Series)		
Resistive.....	10A@120VAC 10A@277VAC 10A@28VDC	
Motor.....	1/4 HP@120VAC 1/3 HP@240VAC	
Pilot Duty.....	B300	
Hybrid (S Series, Bifurcated)		
	Low Side	High Side
Resistive.....	3A@120VAC 3A@277VAC 3A@30VDC	10A@120VAC 8A@277VAC 8A@28VDC
Motor.....	1/16 HP@120VAC —	1/3 HP@120VAC 1 HP@277VAC
Pilot Duty.....	B300	
CSA		
Resistive.....	10A@277VAC	



FEATURES

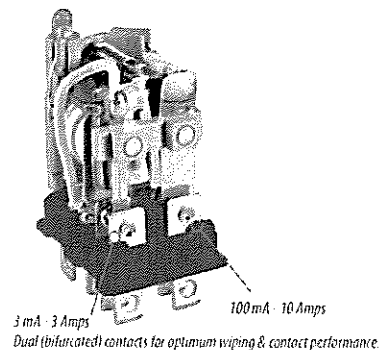
Full featured model:

- Color-coded push button...allows manual operation of relay. AC coils red or DC coils blue
- Removable override lever...when activated, locks push button and contacts in the powered position
- Flag indicator...shows contact status in manual or powered condition
- LED status lamp...shows coil "ON" or "OFF" status
- I.D. tag/write-on plastic label...used for identification of relays in multi-relay circuits
- 2-Way side or DIN rail mounting system...retrofits existing panel mounting and 35 mm DIN rail
- Mating hold-down clip...secures relay to socket (-F sockets)

Low level bifurcated model:

- All of the above full featured benefits
- Bifurcated contacts for high reliability at extremely low current levels
- Perfect for HVAC applications when you need to switch and hold low loads for long periods of time
- Hybrid relay, good for both logic switching and power switching

VMD2B-S has a hybrid design - great for installations where one pole is switching a dry circuit and the other pole is switching a motor starter!

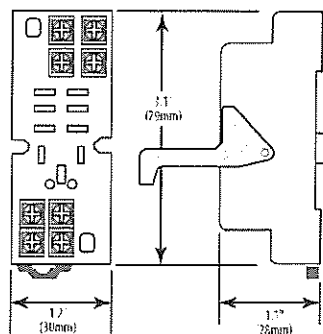
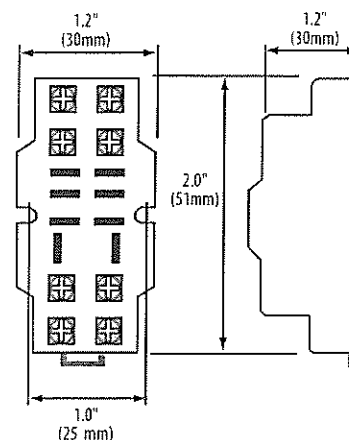
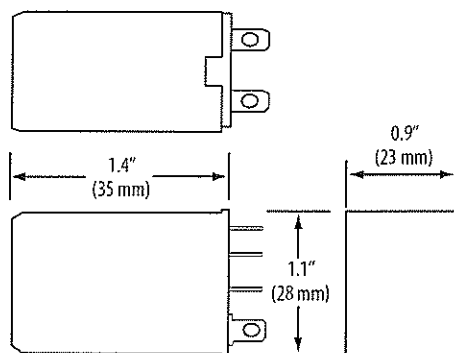


SPECIFICATIONS

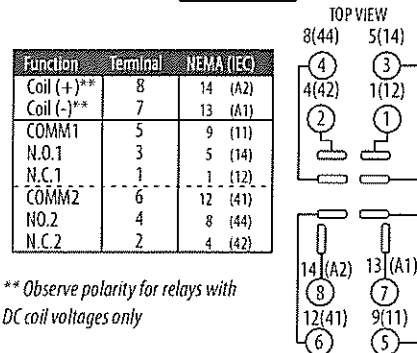


Operating Range	85% to 110% of rated voltage
Drop-out Voltage Threshold	15% of rated voltage
Expected Relay Life	Electrical (@ rated current) 100,000 cycles; Mechanical (unpowered) 10,000,000 cycles
Operating Time	20 msec typical
Dielectric Strength	1500VAC (RMS)
Operating Temperature	-40° to 55°C (-40° to 131°F)

DIMENSIONAL DRAWINGS

VBD2B-F Socket

VBD2B-C Socket

VMD2B Relays


APPLICATION/WIRING EXAMPLE

VBD2B Sockets


ORDERING INFORMATION



MODEL	RELAY TYPE	AMPERAGE RANGE	COIL VOLTAGE	MIN. SWITCHING CURRENT	FULL FEATURED	UL	CE
VMD2B-C12D	DPDT	15A	12VDC	100mA@5VDC		●	●
VMD2B-C24D		15A	24VDC	100mA@5VDC		●	●
VMD2B-C24A		15A	24VAC	100mA@5VDC		●	●
VMD2B-C120A		15A	120VAC	100mA@5VDC		●	●
VMD2B-F12D		15A	12VDC	100mA@5VDC	●	●	●
VMD2B-F24D		15A	24VDC	100mA@5VDC	●	●	●
VMD2B-F24A		15A	24VAC	100mA@5VDC	●	●	●
VMD2B-F120A		15A	120VAC	100mA@5VDC	●	●	●
VMD2B-F240A		15A	240VAC	100mA@5VDC	●	●	●
VMD2B-24SVAC		3A/10A	24VAC	3mA@17VDC/100mA@5VDC	●	●	●
VMD2B-120SVAC		3A/10A	120VAC	3mA@17VDC/100mA@5VDC	●	●	●

These relays are UL Listed, when used with the Veris sockets.

