

PART 1 GENERAL

1.1 DEFINITIONS

- .1 Average Effectiveness Level (AEL): ratio between total test period less any system downtime accumulated within that period and test period.
- .2 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.

1.2 DESIGN REQUIREMENTS

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

1.3 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Conform to the requirements of Section 250501 – EMCS – General Requirements.

.5 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
- .2 Provide Spare Parts and Maintenance Materials
- .3 Final Report:
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor
 - .3 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning.
 - .4 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.4 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.
- .2 Furnish spare parts and maintenance materials.
- .3 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.5 START-UP AND COMMISSIONING

- .1 Start-up and Commissioning shall be undertaken prior to Occupancy.
- .2 Provide equipment, personnel and materials necessary to put the Control Systems into operation.
- .3 Coordinate and cooperate with all the other contractors to place the Mechanical Systems into operation to the satisfaction of the Departmental Representative.
- .4 Provide equipment, personnel, material, and information necessary to assist the Mechanical Contractor in completing the Commissioning Process.
- .5 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.
- .6 Correct deficiencies, and re-test until satisfactory performance is obtained.

- .7 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .8 Load system with project software.
- .9 Perform tests as required.

1.6 COMPLETION OF COMMISSIONING

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

1.7 SYSTEM ACCEPTANCE

- .1 Complete the system installation, start up, calibration and verification prior to acceptance testing by the Departmental Representative. Submit a letter to the Departmental Representative certifying that the controls have been installed, the software programs have been exercised, and requesting system acceptance. Include all verification data and certificates confirming that the work has been installed to the satisfaction of the authorities having jurisdiction.
- .2 Acceptance testing will commence on a mutually agreeable time within 14 calendar days of request.
- .3 At the time of acceptance testing, turn over to the Departmental Representative the revised Operation and Maintenance data and a pre-paid Warranty and Service Agreement. The system will not be accepted without complete documentation.
- .4 Provide operating and maintenance personnel, and tools and material, as required to operate and adjust the system(s), and coordinate with the Departmental Representative, to completely test and verify the operation of the system(s). It is expected that this testing will take place during the cooling season. Allow for additional testing and verification at the beginning of the heating season.
- .5 When the system has been deemed satisfactory for beneficial use, the warranty period will commence.

1.8 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 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.

2.2 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.
 - .1 Application: to conform to normal industry standards.

PART 3 EXECUTION

3.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical
- .2 Conform to the requirements of Section 250112 – EMCS – Training
- .3 Conform to the requirements of Section 250501 – EMCS – General Requirements

3.2 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures as prescribed.
- .3 Debug system software.
- .4 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .5 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.
- .6 Pre-Installation Testing.
 - .1 Consists of field tests of equipment just prior to installation.
 - .2 Testing may be on site or at Contractor's premises.
 - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

- .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, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
- .7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
- .8 Transmitters above 0.5 % error will be rejected.
- .9 DP switches to open and close within 2% of setpoint.
- .7 Completion Testing.
 - .1 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 AC-to-DC 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 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.
- .8 Start-Up Procedures:

- .1 Check power supply.
 - .2 Check starter O/L heater sizes.
 - .3 Check for proper, safe operation.
 - .4 Check installation, operation. Adjust as necessary.
 - .5 Check settings, operation of operating, limit, safety controls, over-temperature, audible/visual alarms, other protective devices.
 - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .7 Test operation of hand-on-auto switch.
 - .8 Test operation of alternator.
 - .9 Adjust alignment of conduit to ensure true flexibility at all times.
- .9 Final Startup Testing:
- .1 Upon satisfactory completion of tests, perform point-by-point test of entire system and provide:
 - .1 Technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 Commissioning to commence during final startup testing.
 - .4 O&M personnel to assist in commissioning procedures as part of training.
 - .5 Commissioning to be supervised by qualified supervisory personnel.
 - .6 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .7 Operate systems as long as necessary to commission entire project.
 - .8 Monitor progress and keep detailed records of activities and results.
- .10 Final Operational Testing:
- .1 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.
 - .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.
- .11 Commissioning Manager to verify reported results.

3.3 CALIBRATION AND ADJUSTMENT OF CONTROLS SYSTEMS

- .1 All components shall be calibrated before the areas are occupied in order to minimize the disruption to the occupants following the takeover the building.
- .2 Upon completion of the installation phase of the project, calibrate and adjust all controls systems and components installed under this contract to provide acceptable space conditions and proper functioning of the systems. Keep a written log of the calibration data for each device, including the instrumentation against which the equipment is calibrated. Include this log in the Operation and Maintenance manuals.
- .3 If requested, the Contractor shall be prepared to provide written documentation of recent calibration checks for all instrumentation and sensors.
- .4 Final adjusting: upon completion of commissioning, set and lock devices in final position and permanently mark settings.

3.4 VERIFICATION AND OPTIMIZATION OF THE OPERATION OF THE MECHANICAL SYSTEMS

- .1 The installation shall be completely tested, demonstrating that the equipment and systems installed are performing in the manner intended.
- .2 Provide equipment, personnel and materials necessary to produce written records for verification of the operation of all control systems and all equipment.
- .3 Provide equipment, personnel and materials necessary to adjust the controls systems as part of the overall optimization of the mechanical systems.
- .4 Adjust control setpoints and tune control algorithm performance to optimize the operation of the systems.
- .5 Provide records consisting of computer generated trending logs, snap shot readings of setpoints and settings of variables, and any other method capable of demonstrating to the Departmental Representative that the systems are operating optimally.

- .6 At the time of completion, provide trend logs for each and every system to demonstrate the satisfactory operation of each system and each component.
- .7 The Contractor shall provide analysis of the trend log data and shall make any and all changes to the controls systems as required to correct deficiencies or to optimize the operation of the systems.
- .8 Trend logs shall be printed on 8-1/2" x 11" paper, clearly labeled for time, date, system and variables tracked. Trend log data shall be stored in a file format capable of being imported into a spreadsheet program for graphing.
- .9 The Contractor shall be aware that additional trend logs may be required to be submitted during the warranty period to troubleshoot system deficiencies. Prepare and submit this data as required

3.5 COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical
- .2 Conform to the requirements of Section 230593 – Testing, Adjusting and Balancing for HVAC
- .3 Conform to the requirements of Section 230801 – Performance Verification of Mechanical Piping Systems
- .4 Conform to the requirements of Section 250501 – EMCS – General Requirements
- .5 In accordance with manufacturer's recommendations.
- .6 Field test each component.
- .7 Develop, with Departmental Representative assistance, detailed instructions for O & M of this installation.
- .8 Performance Verification
 - .1 Record setpoint(s).
 - .1 Mark points of design and actual performance at design conditions.
 - .2 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 in accordance with Section 230501 – Common Work Results - Mechanical and Section 250112 – EMCS – Training.

END OF SECTION 250111

PART 1 GENERAL

1.1 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 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.
- .5 Submit reports within one week after completion of training program that training has been satisfactorily completed.

1.2 QUALITY ASSURANCE

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

1.3 INSTRUCTIONS

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

1.4 TIME FOR INSTRUCTION

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.5 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.

1.6 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 all parties.

- .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.
- .3 Phase 2: 2 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 following:
 - .1 Operator training: provide operating personnel and maintenance personnel with condensed version of Phase 1 training.
 - .2 Equipment maintenance training: provide personnel with 2 days training within 5 day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

1.7 ADDITIONAL TRAINING

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

1.8 MONITORING OF TRAINING

- .1 Departmental Representative 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 250112

PART 1 GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .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, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
 - .1 Canadian Environmental Assessment Act (CEAA).
 - .2 Canadian Environmental Protection Act (CEPA)
- .7 Electrical and Electronic Manufacturers Association (EEMAC).
 - .1 EEMAC 2Y-1, Light Gray Colour for Indoor Switch Gear.
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC).
 - .1 Transportation of Dangerous Goods Act (TDGA)

1.2 ACRONYMS AND ABBREVIATIONS

- .1 Acronyms used in EMCS:
 - .1 AEL - Average Effectiveness Level.

- .2 AI - Analog Input.
- .3 AIT - Agreement on International Trade.
- .4 AO - Analog Output.
- .5 BACnet - Building Automation and Control Network.
- .6 BC(s) - Building Controller(s).
- .7 BECC - Building Environmental Control Center.
- .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 NAFTA - North American Free Trade Agreement.
- .26 NC - Normally Closed.
- .27 NO - Normally Open.
- .28 OS - Operating System.
- .29 O&M - Operation and Maintenance.

- .30 OWS - Operator Work Station.
- .31 PC - Personal Computer.
- .32 PCI - Peripheral Control Interface.
- .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .34 PID - Proportional, Integral and Derivative.
- .35 RAM - Random Access Memory.
- .36 SP - Static Pressure.
- .37 ROM - Read Only Memory.
- .38 TCU - Terminal Control Unit.
- .39 USB - Universal Serial Bus.
- .40 UPS - Uninterruptible Power Supply.
- .41 VAV - Variable Air Volume.

1.3 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 with related equipment (stop, start) and valve 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 minimum 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 or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide minimum 25 character field for each point identifier.
 - .2 Point expansion : comprised of three fields, one for each descriptor. Expanded form of short form or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide minimum 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 250554- EMCS: Identification.

1.4 SYSTEM DESCRIPTION

- .1 Refer to control schematics and control sequences for system architecture.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
 - .1 Building Controllers.
 - .2 Control devices as listed in I/O point summary tables.