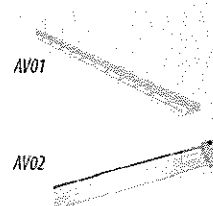
SOCKET ORDERING INFORMATION

MODEL	AMPERAGE RATING	VOLTAGE RATING	FINGER SAFE	HOLD DOWN CLIP	UL	CE
VBD2B-F	20 A	300 V	●	●	●	●

When relays and sockets are used together, ampere rating is the lesser of the two ratings.

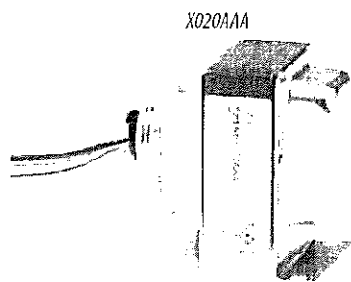
ACCESSORIES

DIN Rail, Stop Clip (AV01, AV02)

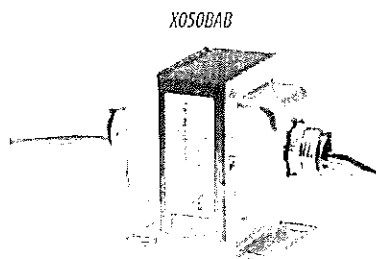


5 Year
Warranty

Control Transformers



1 Hub and Foot Mount



2 Hub and Foot Mount

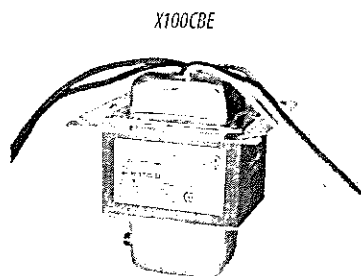
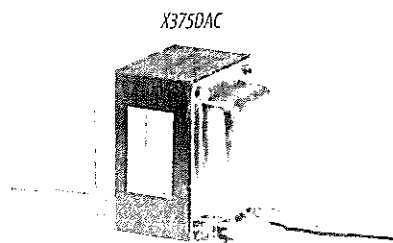
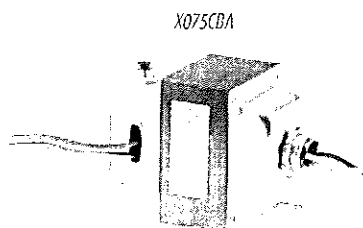


Plate Mount



Foot Mount



1 Hub and Foot Mount with Separated Secondary Wires

Veris X Series Control Transformers are a convenient source of control power for HVAC control and building automation applications. A wide variety of UL-listed transformers are available with single and dual threaded hub mounting options. Multiple current limiting options are available, including a circuit breaker in some models. Save ordering time and purchase order costs when buying other Veris sensors by including transformers in your order.

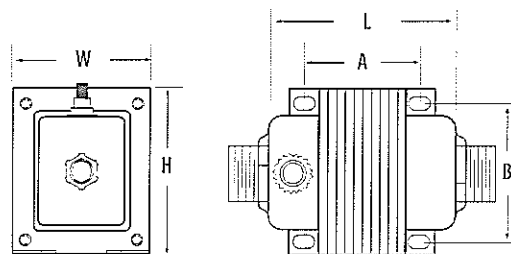
Versatile UL Listed transformers...simplify product selection and installation

- ☐ UL Listings for all models simplify panel building requirements
- ☐ Threaded hub options maximize installation flexibility
- ☐ One stop shopping...save time by ordering along with other Veris products

APPLICATIONS

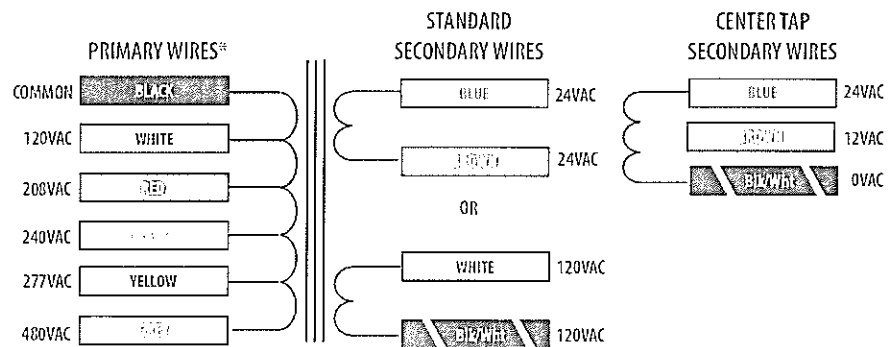
- ☐ Controller power
- ☐ Switching relays and other digital I/O circuits
- ☐ Powering sensors

DIMENSIONAL DRAWINGS



* See ordering table for dimensions.