1.5 OWS(s).

- .1 Data communications equipment necessary to effect EMCS data transmission system.
- .2 Field control devices.
- .3 Software/Hardware complete with full documentation.
- .4 Complete operating and maintenance manuals.
- .5 Training of personnel.
- .6 Acceptance tests, technical support during commissioning, full documentation.
- .7 Wiring interface co-ordination of equipment supplied by others.
- .8 Miscellaneous work as specified in these sections and as indicated.

.2 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 by Departmental Representative prior to installation.
- .3 Location of controllers as reviewed by Departmental Representative prior to installation.
- .4 Provide utility power to EMCS.
- .5 Metric references: in accordance with CAN/CSA Z234.1.

.3 Language Operating Requirements:

- .1 Provide English 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 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.
- .5 Include, in English:
 - .1 Input and output commands and messages from operator-initiated functions, 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.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 SUBMITTALS

.1 Make submittals in accordance with:

- .1 Section 013300 - Submittal Procedures,
- .2 Section 250502 - EMCS: Shop Drawings, Product Data and Review Process.

- .2 Submit for review:
 - .1 Equipment list and systems manufacturers at time of tender.
- .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 250502 - EMCS: Shop Drawings, Product Data 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 Departmental Representative, 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 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.
 - .8 Existing devices shall be replaced with new devices..

1.7 QUALITY ASSURANCE

- .1 Have local office staffed by trained personnel capable of 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 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 013529.06 - Health and Safety Requirements.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials in accordance with Section 017421 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal material in appropriate on-site bins in accordance with Waste Management Plan.
 - .4 Separate for and place in designated containers 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 Regional and Municipal 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 materials from landfill to recycling facility as approved by Departmental Representative.
 - .10 Fold up banding, flatten and place in designated area for recycling.

1.9 EXISTING CONDITIONS - CONTROL COMPONENTS

- .1 Utilize existing control wiring and piping where possible, provided that they conform to applicable codes, standards and specifications. Replace plenum controls cabling/wiring that is not compliant with the current plenum cable/wiring rating requirements.
- .2 Provide new field control devices that conform to applicable codes, standards and specifications.
 - .1 Do not modify existing devices without written permission from Departmental Representative.
 - .2 Provide for new, properly designed devices.
- .3 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.
- .4 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
 - .1 Be responsible for items repaired or replaced by Departmental Representative.
 - .2 Be responsible for repair costs due to negligence or abuse of equipment.

- .3 Responsibility for existing devices terminates upon final acceptance of EMCS as approved by Departmental Representative.
- .5 Remove existing controls not required. Place in approved storage for disposition as directed.

PART 2 PRODUCTS

2.1 EQUIPMENT

- .1 Control Network Protocol and Data Communication Protocol: to ASHRAE STD 135.
- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

- .1 Provide adaptors between metric and imperial components.

PART 3 EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

- .1 Installation: to manufacturer's recommendations.

3.2 PAINTING

- .1 Painting: in accordance with Section 230501 – Common Work Results Mechanical, 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 too extensively damaged to be primed and touched up to make good.
- .4 Clean and prime exposed hangers, racks, fastenings, and other support components.
- .5 Paint unfinished equipment installed indoors.

3.3 FIELD QUALITY CONTROL

- .1 Verification requirements in accordance with Section 230501-Common Work Results-Mechanical: Contractor's Verification, include:

- .2 Materials and resources.
- .3 Storage and collection of recyclables.
- .4 Construction waste management.
- .5 Resource reuse.
- .6 Recycled content.
- .7 Local/regional materials.
- .8 Certified Wood.
- .9 Low-emitting materials.

END OF SECTION 250501

PART 1 GENERAL

1.1 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 or Lontalk.

1.2 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Conform to the requirements of Section 250112 – EMCS – Training.
- .5 Conform to the requirements of Section 250501 – EMCS – General Requirements.
- .6 Conform to the requirements of Section 250503 – EMCS – Project Record Documents.
- .7 Conform to the requirements of Section 250554 – EMCS – Identification.
- .8 Conform to the requirements of Section 250820 – EMCS – Warranty and Maintenance.
- .9 Conform to the requirements of Section 251001 – EMCS – Local Area Network (LAN).

- .10 Conform to the requirements of Section 251002 – EMCS – Operator's work Station (OWS).
- .11 Conform to the requirements of Section 253001 – EMCS – Building Controllers.
- .12 Conform to the requirements of Section 253002 – EMCS – Field Control Devices.
- .13 Conform to the requirements of Section 259001 – EMCS – Site Requirements, Applications, and System sequences of Operation.
- .14 Shop Drawings:
 - .1 As indicated herein
- .15 Shop Drawing Submittal:
 - .1 The Contractor shall provide two copies of the preliminary shop drawings directly to the Departmental Representative's office for review and comment, make any changes requested by the Departmental Representative, and re-submit two copies. Submission and re-submission shall continue in this manner until the preliminary shop drawings have been accepted by the Departmental Representative. Seven copies of the final shop drawings shall be prepared and submitted through the normal channels of communication.
 - .2 Allow for technically qualified personnel to attend meetings at the Departmental Representative's office to discuss and clarify the preliminary shop drawings.
 - .3 The review of the shop drawings is for the sole purpose of ascertaining conformance with the general design concept. The review shall not mean approval of the detailed design inherent in the equipment, the responsibility for which shall remain with the Contractor. The review shall not relieve the Contractor of the responsibility to meet the requirements of the contract documents. The Contractor shall remain responsible for confirming and correlating the dimensions on the jobsite, and for information that pertains to the fabrication process, construction techniques, and installation details, and for coordinating the work with the other Contractors.
- .16 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .1 Submittals to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.
 - .1 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.
 - .2 Soft copy to be in Autocad and Microsoft Word format, structured using menu format for easy loading and retrieval on OWS.

1.3 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.
- .2 Furnish the following spare parts:

- .1 As recommended by Manufacturer.
- .3 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.4 SHOP DRAWINGS

- .1 Submit preliminary shop drawings within 60 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 Schematic diagrams detailing the system architecture showing all points associated with each controller.
 - .3 Spare point capacity of each controller by number and type.
 - .4 Control panel locations and layout;
 - .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 System schematic diagrams and wiring layouts;
 - .10 Wiring diagrams.
 - .11 Piping diagrams and hook-ups.
 - .12 Interface wiring diagrams showing termination connections and signal levels.
 - .13 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
 - .1 Sensing element type and location.
 - .2 Transmitter type and range.
 - .3 Associated field wiring schematics, schedules and terminations.
 - .4 Complete Point Name Lists.
 - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.

- .6 Software and programming details associated with each point.
- .7 Manufacturer's recommended installation instructions and procedures.
- .8 Sensors and control components;
- .9 Miscellaneous components;
- .14 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.
 - .1 Detailed written sequences of operation;
 - .2 Logic flow charts;
 - .1 The Logic Flow Charts submitted as part of the shop drawings, using computer industry standard symbols and nomenclature, shall be developed so as to:
 - .1 Clarify the program code for the Departmental Representative.
 - .2 Demonstrate that the programmer understands the intent of the specifications;
 - .3 Clearly indicate the programming sequences.
- .15 Graphic system schematic displays of systems with point identifiers and textual description of system, as specified.
- .16 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.
- .17 Listing and example of specified reports.
- .18 Listing of time of day schedules.
- .19 Lists of menus and alarms;
 - .1 Sample menu and alarm formats.
- .20 Type and size of memory with statement of spare memory capacity.
- .21 Full description of software programs provided.
 - .1 List of packaged software;
- .22 Sample of "Operating Instructions Manual" to be used for training purposes.
- .23 Outline of proposed start-up and verification procedures. Refer to Section 250111 - EMCS: Start-up, Verification and Commissioning.

- .1 Submit with the shop drawings a Project Test Plan, indicating how the installed system will be tested and verified to be found operating in accordance with the plans and specifications. Include a sample of the trend logs and check sheets to be submitted.

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION 250502

PART 1 GENERAL

1.1 SUBMITTALS

- .1 Submit Record Documents, As-built drawings, Operation and Maintenance Manuals, in English.
- .2 Conform to the requirements of Section 013300 - Submittal Procedures.
- .3 Conform to the requirements of Section 017800 – Closeout Submittals.
- .4 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .5 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual.

.1 SUBMITTAL FORMAT

- .1 Provide soft copies, and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
 - .2 Binders to be 2/3 maximum full.
 - .3 Provide index to full volume in each binder.
 - .4 Identify contents of each manual on cover and spine.
 - .5 Provide Table of Contents in each manual.
 - .6 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.
- .2 Provide Spare Parts and Maintenance Materials

1.2 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.
- .2 Furnish spare parts and Maintenance Materials.
 - .1 As recommended by Manufacturer.
- .3 Furnish list of individual manufacturer's recommended spare parts, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

1.3 AS-BUILTS

- .1 Provide 1 copy of detailed shop drawings generated in Section 250502 - 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 250111 - 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 3 Hard and 1 soft copy incorporating changes made during final review.

1.4 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 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 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 key strokes 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 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's, 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 250503

PART 1 GENERAL

1.1 REFERENCES

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

1.2 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Samples:
 - .1 Submit samples of nameplates and identification tags, and a list of proposed wording.
- .5 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .2 Provide operation and maintenance data in accordance with ANSI/NFPA 20.
 - .3 Provide Spare Parts

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Conform to the requirements of Section 250501 – EMCS – General Requirements.
- .3 Language Operating Requirements: provide identification for control items in English.
- .4 Nameplates, labels and tags shall include function, setpoint and equipment names and ID numbers.