WIRE COLORS



*Primary of 24V isolation transformers = Red/Red

SPECIFICATIONS

Frequency	50/60 Hz
Operating Temperature	-40° to 65°C (-40° to 149°F)
No Load Voltage	27 to 28VAC
Hub Style	Fits 1/2" electrical k.o.
Wire	UL 1015, 18 AWG*
Wire Length	8 inches

*X085AAA, X375DAC have 14AWG, Secondary wires



ORDERING INFORMATION



DIMENSIONS (inches)

MODEL	VA	PRIMARY VOLTAGE (VAC)	SECONDARY VOLTAGE (VAC)	CURRENT LIMITING METHOD	CLASS	MOUNTING	SEPARATED PRIMARY & SECONDARY WIRES	UL	CE	SPECIAL ORDER ONLY *	L	W	H	A	B	
STANDARD																
X020AAA	20	120	24	Inherent	II, III	1HUB+FT		●	●		2.3	1.9	2.6	1.59	1.69	
X020ACA		277		Inherent	II, III	1HUB+FT		●	●		2.3	1.9	2.6	1.59	1.69	
X020ADA		24		Inherent	General	1HUB+FT		●	●		2.3	1.9	2.6	1.59	1.69	
X020ADB		24		Inherent	General	2HUB+FT	●	●	●		2.3	1.9	2.6	1.59	1.69	
X040AAA	40	120	24	Inherent	II, III	1HUB+FT		●	●		2.7	2.2	2.9	1.98	1.81	
X040AAB		120		Inherent	II, III	2HUB+FT	●	●	●		2.7	2.2	2.9	1.98	1.81	
X040ACA		277		Inherent	II, III	1HUB+FT		●	●	●	2.7	2.2	2.9	1.98	1.81	
X040ADA		24		Inherent	II, III	1HUB+FT		●	●		2.7	2.2	2.9	1.98	1.81	
X040AMB	50	120/208/240/277	24	Fuse	II, III	2HUB+FT	●	●	●	●	2.7	2.2	2.9	1.98	1.81	
X040BNA		120/208/240		Fuse	II, III	1HUB+FT		●	●	●	2.7	2.2	2.9	1.98	1.81	
X050BAA		120		Fuse	II, III	1HUB+FT		●	●		2.8	2.2	2.9	2.06	1.81	
X050BAB		120		Fuse	II, III	2HUB+FT	●	●	●		2.8	2.2	2.9	2.06	1.81	
X050BCA	50	277	24	Fuse	II, III	1HUB+FT		●	●		2.8	2.2	2.9	2.06	1.81	
X050BCB		277		Fuse	II, III	2HUB+FT	●	●	●		2.8	2.2	2.9	2.06	1.81	
X050BGB		208/240		Fuse	II, III	2HUB+FT	●	●	●	●	2.8	2.2	2.9	2.06	1.81	
X050CAA		120		Circuit Breaker	II, III	1HUB+FT		●	●		3.5	2.5	3.1	1.91	2.03	
X050CBA	50	120/240/277/480	120	Circuit Breaker	II, III	1HUB+FT		●	●		3.5	2.5	3.1	1.91	2.03	
X050CBB		120/240/277/480		Circuit Breaker	II, III	2HUB+FT	●	●	●		3.5	2.5	3.1	1.91	2.03	
X050CCA		277		Circuit Breaker	II, III	1HUB+FT		●	●	●	3.5	2.5	3.1	1.91	2.03	
X050CEB		208/240/277/480		Circuit Breaker	General	2HUB+FT	●	●	●	●	3.5	2.5	3.1	1.91	2.03	
X050CEG	50	208/240/277/480	120	Circuit Breaker	General	Plate, 90° Sec	●	●	●	●	3.5	4.0	4.0	3.38	3.38	
X050CGG		208/240		Circuit Breaker	II, III	Plate, 90° Sec	●	●	●	●	4.0	4.0	4.0	3.38	3.38	
X050CHA		120/208/240/480		Circuit Breaker	II, III	1HUB+FT		●	●	●	3.5	2.5	3.1	1.91	2.03	
X050CHB		120/208/240/480		Circuit Breaker	II, III	2HUB+FT	●	●	●	●	3.5	2.5	3.1	1.91	2.03	
X050CNA	50	120/208/240	120	Circuit Breaker	II, III	1HUB+FT		●	●	●	3.5	2.5	3.1	1.91	2.03	
X050CNB		120/208/240		Circuit Breaker	II, III	2HUB+FT	●	●	●	●	3.5	2.5	3.1	1.91	2.03	
X050COA		120/208/240/277/480		Circuit Breaker	II, III	1HUB+FT		●	●	●	3.5	2.5	3.1	1.91	2.03	
X050DLB		220		None	II, III	2HUB+FT	●	●	●	●	2.8	2.2	2.9	2.06	1.81	
X075CAA	75	120	24	Circuit Breaker	II, III	1HUB+FT		●	●		3.9	2.5	3.1	2.31	2.03	
X075CAB		120		Circuit Breaker	II, III	2HUB+FT	●	●	●		3.9	2.5	3.1	2.31	2.03	
X075CBA		120/208/240/480		Circuit Breaker	II, III	1HUB+FT	●	●	●		3.9	2.5	3.1	2.31	2.03	
X075CCA		277		Circuit Breaker	II, III	1HUB+FT		●	●		3.9	2.5	3.1	2.31	2.03	
X075CHA	85	120/208/240/480	24	Circuit Breaker	II, III	1HUB+FT		●	●	●	3.9	2.5	3.1	2.31	2.03	
X085AAA		120		Inherent	General	1HUB+FT		●	●		3.2	3.8	3.2	2.2	3.14	
X100CAA		120		Circuit Breaker	II, III	1HUB+FT		●	●		4.1	2.5	3.1	2.51	2.03	
X100CAB		120		Circuit Breaker	II, III	2HUB+FT	●	●	●		4.1	2.5	3.1	2.51	2.03	
X100CBA	99	120/240/277/480	120	Circuit Breaker	II, III	1HUB+FT		●	●		4.3	2.5	3.1	2.70	2.03	
X100CBB		120/240/277/480		Circuit Breaker	II, III	2HUB+FT	●	●	●		4.3	2.5	3.1	2.70	2.03	
X100CBE		120/208/277/480		Circuit Breaker	II, III	Plate		●	●	●	4.3	4.0	4.0	3.38	3.38	
X100CHB		120/208/240/480		Circuit Breaker	II, III	2HUB+FT	●	●	●	●	4.3	2.5	3.1	2.70	2.03	
X100CKB	100	480	120	Circuit Breaker	General	2HUB+FT	●	●	●	●	4.1	2.5	3.1	2.51	2.03	
X100CLB		220		Circuit Breaker	II, III	2HUB+FT	●	●	●	●	4.1	2.5	3.1	2.51	2.03	
X150CAA		150		120	Circuit Breaker	General	1HUB+FT		●	●		3.5	3.8	3.2	2.08	3.26
X175CAB		120		None	General	2HUB+FT	●	●	●		4.1	3.8	3.2	3.19	3.14	
X175CLB	175	220	24	None	General	Foot	●	●	●	●	3.8	3.8	3.2	3.05	3.14	
X175DGC		208/240		None	General	Foot	●	●	●		4.1	3.8	3.2	3.19	3.14	
X240DAA		240		120	None	General	1HUB+FT	●	●	●		3.7	3.8	4.5	3.24	3.18
X375DAC		375		120	None	General	Foot	●	●	●		4.3	3.8	4.5	3.83	3.18
CENTER TAP																
X020APC	20	24	12/24	Inherent	II, III	Foot	●	●	●	●	2.3	1.9	2.6	1.59	1.69	
X020AQC		120/208/240		Inherent	II, III	Foot	●	●	●	●	2.3	1.9	2.6	1.59	1.69	
X040BPC		40		24	Fuse	II, III	Foot	●	●	●	●	2.7	2.2	2.9	1.98	1.81
X040BQC		120/208/240		Fuse	II, III	Foot	●	●	●	●	2.7	2.2	2.9	1.98	1.81	
X050CIA	50	120	24	Circuit Breaker	II, III	1HUB+FT	●	●	●	●	2.8	2.2	2.9	2.06	1.81	
X100CRC	100	120/240		Circuit Breaker	II, III	1HUB+FT	●	●	●	●	4.3	2.5	3.1	2.70	2.03	