2.2 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.
 - .1 Sizes: 25 x 75 mm minimum.

- .2 Lettering: minimum 7 mm high, black.
- .3 Inscriptions: machine engraved to identify function.
- .4 mechanically fastened to equipment with screws or rivets

2.3 NAMEPLATES FOR FIELD DEVICES

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

2.4 NAMEPLATES FOR ROOM SENSORS

- .1 Identify by stick-on labels using point identifier.
 - .1 Labels shall be self adhesive white tape with black embossed lettering, similar to Brother P-touch. 'Dymo' labels will not be acceptable.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

2.5 TAGS FOR VALVES

- .1 Tags shall be engraved, all metal, attached with metal key chains.

2.6 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.

2.7 CONDUIT

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.

- .3 Coding: use fluorescent orange paint and confirm color with Departmental Representative during "Preliminary Design Review".

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical
- .2 Conform to the requirements of Section 250501 – EMCS – General Requirements.
- .3 Install using Manufacturers Recommended Instructions

3.2 NAMEPLATES, LABELS AND TAGS

- .1 Provide nameplates for all panels and major components.
- .2 Provide labels inside of panels and cabinets, and at all remote locations, for adjustment and readout points.
- .3 Provide tags at all valves and equipment not suited for attaching nameplates.
- .4 Identify all equipment mounted on the front of control panels with lamacoid nameplates.
- .5 Identify instruments inside of control panels with tape labels.

3.3 MANUFACTURER'S NAMEPLATES AND LABELS

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

3.4 COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical
- .2 Conform to the requirements of Section 250501 – EMCS – General Requirements.
- .3 In accordance with manufacturer's recommendations.

END OF SECTION 250554

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

.1 Electrical:

- .1 Provide power wiring from emergency power panels where emergency power is provided to EMCS field panels. If no emergency power provided, install UPS Device. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches. Coordinate with Electrical.
- .2 Provide the Global Controller with a UPS for sized for it. The UPS is to be powered from emergency power. Coordinate with Electrical.
- .3 Hard wiring between field control devices and EMCS field panels.
- .4 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
- .5 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as required.
- .6 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 Departmental Representative before commencing work.
- .7 All control wiring 50 V and less for equipment supplied by Division 25 shall be the responsibility of Division 25- Integrated Automation Contractor. Conduit and wire associated with this is the responsibility of Division 25.

.2 Mechanical:

- .1 Pipe taps required for EMCS equipment shall be supplied and installed by Mechanical Division.
- .2 Wells and control valves shall be supplied by EMCS Contractor and installed by Mechanical.
- .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Mechanical. Costs to be carried by designated trade.

.3 Low Pressure Bypass VAV Terminal Units.

- .1 Remove the existing controls serving the existing VAV Low Pressure Bypass Boxes and replace them with new digital controls capable of being controlled/monitored by the New Building Automation System. The new controls shall electronically maintain the existing minimum positions on the existing low pressure bypass boxes, but the new controls shall allow the minimum positions to be adjusted from the Operator's Work Station. Controls shall be supplied, installed and commissioned by the EMCS contractor. Coordinate air flow adjustments with the balancing trade.

.4 Structural:

- .1 Special steelwork as required for installation of work.

1.2 PERSONNEL QUALIFICATIONS

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

1.3 EXISTING CONDITIONS

- .1 Cutting and Patching: Refer to Section 017300 – Execution Requirements 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: Refer to Hydronic Systems: Steel and Copper.
- .2 Sleeves, escutcheons: refer to Section 230505 – Installation of Pipework.
- .3 Hangers and supports: refer to Section 230529 – Hangers and Supports for HVAC Piping and Equipment.
- .4 Insulation: refer to Section 210720 – Thermal Insulation for 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 Electrical Divisions.
- .2 For 50V 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 50 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
- .4 Sizes:
 - .1 120V Power supply: to match or exceed breaker, size #12 minimum.

- .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
- .3 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
- .4 Analog input and output: shielded #18 minimum solid copper or #20 minimum stranded twisted pair. Wiring must be continuous without joints.
- .5 More than 4 conductors: #22 minimum solid copper.
- .5 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 Electrical Division.
- .2 Electrical metallic tubing to CSA C22.2 No. 03. Flexible and liquid tight flexible metal conduit to CSA C22.2 No.56. Rigid steel threaded conduit to CSA C22.2 No. 45.
- .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 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: refer to Section Hydronic Systems: Steel and Copper.
- .2 Insulation: refer to Section 210720 – Thermal Insulation for Piping.

3.3 MECHANICAL PIPING

- .1 Install piping in accordance with Section 230505 – Installation of Pipework.

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 Electrical Divisions, this specification.
 - .2 CSA 22.1 Canadian Electrical Code, latest edition.
 - .3 ANSI/NFPA 70.
 - .4 ANSI C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage (above 50 V) 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 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
- .2 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Owner's Representative before starting such work. Provide complete conduit system to link field panels and devices unless noted otherwise (Refer to drawings). Conduit size to match conductors plus future expansion capabilities as specified.

- .3 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
- .4 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
- .5 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .6 Limit conduit length between pull boxes to less than 30 m.
- .7 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
- .8 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 Owner's Representative.
- .9 Install polypropylene fish cord in empty conduits for future use.
- .10 Where conduits become blocked, remove and replace blocked sections.
- .11 Pass conduits through structural members only after receipt of Owner's Representative's written approval.
- .12 Conduits may be run in flanged portion of structural steel.
- .13 Group conduits wherever possible on suspended or surface channels.
- .14 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.
- .15 Install terminal blocks or strips indicated in cabinets to Electrical Division.
- .16 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 Owner's 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 control connections as indicated. Power connections above 50V by Electrical Division.
- .2 Install correct over-current devices.
- .3 Identify each control 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 250820 - EMCS: Warranty and Maintenance.
 - .2 Give 14 days written notice of intention to test.
 - .3 Conduct in presence of Owner's Representative and authority having jurisdiction.
 - .4 Conceal work only after tests satisfactorily completed.
 - .5 Report results of tests to Owner's 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:
 - .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
 - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Owner's Representative and authority having jurisdiction.

3.12 IDENTIFICATION

- .1 Refer to Section 250554- EMCS: Identification.

END OF SECTION 250560

PART 1 GENERAL

1.1 REFERENCES.

- .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
- .2 Canadian Standards Association (CSA International).
 - .1 CSA Z204-, Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 SUBMITTALS - GENERAL

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .2 Provide Spare Parts

1.3 SUBMITTALS

- .1 Submit detailed preventative maintenance schedule for system components.
- .2 Submit detailed inspection reports.
- .3 Submit dated, maintenance task lists, 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.
- .4 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .5 Records and logs: in accordance with Section 017800 - 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 after inspection, indicating that planned and systematic maintenance have been accomplished.

- .6 Revise and submit in accordance with Section 017800 - Closeout Submittals: "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. 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 within 3 hours 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.

1.5 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.
- .2 Furnish the following spare parts:
 - .1 Radiant Panel/Radiation Hydronic Heating Control Valves:
 - .1 4 spares for each valve size complete with actuator and all appurtenances
 - .2 Three-way Hydronic Heating Control Valve:
 - .1 2 spares complete with actuator and all appurtenances
 - .3 Communicating thermostats serving the Low Pressure Bypass VAV Boxes:
 - .1 4 spares complete with all appurtenances
 - .4 Controllers serving the Low Pressure Bypass VAV Boxes:
 - .1 4 spares complete with all appurtenances
 - .5 Controllers serving AH-1, Boilers & Pumps:
 - .1 2 spares of each type complete with all appurtenances
 - .6 Controllers serving Weeping Tile Pit, Sanitary Pit & Domestic Cold Water Main Recirculation monitoring:
 - .1 2 spares of each type complete with all appurtenances
 - .7 Line Voltage Thermostats & Humidistats:
 - .1 2 spares of each type complete with all appurtenances
 - .8 Duct or Pipe mounted sensors (temperature, humidity, CO2, electrical current, etc.):
 - .1 2 spares of each type complete with all appurtenances
 - .9 Damper actuators:
 - .1 2 spares of each type complete with all appurtenances
 - .10 Spare Global Controller complete with UPS
 - .11 Other spare parts as recommended by Manufacturer.
- .3 Furnish list of individual manufacturer's recommended spare parts for equipment, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 EXECUTION

3.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical
- .2 Conform to the requirements of Section 250501 – EMCS – General Requirements

3.2 FIELD QUALITY CONTROL

- .1 Perform as minimum, 2 two minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report 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 each field input/output device in accordance with CSA Z204.
 - .3 Provide dated, maintenance task lists, as described in Submittal article, 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 Review system performance with Departmental Representative 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.
 - .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 250820

PART 1 GENERAL

1.1 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.

1.2 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 / TIA/EIA-569-A / TBITS 6.9.
 - .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 include, but not limited to:
 - .1 Modems.
 - .2 Network interface cards.
 - .3 Network management hardware and software.

- .4 Network components necessary for complete network.

1.3 DESIGN REQUIREMENTS

- .1 EMCS Local Area Network (EMCS-LAN).
 - .1 High speed, high performance, local area network over which 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: BACnet.
 - .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, or shielded twisted cable compatible with network protocol to be used within buildings..