* Special orders are not kept in stock, and may require some additional lead time. Call the factory for more details.



800.354.8356



805.598.4564

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A911 - HVAC Upgrade - Ardgowan

2 Palmers Ln,
Charlottetown, PE C1A 5V8

As Prepared By:

MEMCO
CONTROLS

1109 Champlain Street
Dieppe, NB E1A 1P9
T: 506-854-2496 F: 506-384-8452

PROJECT TEAM

Client Name: Entire Mechanical Contractors
Owner: Ardgowan

ALC Design Engineer: Sebastien Ferguson
ALC Project Manager: Jacques Bourgeois
Project Number: A911
Drawing Designation: Submittal
Drawing Date: 19/07/2017

E.M.C. Ltd.
569-1650

Job: Ardgowan HVAC Upgrade

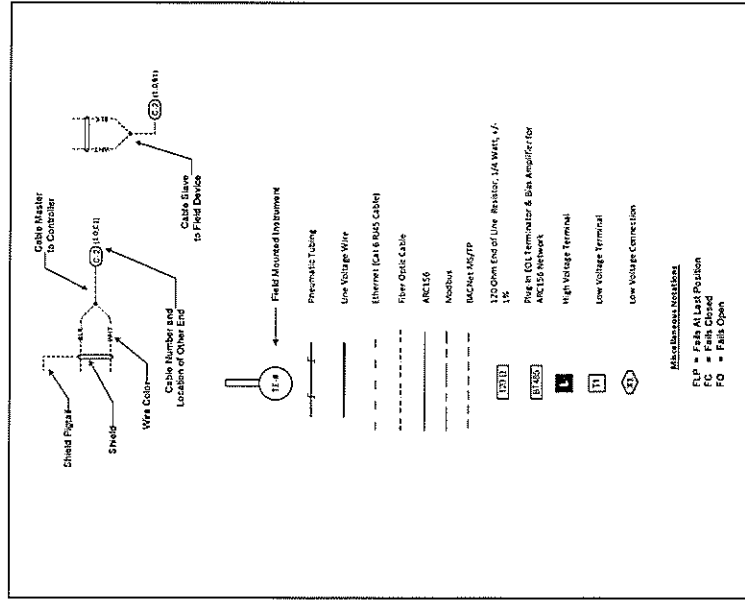
Contractor: EMC

Engineer: MCA

Reviewed: CM

Date: July 20/17

LEGEND



TAG DESCRIPTIONS

AA	Remote Annunciator Module & Auto Dialer	P	Pressure Probe
ALC	Automated Logic Controller	PDS	Pressure Differential Switch
ASA	Smoke Detector	PDT	Pressure Differential Transmitter
CR	Control Relay	PS	Pressure Switch
ENC	Enclosure	PT	Pressure Transmitter
ES	Direct Current Power Supply	QT	Gas Transmitter
FCV	Flow Control Valve / Damper Actuator	ST	Speed Transmitter
FE	Flow Element	SUB	Subpanel
FS	Flow Switch	TE	Temperature Element
FT	Flow Transmitter	TS	Temperature Switch
G	Generic Device	TSH	Temperature Switch High
IP	Electro-Pneumatic Transducer	TSL	Temperature Switch Low
IS	Current Switch	TT	Temperature Transmitter
ISE	Circuit Breaker	TY	Dew Pt/Enthalpy/Wet Bulb Transducer
IT	Current Transducer	V	Valve
JT	BTU Meter	VT	Vibration Transmitter / Switch
JY	Power Meter	X	Unclassified
KS	Electronic Timeclock	XF	Transformer
LS	Level Switch	YKS	Position Transmitter
LT	Level Transmitter	YL	Position Transmitter
MS	Humidistat	YS	Leak Detector
MT	Humidity Transmitter	YSE	Emergency Stop
MTE	Humidity Transmitter w/ Temperature Element	YY	Transducer
MTT	Humidity Transmitter w/ Temperature Transmitter	ZS	Position Indicating Switch
N	Accessories	ZT	Position Transmitter
NY	Network Device		

<u>DRAWING#</u>	<u>DRAWING NAME</u>
SYM.1	Symbol Legend
TOC.1	Table of Contents
1.0	Room Schedule
1.3	Room Schedule - Continued
2.0	HVAC Architecture
3.0	Bacnet/IP
4.0	Boiler Room - Controller
4.1	Boiler Room - Schematic
4.2	ERV-X - Controller
4.3	ERV-X - Schematic
5.0	Summary Bill Of Materials

A B C D E F G H

Room Schedule

Basement - Room Schedule

Room #	Room Description	Control Module Name	Module Type	Config	Room Sensor Type	Damper Actuator	ERV#	Intel. Motorised Damper	Heating			EVAP#	Exhaust Fan	NOTES
									Hot Water Baseboard	Control Relay				
Rm 100					Existing Tstat				Existing HWBB					Existing Components
Rm 101	Boiler Room	CM-12	SE6104a	Boiler Room										