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION 251001

PART 1 GENERAL

1.1 OWS SYSTEM DESCRIPTION

- .1 The Operator's Terminal shall be located in the Building Engineer's Office.
- .1 Consists of commercially-available color-graphic desktop computer with an external monitor in current production, with sufficient memory and processor capacity to perform functions specified. Also provide a tablet for use a portable operator's interface device for access to controllers.
- .2 OWS to include:
 - .1 Provide all documentation relating to the upgrades of the operator terminal and software in a separate binder.
 - .2 Suitably sized computer with diskette drive, CD Rom drive, Hard Disk Drive, one parallel port, two serial ports, keyboard.
 - .3 Minimum: 19" colour monitor, 1024x768 resolution, 0.28mm dot pitch.
 - .4 Mouse. Provide mouse pad.
 - .5 Colour graphics printer, with 400 sheets of paper, and a spare ink cartridge.
 - .6 Modem hardware and software.
 - .7 Installed Software
 - .8 UPS Power bar with surge suppression and filtering. Unit shall guarantee connected hardware for 5 years.

1.2 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Conform to the requirements of Section 250111 – EMCS – Start-up, Verification and Commissioning.
- .5 Conform to the requirements of Section 250112 – EMCS - Training.
- .6 Conform to the requirements of Section 250501 – EMCS - General Requirements.
- .7 Conform to the requirements of Section 250502 – EMCS - Submittals and Review Process.
- .8 Conform to the requirements of Section 250503 – EMCS - Project Record Documents.
- .9 Shop Drawings:
 - .1 Submit data for items supplied in this section.
- .10 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into O & M manual.
- .2 Provide Spare Parts and Maintenance Materials

1.3 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.
- .2 Furnish the following spare parts:
 - .1 As recommended by Manufacturer.

1.4 ENVIRONMENTAL CONDITIONS

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

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Conform to the requirements of Section 250501 – EMCS – General requirements.

2.2 OWS PC COMPONENTS

- .1 OWS: IBM compatible laptop or tablet PC with an external monitor and the following as minimum:
 - .1 Processor: micro-processor, operating at minimum clock speed of 2 Gigahertz, capable of supporting software necessary to perform functions specified in this section. System backplane bus (100 Megahertz) to support PCI and ISA boards.
 - .2 Operating System (OS)
 - .1 OS to support complement of hardware terminals and software programs specified.
 - .2 OS to be true multitasking operating environment.
 - .3 MS DOS or PC DOS based software platforms not permitted.
 - .4 OWS software to operate in "Windows" based operating environment: Windows 10 or Unix "X" Windows based system.
 - .3 Internal clock.
 - .1 Uninterruptible clock: accuracy of plus or minus 5 seconds/month, capable of deriving year / month / day / hour / minute / second.
 - .2 Rechargeable batteries: to provide minimum 48 h clock operation in event of power failure.

- .4 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.
- .5 Power supply unit to accept 120 V / 60 Hz source and include line surge and low voltage protection for processor and its peripherals.
- .6 IDE Disk drive controller to support 4 drives.
 - .1 1 @ 932 GB hard disk drive.
 - .2 1 @ 48X/24X/48X CD-RW drive.
- .7 16 GB RAM minimum.
- .8 Enhanced 101 key keyboard.
- .9 PS2 mouse.
- .10 Colour monitor: 19". Flat panel display IPS, resolution 1280 X 1040, dot pitch 0.26 mm, colour support 24 bit,
- .11 Video card with 512 MB video RAM.
- .12 4 USB ports.
- .13 Internal or external Modem - 56 k.
 - .1 Provide modem hardware and software as follows:
 - .1 Auto answer send/receive fax modem.
 - .2 56 Kbps capable of V.92 Specification.
- .14 PCI Ethernet LAN Adapter to connect to local Ethernet LAN network.
- .15 200 W maximum power supply.

2.3 PRINTER

- .1 Colour graphics printer include following features:
 - .1 Ink-jet technology capable of printing high quality colour images at speed of 4 pages per minute.
 - .2 Black cartridge to be separate cartridge from red green blue cartridge.
 - .3 Minimum colour resolution 2400 by 1200 dpi.
 - .4 Minimum black and white resolution 1200 by 1200 dpi.
 - .5 Minimum 8 MB RAM.
- .2 Include minimum 400 spare sheets of 8.5 X 11" paper.

2.4 OWS CONTROL SOFTWARE

- .1 General:

- .1 Install and configure all software to provide a smoothly integrated computer system. Provide system setup programming to permit the operator to easily accomplish the functions of monitoring the systems, controlling the systems, and printing reports and logs.
- .2 The Operator shall be able to modify the setpoints of the systems and zones.
- .3 The system shall be capable of being reloaded with the software.
- .4 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.
- .5 Each of the controlled systems shall operate independently (i.e.: calls for heat/cool/fan for one system will not affect another system)
- .6 Provide software for start/stop optimization.
- .7 Provide auto restart after power failures.
- .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 250501 - 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 system including:
 - .1 Operator Log-in from user interface device.
 - .2 Communication messages: errors, failures and recovery.
 - .3 Event notifications and alarms by category.
 - .4 Record of operator initiated commands.
- .5 General Event Log:

- .1 Hold minimum of 4 months information and be readily accessible to operator.
- .2 Able to be archived as necessary to prevent loss of information.
- .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) following functions are 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 operator.
 - .2 Requests for status, analog values, graphic displays, logs and 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 Dial-up host Module for off site OWSs.
 - .1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.
 - .2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.
 - .3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.
- .8 Message Handling Module - and Error Messages: to provide message handling for following conditions:
 - .1 Message and alarm buffering to prevent loss of information.
 - .2 Error detection correction and retransmission 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.
 - .4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.
- .9 Access Control Module.
 - .1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. 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 = 5 minutes.

- .10 Provide run time accumulators as follows:
 - .1 Accumulators shall have a range of 0-65,000 hours and shall provide an alarm indication on the operator's terminal at an adjustable trip point selected by the operator.
 - .2 Accumulators shall be capable of operation without the operator's terminal being turned on.
 - .3 Provide a separate alarm for each accumulator.
- .11 Provide system viewing and programmable trending analysis as follows:
 - .1 The status of all setpoints and the readout of all sensors shall be polled every 2 minutes (adjustable) in order to provide a snap-shot view or a trend log of the systems. Status will be monitored without the need to have the Operator's terminal running;
 - .2 Automatic printout will be available for each snap-shot or trend log on an adjustable time schedule;
 - .3 Snap-shot views shall be available for each system, providing complete information regarding setpoints and readouts.
 - .4 Trend logs shall be available for each controlled point, indicating setpoint and readout.
- .12 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 4 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 following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of .5 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 concurrent plotting of Measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as 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 6 trend points concurrently or 1 Control Loop Plot. For display output of real time 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.
- .13 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 253001 - 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:

- .2 Points in accessible from this OWS (total connected for this location), multiple "areas".
- .3 Area (points and systems in Area).
- .4 Area, system (points in system).
- .5 System (points by system type).
- .6 System point (points by system and point object type).
- .7 Area point (points by system and point object type).
- .8 Point (points by point object type).
- .5 Summary report: printout or display of point objet 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.
- .14 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 259001 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
 - .1 Supply and install graphics hardware and software as required to provide dynamic graphics capabilities incorporating variables such as operating values, setpoint values and alarm trip points.
 - .2 Provide programming for graphic screens
 - .3 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, overlaid 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.
 - .4 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.
 - .5 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.
 - .6 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 elements.
- .10 Establish co-relation between symbols or text and associated system points or other graphic displays.
- .7 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent 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.
- .8 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.
- .9 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.
- .10 Utilize graphics package to generate system schematic diagrams as required in Section 259001 - EMCS: Site Requirements, Applications and System Sequences of Operation. 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 associated heating coil or radiation valve. Provide display of Equipment in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.
- .11 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.
- .12 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.
- .15 Provide alarm monitoring and annunciation as follows:
 - .1 Alarm functions shall be capable of operation without the operator's terminal being turned on. These alarm conditions shall be immediately annunciated on the local operator terminal and associated alarm printer, or when the terminal is first turned on, if it has been turned off.
 - .2 Alarm conditions shall be capable of being deemed 'maintenance' or 'critical' by the Operator. Alarm lists shall be capable of being revised by the Operator.
 - .3 Alarm conditions which indicate a serious malfunction of the mechanical systems, which require immediate attention, shall be designated as "Critical Alarms".

- .4 In addition to being annunciated on the local operator terminal, 'critical' alarms shall also provide an alarm at the Nursing Station E101. The alarm shall be a light, buzzer and silence switch. This Alarm shall be capable of being voided through the Operator Terminal Software.
- .5 In addition to being annunciated on the local operator terminal, 'critical' alarms shall also initiate the autodial alarm.
- .6 Monitor and annunciate alarms for systems, conditions and equipment as follows:
 - .1 Fan failure (critical);
 - .2 Heating mode out of nominal range (critical);
 - .3 Cooling mode out of nominal range (critical);
 - .4 Low space temperature (critical);
 - .5 High space temperature (critical);
 - .6 Run time accumulator reached;
 - .7 Pump failure (critical).
- .7 When the air systems are running, supply air temperatures above 120 deg. F (adjustable) will provide an alarm.
- .8 When the air systems are running, supply air temperatures below 55 deg. F (adjustable) on a call for heat will provide an alarm. Provide adjustable time delay software as required to ensure that false alarms are prevented on initial heating call.
- .9 When the air systems are running, supply air temperatures below 47 deg. F (adjustable) will shut the system down and provide an alarm.
- .10 At any time, when any zone temperature sensor senses temperature below 55 deg. F (adjustable) or above 90 deg. F (adjustable) the EMCS system shall signal an alarm. Each sensor shall provide a separate alarm.
- .11 When a run time accumulator has reached it's setpoint, an alarm shall be signalled. Each accumulator shall provide a separate alarm.
- .12 When a pump is scheduled to be operational, a lack of signal from a current sensing switch will provide an alarm. Provide adjustable time delay software as required to ensure that false alarms are prevented on initial start-up. Each sensor shall provide a separate alarm.
- .16 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 field device within following time periods of detection:
 - .1 Critical - 5 seconds.
 - .2 Cautionary - 10 seconds.
 - .3 Maintenance - 10seconds.
- .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. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of 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 or loss of communication.
 - .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.
- .17 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.
- .18 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.

2.5 ADDITIONAL UTILITY SOFTWARE

- .1 Supply and install on primary OWS, following software:
- .2 One installed copy of the latest version of Microsoft Windows, Microsoft Office, Excel spreadsheet for Windows; and other software as required to integrate all provided components.
 - .1 AutoCAD LT latest version CAD software products by Autodesk Inc. and include:
 - .1 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.
 - .2 Enter soft copy submissions, including "Record" drawings specified in Section 250503 - EMCS: Project Record Documents in OWS.
 - .3 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Departmental Representative.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical
- .2 Conform to the requirements of Section 250501 – EMCS – General requirements
- .3 Install using Manufacturers Recommended Instructions

- .4 Provide necessary power as required from local 120 V receptacle.

3.2 COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical
- .2 Conform to the requirements of Section 250111 – EMCS – Startup, Verification and Commissioning
- .3 Conform to the requirements of Section 250501 – EMCS – General Requirements
- .4 In accordance with manufacturer's recommendations.

END OF SECTION 251002

PART 1 GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
 - .1 ASHRAE, Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA International).
 - .1 C22.2 No.205, Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE C37.90.1, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 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: <http://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

1.2 SYSTEM DESCRIPTION

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as required 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 Controller 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 to 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 to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
 - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

- .3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.
 - .1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.
 - .2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

1.3 DESIGN REQUIREMENTS

- .1 To include:
 - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
 - .2 Perform On-Off digital control of connected points, including 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 10 % of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
 - .1 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 logics devices and associated field equipment.
 - .3 Lockable wall cabinet.
 - .4 Required communications equipment and wiring (if remote units).
 - .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.
 - .2 Provide for following input signal types and ranges:

- .1 4 - 20 mA;
 - .2 0 - 10 V DC;
 - .3 100/1000 ohm RTD input;
- .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
 - .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 120 V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees 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 and TCUs to be mounted in equipment enclosures or separate enclosures.
- .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.

1.4 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals.
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Conform to the requirements of Section 250501 – EMCS – General Requirements.
- .5 Shop Drawings:
 - .1 Submit data for items supplied in this section.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 017800 - Closeout Submittals.
 - .2 Provide Spare Parts and Maintenance Materials

1.5 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.
- .2 Furnish the following spare parts:
 - .1 Refer to Section 250820 EMCS-Warranty And Maintenance
 - .2 Other spare parts as recommended by Manufacturer
- .3 Furnish list of individual manufacturer's recommended spare parts for equipment, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Conform to the requirements of Section 250501 – EMCS – General requirements.
- .3 Conform to Manufacturers Recommendations.

2.2 PANELS - GENERAL

- .1 Provide all pre-wired control panels, except for those furnished as part of equipment under other sections.
- .2 Fabricate fully enclosed cabinets using all steel construction with enamel finish:
 - .1 Use hinged locking door
 - .2 Common key all locks
- .3 Provide either wall mount or freestanding panels as required by the actual installation.
- .4 Where heat-generating equipment is to be mounted inside of an enclosure, provide vented cabinets.
- .5 Mount all routinely operated, manually adjusted, and indicating devices on the panel door. Enclose all other devices.
- .6 Mount plasticized control schematics inside the panels.

2.3 SYSTEM CONTROLLERS

- .1 Configurable controllers will not be accepted.
- .2 Provide dedicated controllers as required with the following characteristics:
 - .1 Modular, fully programmable and fully flexible, capable of being integrated into a network and capable of being expanded;
 - .2 Full “stand alone” operation following programming, including time of day scheduling;
 - .3 Peer-to-peer communications with all other controllers on the system over a communications bus for data sharing;
 - .4 Full and independent operation without the need to have the Operator’s terminal running;
 - .5 Power backup by rechargeable batteries capable of sustaining the program in RAM for a minimum of 60 days. Recharging circuitry shall be built into each panel. Battery status shall be displayed on the face of the controller. Battery failure shall be annunciated as a service alarm;
 - .6 Jack for portable operator's terminal;
 - .7 Powerline filters to eliminate surges, spikes, and line noise;
 - .8 Auxiliary 120V receptacle within the enclosure for powering diagnostic equipment.
- .3 In at least one of the system control panels, provide autodialer/modem hardware and software capable of four numbers of 11 digits each. Autodialer shall be capable of operation without the operator's terminal being on.
- .4 Controllers shall be capable of the following functions:
 - .1 Providing digital and/or analog outputs, as required, for controlling equipment;
 - .2 Communicating with the network;

- .3 Operating on a stand-alone basis.

2.4 MASTER CONTROL UNIT (MCU)

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in 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.
 - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
 - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
 - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
 - .1 Processor to consist of 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 performance and technical specifications to include but not limited to:
 - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
 - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) 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.
 - .4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

2.5 LOCAL CONTROL UNIT (LCU)

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.

- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
 - .1 Include minimum 2 interface ports for connection of local computer terminal.
 - .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
 - .3 Physically separate line voltage (70V 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.

2.6 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
 - .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .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.

2.7 SOFTWARE

- .1 Conform to the requirements of Section 251002 – EMCS – Operators Work Station (OWS).
- .2 General.
 - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
 - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
 - .3 Include initial programming of Controllers, for entire system.
- .3 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 including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

- .4 Programming languages.
 - .1 Program Control Description Logic software (CDL) 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.
- .5 Operator Terminal interface.
 - .1 Operating and control functions include:
 - .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.
 - .6 Point identification.
- .6 Pseudo or calculated points:
 - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
- .7 Inputs and outputs for process:
 - .1 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 number of other processes (e.g. cascading).
- .8 Control Description Logic (CDL):
 - .1 Capable of generating on-line project-specific CDLs which are 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 (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
 - .3 Perform changes to CDL on-line.
 - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

- .5 Energy optimization routines including enthalpy control, supply temperature reset, 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 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
 - .4 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:
 - .1 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.
- .10 Event and Alarm management:
 - .1 Use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by 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. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.
- .11 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated 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 Peak demand limiting.

- .8 Temperature compensated load rolling.
- .9 Pump speed/flow pressure control.
- .10 Hot water reset.
- .11 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.
- .12 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 99,999.99 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.

2.8 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.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical

- .2 Conform to the requirements of Section 250501 – EMCS – General Requirements
- .3 Install using Manufacturers Recommended Instructions
- .4 Location of Controllers to be approved by Departmental Representative.
- .5 Install Controllers in secure locking enclosures, all common keyed.
- .6 Provide necessary power from local 120 V circuit.
- .7 Install tamper locks or other suitable detriment to access on all control breakers of circuit breaker panel.
- .8 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

3.2 COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical
- .2 Conform to the requirements of Section 250501 – EMCS – General requirements
- .3 In accordance with manufacturer's recommendations.
- .4 Develop, with Owner assistance, detailed instructions for O & M of this installation.

END OF SECTION 253001

PART 1 GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI C12.7, Requirements for Watthour Meter Sockets.
 - .2 ANSI/IEEE C57.13, Standard Requirements for Instrument Transformers.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B148, Standard Specification for Aluminum-Bronze Sand Castings.
- .3 National Electrical Manufacturer's Association (NEMA).
 - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 Air Movement and Control Association, Inc. (AMCA).
 - .1 AMCA Standard 500-D, Laboratory Method of Testing Dampers For Rating.
- .5 Canadian Standards Association (CSA International).
 - .1 CSA-C22.1, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.2 SUBMITTALS

- .1 Conform to the requirements of Section 013300 - Submittal Procedures.
- .2 Conform to the requirements of Section 017800 – Closeout Submittals
- .3 Conform to the requirements of Section 230501 – Common Work Results - Mechanical.
- .4 Conform to the requirements of Section 250501 – EMCS – General Requirements
- .5 Shop Drawings:
 - .1 Submit data for items specified in this section.
- .6 Closeout Submittals:
 - .1 Provide operation and maintenance data for inclusion with manual specified in Section 017800 - Closeout Submittals.
 - .2 Provide Spare Parts per Section 250820-EMCS-Warranty and Maintenance

1.3 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 017800 - Closeout Submittals.

- .2 Furnish the following spare parts:
 - .1 As recommended by Manufacturer.
- .3 Furnish list of individual manufacturer's recommended spare parts for equipment, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical.
- .2 Conform to the requirements of Section 250501 – EMCS – General Requirements
- .3 Control devices of each category to be of same type and manufacturer.
- .4 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight assembly.
- .5 Operating conditions: suitable for ambient conditions of 0 - 32 degrees C with 10 - 90 % RH (non-condensing) unless otherwise specified.
- .6 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .7 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .8 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .9 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .10 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 EMCS SYSTEM SENSORS - GENERAL

- .1 For Public Locations, and other areas not requiring local occupant control or override, wall mounted space temperature sensors shall have blank cover plates without indication.
- .2 For Locations where local occupant control or override is allowed, wall mounted space temperature sensors/controllers shall have:
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint
 - .3 Buttons for occupant selection of occupied/unoccupied mode.