Rm 104					Zone Controller			2	Existing HWBB	Relay Box #1	1			
Rm 105					Reverse Acting								EF-1	
Rm 106					Zone Controller									
Rm 110					Zone Controller			1	Existing HWBB	Relay Box #4	4			
Rm 111					Principle Controller			1	Existing HWBB	Relay Box #4	4			
Rm 112					Zone Controller			1						
Rm 115					Zone Controller			1						

Main Floor - Room Schedule

Room #	Room Description	Control Module Name	Module Type	Config	Room Sensor Type	Damper Actuator	ERV#	Intel. Motorised Damper	Heating			EVAP#	Exhaust Fan	NOTES
									Hot Water Baseboard	Control Relay				
Rm 200					Existing Tstat				Existing HWBB					Existing Components
Rm 201					Principle Controller			1	Existing HWBB	Relay Box #3	3			
Rm 202					Principle Controller			1	(2X)Existing HWBB	Relay Box #2	2			
Rm 205					Zone Controller			1	Existing HWBB	Relay Box #3	3			
Rm 206					Existing Tstat				Existing HWBB					Existing Components
Rm 207					Zone Controller			1	Existing HWBB	Relay Box #3	3			
Rm 208					Principle Controller			1	Existing HWBB	Relay Box #1	1			
Rm 209					Zone Controller			1	Existing HWBB	Relay Box #1	1			
Rm 211					Existing Tstat				Existing HWBB					Existing Components
Rm 212					w/Rm 211				Existing HWBB					Existing Components
Rm 213					w/Rm 211				Existing HWBB					Existing Components
Rm 214					Principle Controller			1	Existing HWBB	Relay Box #5	5			
Rm 215					Zone Controller			1	Existing HWBB	Relay Box #5	5			
Rm 217					Zone Controller			1	Existing HWBB	Relay Box #4	4			
Rm 218					Zone Controller			1	Existing HWBB	Relay Box #5	5			
Rm 220					Zone Controller			1	Existing HWBB	Relay Box #4	4			



PROJECT: A911 - HVAC Upgrade - Ardowan
 Client: PE C/A SVB
 Charlestown, PE C/A SVB
 FILENAME: I Room Schedules

REV	DESCRIPTION	DATE	BY

DRAWING NO.: 1.0
 CONTRACT NO. A911
 ROOM SCHEDULE
 DRAWING NO.: 1.0

Room Schedule - Continued												
Second Floor- Room Schedule												
Room #	Room Description	Control Module Name	Module Type	Config	Room Sensor Type	Damper Actuator	ERV#	Intel. Motorised Damper	Heating		Exhaust Fan	NOTES
									Hot Water Baseboard	Control Relay		
Rm 300					Zone Controller	-	-	1	Existing HWBB	Relay Box # 2	2	
Rm 301					Zone Controller	-	-	1	(2X)Existing HWBB	Relay Box # 2	2	
Rm 302					Zone Controller	-	-	1	-	-	-	
Rm 303					Zone Controller	-	-	1	Existing HWBB	Relay Box # 5	5	
Rm 304		CM-1	LGR25	Bacnet/IP	-	-	-	-	-	-	-	DELL PC, Network Switch
Rm 305		CM-10	SE6104a	ERV-X	-	NFB24	1	-	-	-	-	
Rm 306		CM-11	SE6104a	ERV-X	-	NFB24	2	-	-	-	-	

PROJECT: A911 - HVAC Upgrade - Aridgowan
2 Palms Ln,
Charlottesville, PE C1A SV8

FILE NAME: 1 Room Schedule

MEMCO
CONTROLS

1.3

DRAWING NAME:
Room Schedule - Continued

CONTRACT NO. 2411

DATE: 0

BY: 0

REV: 0

DESCRIPTION:

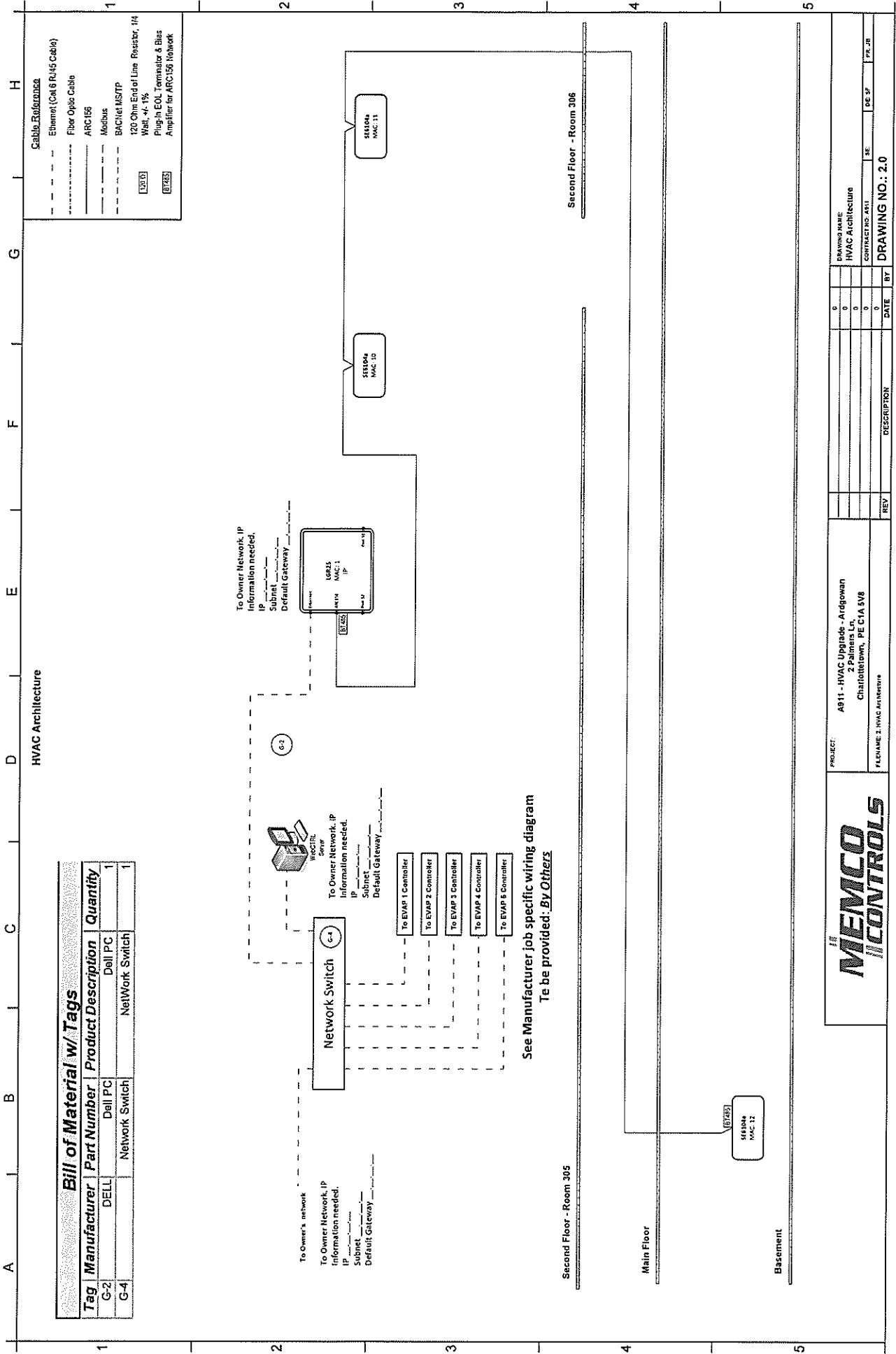
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MEMCO
CONTROLS

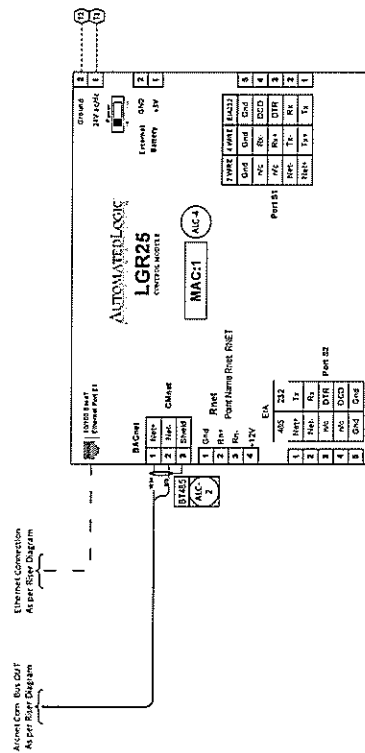
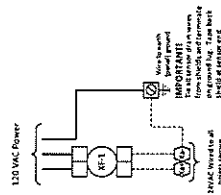
PROJECT: A911 - HVAC Upgrade - Ardgowan
2 Palmer's Ln.
Charlottesville, PE 014 5V8
FILENAME: 1_Room Schedule