- .3 Wall mounted space humidity sensors shall have blank cover plates, without indication.

2.3 TEMPERATURE SENSORS

- .1 General: except for room sensors, to be resistance or thermocouple type to following requirements:
 - .1 Thermocouples: limit to temperature range of 200 degrees C and over.
 - .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
 - .3 Sensing element: hermetically sealed.
 - .4 Stem and tip construction: copper or type 304 stainless steel.
 - .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
- .2 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm.
- .3 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .1 Where specified, LCD display to show space temperature and temperature setpoint.
 - .2 Where specified, Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .3 Jack connection for access to zone bus.
 - .4 Integral thermistor sensing element 10,000 ohm at 24 degrees.
 - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
 - .6 Stability 0.02 degrees C drift per year.
 - .7 Separate mounting base for ease of installation.
 - .2 Room temperature sensors.
 - .1 Wall mounting, in slotted type covers, with guard where specified.
 - .2 Element 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.
- .4 Duct temperature sensors:
 - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.
 - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at any point along probe without degradation of performance.

.5 Outdoor air temperature sensors:

- .1 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 wiring conduit, weatherproof construction in NEMA 4 enclosure.

2.4 TEMPERATURE TRANSMITTERS

.1 Requirements:

- .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
- .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees 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 or 1000 ohm RTD sensor: not to exceed 25 mA.
- .8 Integral zero and span adjustments.
- .9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees 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 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
 - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
 - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
 - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
 - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.5 HUMIDITY SENSORS

.1 Room and Duct Requirements:

- .1 Range: 5 - 90 % RH minimum.
- .2 Operating temperature range: 0 - 60 degrees C.

- .3 Absolute accuracy:
 - .1 Duct sensors: plus or minus 3 %.
 - .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 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.
- .6 Room sensors: wall mounted as indicated.
- .7 Duct mounted sensors: locate so that sensing element is in air flow in duct.
- .2 Outdoor Humidity Requirements:
 - .1 Range: 0 - 100 % RH minimum.
 - .2 Operating temperature range: -40 - 50 degrees C.
 - .3 Absolute accuracy: plus or minus 2 %.
 - .4 Temperature coefficient: plus or minus 0.03%RH/ degrees C over 0 to 50 degrees C.
 - .5 Must be unaffected by condensation or 100% saturation.
 - .6 No routine maintenance or calibration is required.

2.6 HUMIDITY TRANSMITTERS

- .1 Requirements:
 - .1 Input signal: from RH sensor.
 - .2 Output signal: 4 - 20 mA onto 500 ohm maximum load.
 - .3 Input and output short circuit and open circuit protection.
 - .4 Output variations: not to exceed 0.2 % of full scale output for supply voltage variations of plus or minus 10 %.
 - .5 Output linearity error: plus or minus 1.0% maximum of full scale output.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect: plus or minus 1.0 % full scale/ 6 months.
 - .8 Long term output drift: not to exceed 0.25 % of full scale output/ 6 months.

2.7 PRESSURE TRANSDUCERS

- .1 Requirements:
 - .1 Combined sensor and transmitter measuring pressure.
 - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

- .2 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .3 Output variations: less than 0.2 % 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 0.5 % of full scale output over entire range.
- .5 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.
- .6 Over-pressure input protection to at least twice rated input pressure.
- .7 Output short circuit and open circuit protection.
- .8 Accuracy: plus or minus 1 % of Full Scale.

2.8 DIFFERENTIAL PRESSURE 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 into 500 ohm maximum load.
 - .3 Output variations: less than 0.2 % 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 0.5 % 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 degrees C.
 - .7 Over-pressure input protection to at least twice rated input pressure.
 - .8 Output short circuit and open circuit protection.
 - .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.9 STATIC PRESSURE SENSORS

- .1 Requirements:
 - .1 Multipoint element with self-averaging manifold.
 - .2 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
 - .3 Accuracy: plus or minus 1 % of actual duct static pressure.

2.10 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

- .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
- .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
- .3 Accuracy: 0.4 % of span.
- .4 Repeatability: within 0.5 % of output.
- .5 Linearity: within 1.5 % of span.
- .6 Deadband or hysteresis: 0.1% of span.
- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.11 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

- .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
- .2 Adjustable setpoint and differential.
- .3 Switch: snap action type, rated at 120V, 15 amps AC or 24 V DC, as required.
- .4 Switch 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 switches with isolation valve and snubber, where code allows, between sensor and pressure source.

2.12 THERMOSTATS

- .1 Where required for direct local control of terminal heat transfer units or fan coil units, provide wall mounted thermostat with concealed adjustment less thermometer.

2.13 TEMPERATURE SWITCHES

.1 Requirements:

- .1 Operate automatically. Reset automatically:
- .2 Adjustable setpoint and differential.

- .3 Accuracy: plus or minus 1 degree C.
- .4 Snap action rating: 120V, 15 amps or 24V DC as required. Switch to be DPST for hardwire and EMCS connections.
- .5 Type as follows:
 - .1 Room: for wall mounting on standard electrical box, with protective guard as specified
 - .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 Low temperature detection: continuous element with 6000 mm insertion length, duct mounting, to detect coldest temperature in any 30 mm length.
 - .5 Strap-on: with helical screw stainless steel clamp.

2.14 WATER FLOW SWITCHES

- .1 Where required for water flow indication, provide paddle type flow switch with digital output for EMCS system readout.
 - .1 Current sensing switches on pumps are an acceptable substitute.

2.15 MANUAL TIMERS

- .1 Where required for manual override, provide wall mounted spring return timer for 0-8 hours in 15 minute increments.

2.16 ELECTROMECHANICAL 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

2.17 SOLID STATE RELAYS

- .1 General:
 - .1 Relays to be socket or rail mounted.
 - .2 Relays to have LED Indicator
 - .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
 - .4 Operating temperature range to be -20 degrees C to 70 degrees C.

- .5 Relays to be CSA Certified.
- .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
- .7 Operational frequency range, 45 to 65 HZ.
- .2 Input:
 - .1 Control voltage, 3 to 32 VDC.
 - .2 Drop out voltage, 1.2 VDC.
 - .3 Maximum input current to match AO (Analog Output) board.
- .3 Output.
 - .1 AC or DC Output Model to suit application.

2.18 CURRENT TRANSDUCERS

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:
 - .1 4-20 mA DC.
 - .2 0-1 volt DC.
 - .3 0-10 volts DC.
 - .4 0-20 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 MCC.

2.19 CURRENT SENSING RELAYS

- .1 Requirements:
 - .1 Suitable to detect belt loss or motor failure.
 - .2 Trip point adjustment, output status LED.
 - .3 Split core for easy mounting.
 - .4 Induced sensor power.
 - .5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.

- .6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.
- .7 Adjustable latch level.

2.20 CONTROL DAMPERS

- .1 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
 - .1 Size/Capacity: refer to floor plans
 - .2 25 L/s/m2 maximum allowable leakage against 1000 Pa static pressure for outdoor air and exhaust air applications.
 - .3 Temperature range: minus 40 degrees C to plus 100 degrees C.
- .2 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 mm high.
 - .1 Multiple sections to have stiffening mullions and jack shafts.
- .3 Materials:
 - .1 Frame: 2.03 mm minimum thickness extruded aluminum. For outdoor air and exhaust air applications, frames to be insulated.
 - .2 Blades: extruded aluminum. For outdoor air/exhaust air applications, blades to be internally insulated.
 - .3 Bearings: sealed, maintenance free, synthetic type of material.
 - .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
 - .5 Low leakage design with edge seals and blade seals.
 - .1 Seals: synthetic type, mechanically locked into blade edges.
 - .2 Frame seals: synthetic type, mechanically locked into frame sides.
- .4 Jack shafts:
 - .1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.
 - .2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.
 - .3 Install using manufacturers installation guidelines.
 - .4 Use same manufacturer as damper sections.
- .5 Mixing dampers shall be of parallel blade or opposed blade design, set to face or oppose each other as required to eliminate stratification of air streams.

2.21 ELECTRIC CONTROL DAMPER ACTUATORS

- .1 Damper operators shall be sized to provide adequate power for opening, closing and modulating the dampers as required. They may be 24V or 120V at the Contractor's option.
- .2 Outdoor dampers/operators shall be suitable for proper operation down to -50 deg. F and be weatherproof.
- .3 Provide each operator with a bracket for attaching to ductwork, building structure or equipment.
- .4 Requirements:
 - .1 Direct mount proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated. Power return operators will not be accepted.
 - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
 - .4 Power requirements: 5 VA maximum at 24 V AC.
 - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
 - .6 Damper actuator to drive damper from full open to full closed in less than 30 seconds.

2.22 CONTROL VALVES

- .1 Automatic control valves shall be properly sized and selected by the Manufacturer in accordance with the load requirements and characteristics of the system to which they are applied.
- .2 Maximum water pressure drop through control valves shall be 2.5 p.s.i.
- .3 All valves shall be of a suitable physical size to fit the intended location.
- .4 All valves shall have integral seats ground into the body. Disc assemblies shall be replaceable and selected for the fluid to be controlled.
- .5 Globe style, or characterized ball.
 - .1 Flow characteristic as required: linear, equal percentage, quick opening.
 - .2 Normally open / Normally closed, as indicated.
 - .3 Two or Three port, as indicated.
 - .4 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
 - .5 Packing easily replaceable.
 - .6 Stem: stainless steel.
 - .7 Plug and seat: stainless steel, brass, bronze.
 - .8 Disc, replaceable, material to suit application.