REV: 0
DESCRIPTION: Room Schedule - Continued
DRAWING NO.: 1.3

DATE: 0
BY: 0
DE: 0
SE: 0
PR: 0



Tag	Manufacturer	Part Number	Product Description	Quantity
ALC-2	Automated Logic	BT485	ARCNET156 Terminating and Biasing plug in board	2
ALC-4	Automated Logic	LGR25	BACnet Router, 25 Point Gateway	1
X5-1	Veris	X50CAA	120Vac Transformer 50VA	1



CONTROLLER MODULE (CM-1)
COMMON OF 1, SEE ROOM SCHEDULE FOR DETAILS

MEMCO
CONTROLS

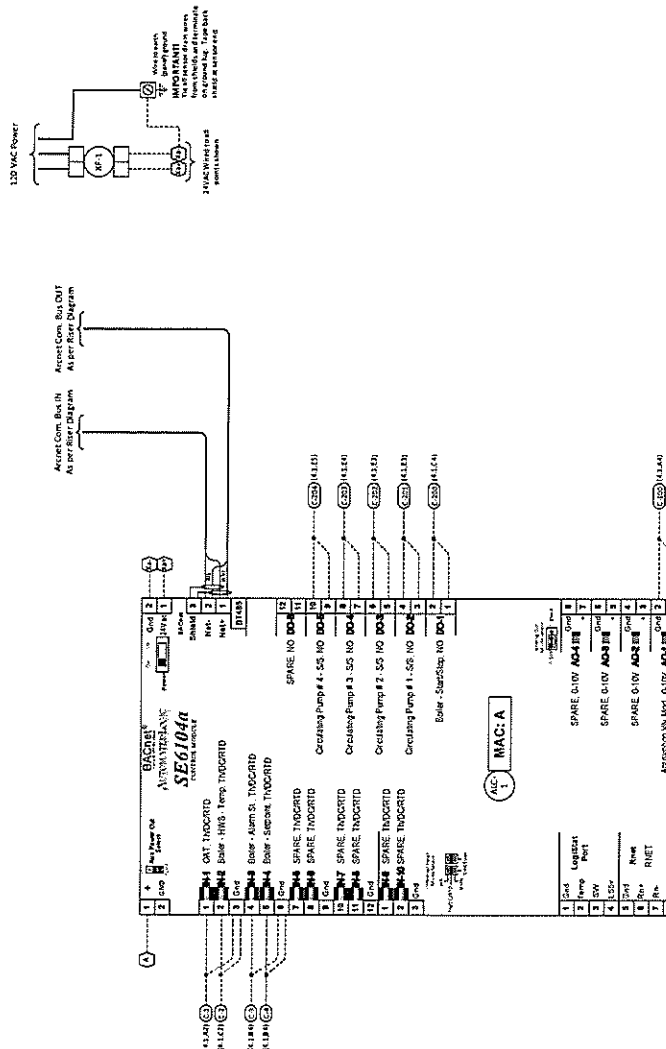
PROJECT: A911 - HVAC Upgrade - Ardgowan
2 Palmers Ln,
Charlottetown, PE C1A 5V8

FILENAME: 3_Babel IP

DRAWING NAME		Barnetrip	
CONTRACT NO. AB11	DE. #	PR. JB	
DRAWING NO. 3.0			

Bill of Material w/ Tags

Tag	Manufacturer	Part Number	Product Description	Quantity
ALC-1	Automated Logic	SE6104a	Control Module, 6DO, 10UI, 4AO	1
X5-1	Veris	X150CAA	120vac Transformer 150VA	1



CONTROLLER MODULE (CM-10)
COMMON OF 1, SEE ROOM SCHEDULE FOR DETAILS

		PROJECT		A911 - HVAC Upgrade - Ardgowan 2 Palmers Ln, Charlottetown, PE C1A 5V6		DRAWINGS NAME Beller Room - Controller	
		REVISION 4, Configuration				CONTRACT NO A911	
REV	DESCRIPTION	DATE	BY	DRAWING NO: 4.0		DE \$	PR \$

Boiler Room - Schematic

Tag

Manufacturer

Part Number

Product Description

Quantity

TE-2

BAPI

ALC/10K-2-O-EU

Outside Air Temp, 10K, Type 2

1

TE-1

Greystone

TE200C24B2E

Immersion 4" Temperature Sensor

1

N-1

Tamco Controls

TI-1/2 BR4

4" Brass Well

1

CR-1

Veris

FKIT-VMD2B-F24A

Relay Kit 24Vac

1

CR-2

Veris

FKIT-VMD2B-F24A

Relay Kit 24Vac

1

CR-3

Veris

FKIT-VMD2B-F24A

Relay Kit 24Vac

1

CR-4

Veris

FKIT-VMD2B-F24A

Relay Kit 24Vac

1

CR-5

Veris

FKIT-VMD2B-F24A

Relay Kit 24Vac

1

Typical Outside Air Temperature Sensor

See Room Schedule for location

Supplied and Installed By Others

Antisiphon Valve

HWR

Zone 1

Zone 2

Zone 3

Zone 4

SEQUENCE OF OPERATION:

Hot Water Baseboard Radiation

On a call for first stage auxiliary heat from local module, activate radiant heat relay to open associated on/off temperature control valve.

Heating Boiler

Boiler to be controlled from the EMCS and shall provide the functions described below.

Boiler shall be equipped with manual reset high limit aquastats for safety shutdown. Burners are equipped with alarm contacts for EMCS monitoring of alarm conditions. Burners will accept enable command from EMCS and modulating input signal for supply water reset.