- .9 NPS 2 and under:
 - .1 Screwed National Pipe Thread (NPT) tapered female connections.
 - .2 Valves to ANSI Class 250, valves to bear ANSI mark.
 - .3 Rangeability 50:1 minimum.
- .10 NPS 2.5 and larger:
 - .1 Flanged connections.
 - .2 Valves to ANSI Class 150, valves to bear ANSI mark.
 - .3 Rangeability 100:1 minimum.
- .6 Butterfly Valves NPS 2 and larger:
 - .1 Body: for chilled water ANSI Class 150 cast iron lugged body and wafer body installed in locations as indicated. For heating water ANSI Class 150 carbon steel lugged body and wafer body.
 - .2 End connections to suit flanges that are ANSI Class 150.
 - .3 Extended stem neck to provide adequate clearance for flanges and insulation.
 - .4 Pressure limit: bubble tight sealing to 170 kilopascals.
 - .5 Disc/vane: 316 stainless steel, or aluminum bronze to ASTM B148.
 - .6 Seat: for service on chilled water PTFE (polytetrafluoroethylene), or EPDM (ethylene propylene diene monomer). For service on heating water PTFE, or RTFE (reinforced PTFE).
 - .7 Stem: 316 stainless steel.
 - .8 Flow characteristic linear.
 - .9 Normally open / Normally closed, as indicated.
 - .10 Valves are to be provided complete with mounting plate for installation of actuators.

2.23 ELECTRONIC / ELECTRIC VALVE ACTUATORS

- .1 Valve operators shall be modulating, spring return, fail safe models. Power return operators will not be accepted.
- .2 Valve operators shall be sized to provide adequate power for opening, closing and modulating the valves as required. They may be 24V or 120V at the Contractor's option.
- .3 Requirements:
 - .1 Construction: steel, cast iron, aluminum.
 - .2 Control signal: 0-10V DC or 4-20 mA.

- .3 Positioning time: to suit application. 30 sec maximum.
- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

2.24 PANELS

- .1 Wall mounted enamelled steel cabinets with hinged and key-locked front door.
- .1 All Panels to be lockable with same key.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Conform to the requirements of Section 230501 – Common Work Results – Mechanical
- .2 Conform to the requirements of Section 230505 – Installation of Pipework
- .3 Conform to the requirements of Section 250501 – EMCS – General Requirements
- .4 Install using Manufacturers Recommended Instructions
- .5 Make connections to motor and equipment controls as required.

3.2 TEMPERATURE AND HUMIDITY SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application 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 non-corroding shields.
 - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate 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 to respond to air temperature only.
 - .5 Support sensor element separately from coils, filter racks.
 - .6 Averaging duct type temperature sensors.
 - .7 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
 - .8 Wire multiple sensors in series for low temperature protection applications.
 - .9 Wire multiple sensors separately for temperature measurement.
 - .10 Use software averaging algorithm to derive overall average for control purposes.
- .5 Thermowells: install for piping installations.
- .1 Locate well in elbow where pipe diameter is less than well insertion length.
 - .2 Thermowell to restrict flow by less than 30%.
 - .3 Use thermal conducting paste inside wells.

3.3 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.

3.4 PANELS

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .3 Identify wiring and conduit clearly.

3.5 IDENTIFICATION

- .1 Identify field devices in accordance with Section 250554 - EMCS: Identification.

3.6 COMMISSIONING

- .1 Conform to the requirements of Section 230501 – Common Work Results - Mechanical
- .2 Conform to the requirements of Section 250111 – EMCS – Startup, Verification and Commissioning
- .3 Conform to the requirements of Section 250501 – EMCS – General Requirements

- .4 In accordance with manufacturer's recommendations.

END OF SECTION 253002

PART 1 GENERAL

1.1 GENERAL

- .1 The plans and specifications are performance based documents and are not installation shop drawings. The Controls Contractor shall study the intent of the performance based plans and specifications to produce a set of installation Controls Shop Drawings that represents complete and fully functional controls systems which meets the intent of the performance based plans and specifications complete with all required appurtenances (wiring, sensors, actuators, control panels, etc.), programming, etc.
- .2 The existing systems must remain operational while the existing control systems and the existing control valves are being upgraded and replaced. Refer to the proposed phasing plan for phasing details.
- .3 Provide the Controls System with a modem to allow intermittent/invited remote access to the controls system for trouble shooting to trace and correct programming/operational/setpoint faults.

1.2 SEQUENCES OF OPERATION

1.3 AIR HANDLING SYSTEM AH-1 AND ASSOCIATED COMPONENTS

- .1 Basement Air Handling System AH-1 Consists of:
 - .1 Air Handling Unit AH-1 with supply fan, return fan, outside/relief/return air dampers, etc.
 - .2 Condensing Unit with DX Cooling Coil, etc.
 - .3 Glycol Heating Coil with Circulation Pump P-6 and Three Way Mixing Valve
 - .4 Heat Reclaim Ventilator HRV-1,
 - .5 Heat Reclaim Ventilator HRV-2,
 - .6 Humidifier H-1 with Water Treatment Plant,
- .2 The Air Handling System shall be controlled by the New Building Automation System. Remove all existing control sensors and actuators serving the existing Air Handling System and replace them with new digital controls capable of being controlled/monitored by the New Building Automation System. Provide new normally open hydronic heating system three way mixing control valve serving the pumped heating coil in AH-1.
- .3 The Air Handling System shall have a Heating/Cooling Mode and operate on an occupied/unoccupied schedule controlled thru the Building Automation System:
 - .1 Occupied Mode:
 - .1 When the supply fan is energized, this shall also energize the return fan via hardwire interlock and enable the controls.
 - .2 The economizer section shall become active:
 - .1 The outside air damper, the return air damper and the relief air damper shall modulate in sequence to maintain mixed air temperature setpoint subject to the outside air damper minimum position setting (set at 0% open, adjustable).
 - .2 The economizer outside air damper shall revert to minimum position when the outside air temperature is above 60°F (15.6°C)
 - .3 Discharge Air Temperature control shall become active and have a Heating Mode discharge air temperature setpoint (adjustable) that is initially set at 78.8°F (26°C) and a Cooling Mode discharge air temperature setpoint (adjustable) that is initially set at 55°F (12.8°C):

- .1 AH-1 Heating/Cooling Mode shall be determined based on outside air temperature and initially set to operate in Cooling Mode when the outside air temperature is above 55°F (12.8°C) (adjustable).
- .2 Sequence heating and cooling to maintain Heating/Cooling Mode discharge air temperature setpoint:
 - .1 Heating Mode:
 - .1 Modulate three way valve to maintain setpoint
 - .2 Cooling Mode:
 - .1 First Stage Cooling shall be economizer operation. If the outside air is suitable for cooling, but the outside air damper minimum position is set too low to allow effective free cooling, then override the minimum position to provide effective free cooling (which is also free ventilation).
 - .2 Second Stage Cooling shall be 1st stage of the condensing unit
 - .3 Third Stage Cooling shall be 2nd stage of the condensing unit
- .2 Monitor all of the low pressure bypass box's thermostats space temperatures and setpoints to reset the Discharge Air Temperature setpoint up or down (within specific adjustable limits) according to load conditions and the heating/cooling zone with the most extreme demand. Refer to Bypass Box for additional requirements.
- .4 HRV-2 shall be energized on medium speed to provide washroom exhaust and fresh air to the space.
- .5 Indoor air quality sensor (CO₂ sensor set at 800 ppm) shall become active:
 - .1 Cycle HRV-1 "on" and "off" to maintain air quality sensor setpoint.
- .6 Humidifier H-1 shall become active:
 - .1 Modulate to maintain return air humidity setpoint.
 - .2 Supply air duct humidity high limit set at 90% RH shall limit the humidifier output to prevent wetting the ductwork.
 - .3 If the Supply air duct humidity high limit is activated, sound a local audible alarm that can be silenced with a pushbutton and alarm at the New Building Automation System.
 - .4 Interlock humidifier operation with AH-1 fan operation.
- .2 Unoccupied Mode:
 - .1 The supply and return fans shall shutdown after an adjustable time delay to dissipate any residual heating/cooling.
 - .2 The heating system, cooling system, air quality sensor, humidification system and both HRV-1 & HRV-2 shall shutdown.
 - .3 The system shall remain in this state until the next scheduled occupancy or if an override button is pressed on any of the thermostats serving the low pressure bypass VAV boxes, the system shall return to occupied mode for an hour (adjustable).
- .3 Provide discharge air freezestat to shutdown the system if the supply air temperature drops below 5°C (41°F). Economizer dampers, heating, cooling, humidification, etc. shall go to "failsafe" positions – i.e. outside/relief air dampers shall close 100% and the heating valve shall open 100%, the HRVs shall be "off" and the humidifier shall be "off". Sound a local audible alarm that can be silenced with a pushbutton and alarm at the New Building Automation System. The system shall remain shutdown until the freezestat is manually reset by the operator.

- .4 Provide Controllers serving this system that have Controller mounted Hand Off Auto (HOA) and manual override control of outputs that can be temporarily used in the event of failure.