Automatic Controls contractor shall wire electric antisiphon solenoid valves to burner. Valves to close upon burner shutdown. Antisiphon valves located at fuel oil storage tank.

Outdoor Air Reset: EMCS shall reset Heating Water Supply setpoint to facility based on outdoor air reset schedule. Outdoor air sensor by others. Heating Supply Water temperature shall be initially set as follows:

Initial Settings:

OAT 13°C -18°C

Supply Temp 60°C 82°C

Minimum supply temp 60°C, maximum supply temp 82°C.

Boiler Setpoint Reset: EMCS shall reset Boiler Supply Water temperatures to maintain the Heating Water Supply setpoint.

Boiler Supply Range: 60°C to 100°C

Boiler Alarm Monitoring: EMCS shall monitor boiler general alarm fault via the alarm monitoring contacts in the burner control. Initiate local and remote alarms if boilers initiate alarm.

Main existing heating circulators (4) shall operate from the EMCS based on outdoor air temperature. Circulators for any particular zone to run during heating season on a call for perimeter heat from that zone.

PROJECT:

A911 - HVAC Upgrade - Ardgowan

2 Palmer's Ln

Charlottesville, PE 014 5V8

FILENAME: Configuration

REVISIONS:

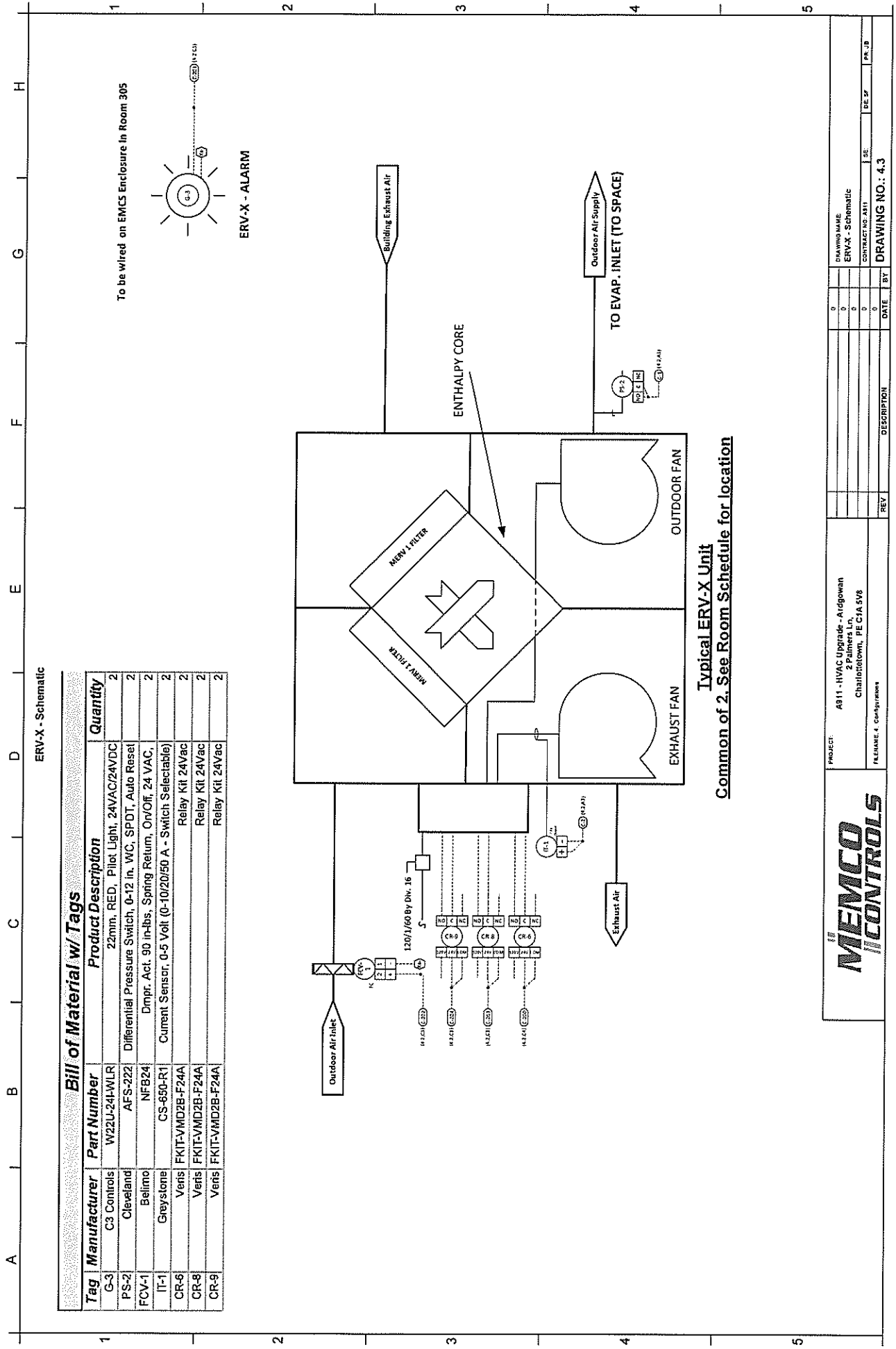
REV

DESCRIPTION

DATE

BY

DRAWING NO.: 4.1



PROJECT: A311 - HVAC Upgrade - Airdgwan
2 Palms Ln
Chattanooga, TN 37414 S18

REV: 0

DESCRIPTION: ERV-X - Schematic

DATE: 08/27

BY: PAJ/B

DRAWING NO.: 4.3