- .5 Monitor/Control

- .1 All Setpoints,
 - .2 Economizer damper positions,
 - .3 Outside Air Temperature,
 - .4 Return Air Temperature,
 - .5 Mixed Air Temperature,
 - .6 Discharge Air Temperature,
 - .7 Return Air Humidity
 - .8 Supply Air Humidity
 - .9 Air Quality (CO2) Sensor,
 - .10 Heating Coil Three Way Valve Position
 - .11 Heating Coil Pump Status
 - .12 Heating Coil Glycol Supply Temperature
 - .13 Heating Coil Glycol Return Temperature
 - .14 Supply/Return Fan Status
 - .15 Condensing Unit Status Indicating Active Stages of Cooling
 - .16 Humidifier Status & Output
 - .17 Freezestat Status
 - .18 HRV-1: Status, Supply Air Temperature, Exhaust Air To Outside Temperature
 - .19 HRV-2: Status, Supply Air Temperature, Exhaust Air To Outside Temperature
 - .20 Space Temperatures From Low Pressure Bypass VAV Box Thermostats

- .6 Provide the following spare points:

- .1 Analog Output: 4 points
 - .2 Analog Input: 4 points
 - .3 Binary Output 4 points
 - .4 Binary Input: 4 points

1.2 BOILER PLANT & BOILER PUMPS

- .1 The Boiler Plant Consists of:

- .1 Propane Boiler B-1 (Modulating Fulton Pulse Boiler 90/270 MBH Output)
 - .2 Electric Boiler B-2 (Caloritech 3 Stage Electric Boiler 72 Kw Output (24 Kw Per Stage))
 - .3 Primary Boiler Loop Pumps P-1 & P-2 which provide flow thru the boilers

- .2 Remove existing controls serving the Boiler Plant and replace them with new digital controls capable of being controlled/monitored by the New Building Automation System.

- .3 Provide user selectable lead/lag boiler control with the ability to have both boilers operate simultaneously. Normally the lead boiler shall be the Electric Boiler. Sequence & stage boilers to maintain the supply glycol temperature. Upon lead boiler failure, the system shall start and operate the lag boiler, if it is not already operating. On boiler failure (lead and/or lag), sound a local audible alarm that can be silenced with a pushbutton and alarm at the New Building Automation System.

- .4 Heating shall be available year round. Boiler supply glycol temperature shall be reset based on: an adjustable indoor-outdoor reset schedule, the supply/return glycol temperature differential and the heating zone with the greatest demand as determined by monitoring the space temperatures and space temperature setpoints thru the thermostats controlling the new hydronic heating system control valves. The maximum boiler supply glycol temperature shall be 62.2°C (180°F) at -40°F (adjustable).

- .5 Provide user selectable lead/lag boiler loop pump control with the ability to turn both pumps “off”. Provide current sensing relays to monitor pump status. Upon lead pump failure, the system shall energize the lag pump. On pump failure (lead and/or lag), sound a local audible alarm that can be silenced with a pushbutton and alarm at the New Building Automation System. Interlock/enable boilers with pumps.
- .6 Provide Controllers serving this system that have Controller mounted Hand Off Auto (HOA) and manual override control of outputs that can be temporarily used in the event of failure.
- .7 Monitor/Control
 - .1 Boiler controller alarms
 - .2 Pump motor current out range alarms
 - .3 Pump “on”/”off”
 - .4 Pump lead/lag
 - .5 High/low boiler supply temperature alarms
 - .6 High/low boiler return temperature alarms
 - .7 Supply/Return Glycol Temperatures
 - .8 Outside Air Temperature,
 - .9 Boiler lead/lag; “on”/”off”; firing rates,
- .8 Provide the following spare points:
 - .1 Analog Output: 4 points
 - .2 Analog Input: 4 points
 - .3 Binary Output 4 points
 - .4 Binary Input: 4 points

1.3 SECONDARY LOOP HYDRONIC HEATING SYSTEM CIRCULATION PUMPS

- .1 The Secondary Loop Pumps Consists of:
 - .1 Secondary Boiler Loop Pumps P-3 & P-4
- .2 Remove existing controls serving the Secondary Loop Pumps and replace them with new digital controls capable of being controlled/monitored by the New Building Automation System.
- .3 Provide user selectable lead/lag secondary loop pump control with the ability to turn both pumps “off”. Provide current sensing relays to monitor pump status. Upon lead pump failure, the system shall energize the lag pump. On pump failure (lead and/or lag), sound a local audible alarm that can be silenced with a pushbutton and alarm at the New Building Automation System.
- .4 Monitor/Control
 - .1 Pump motor current out range alarms
 - .2 Pump “on”/”off”
 - .3 Pump lead/lag
- .5 Provide the following spare points:
 - .1 Analog Output: 2 points
 - .2 Analog Input: 2 points
 - .3 Binary Output 2 points
 - .4 Binary Input: 2 points

1.4 LOW PRESSURE BYPASS VAV BOX WITH HYDRONIC RADIATION/RADIANT CEILING PANEL

- .1 Control shall be by New Building Automation System.
- .2 Remove existing analog controls serving the existing low pressure bypass VAV boxes and replace them with new digital controls capable of being controlled/monitored by the New Building Automation System. Provide new modulating normally open hydronic heating system control valve. Maintain the existing minimum positions on the existing low pressure bypass VAV boxes.
- .3 Provide occupied/unoccupied mode space temperature setpoints and unoccupied mode override button on the thermostat.
- .4 The low pressure bypass box is a constant volume device that varies the amount of either hot or cold supply air from AH-1 that is supplied to the occupied space by modulating the amount of excess either hot or cold supply air that is bypassed into the return airstream in sequence with the heating valve to maintain space temperature setpoint.
 - .1 The low pressure bypass box and communicating thermostat shall have a Heating Mode and a Cooling Mode.:
 - .1 Heating Mode:
 - .1 When the low pressure bypass box controls sense that the supply air temperature is above 78°F (26°C) (adjustable) it shall be in Heating Mode.
 - .2 On a rise in room temperature above set point, the bypass damper shall modulate closed to reduce the flow of warm air into the room to maintain set point while opening the bypass to bypass excess warm air into the return air. Provide an adjustable minimum position capable of being changed thru the New Building Automation System.
 - .3 On a fall in room temperature below set point, the bypass damper shall modulate open to increase the flow of warm air into the room to maintain set point while closing the bypass to bypass less warm air into the return air.
 - .4 If the room temperature continues to fall, the thermostat shall modulate the Radiation/Radiant Ceiling Panel Hydronic Heating System Control Valve open in sequence to maintain space temperature setpoint. Provide adjustable minimum position for heating control valve.
 - .2 Cooling Mode:
 - .1 When the low pressure bypass box controls sense that the supply air temperature is below 75°F (24°C) (adjustable) it shall be in Cooling Mode.
 - .2 On a rise in room temperature above set point, the bypass damper shall modulate open to increase the flow of cold air into the room to maintain set point while closing the bypass to bypass less cold air into the return air.
 - .3 On a fall in room temperature below set point, the bypass damper shall modulate closed to decrease the flow of cold air into the room to maintain set point while opening the bypass to bypass excess cold air into the return air. Provide an adjustable minimum position capable of being changed thru the New Building Automation System.
 - .4 If the room temperature continues to fall, the thermostat shall modulate the Radiation/Radiant Ceiling Panel Hydronic Heating System Control Valve open in sequence to maintain space temperature setpoint. Provide adjustable minimum position for heating control valve.

- .2 In occupied mode:
 - .1 The communicating space thermostat shall modulate the Radiation/Radiant Ceiling Panel Hydronic Heating System Control Valve and the low pressure bypass box in sequence to maintain space temperature setpoint while maintaining a predetermined adjustable minimum position on the low pressure bypass box. The adjustable minimum position shall be capable of being changed thru the New Building Automation System. Provide adjustable minimum position for heating control valve.
- .3 In unoccupied mode:
 - .1 AH-1 “off”, the space thermostat shall modulate the Hydronic Heating System Control Valve to maintain unoccupied mode heating setback temperature.
- .4 In either occupied mode or unoccupied mode, if the thermostat's setpoint cannot be satisfied with the available supply air temperature and/or the available Heating Glycol Supply Temperature, then this shall be used as a signal to reset the supply air temperature from AH-1 and/or the Heating Glycol Supply Temperature from the Boiler Plant to satisfy the space temperature setpoint.
- .5 Provide adjustable limits on the range of temperature adjustment available at the thermostat thru the New Building Automation System. Provide communicating thermostats that have an anti-tamper lockout code (adjustable) that can be enabled (if required) to prevent unauthorized adjustments/access.
- .6 Monitor/Control
 - .1 Space Temperature
 - .2 Space Temperature Setpoint
 - .3 Supply Air Temperature
 - .4 Hydronic Heating Valve Position
 - .5 Heating Glycol Supply Temperature
 - .6 Low pressure bypass box damper position
 - .7 Low pressure bypass box damper minimum position
 - .8 Provide High/Low Space/Supply Air Temperature Alarms
- .7 Provide the following spare points:
 - .1 Analog Output: 1 points
 - .2 Analog Input: 1 points
 - .3 Binary Output 1 points
 - .4 Binary Input: 1 points

1.1 HYDRONIC RADIATION/RADIANT CEILING PANEL

- .1 Control shall be by New Building Automation System.
- .2 Remove existing controls serving the existing hydronic heating system control valves and replace them with new digital controls capable of being controlled/monitored by the New Building Automation System. Provide new normally open hydronic heating system control valve.
- .3 Provide occupied/unoccupied mode space temperature setpoints and unoccupied mode override button on the thermostat.
- .4 Space temperature thermostat shall modulate normally open hydronic heating system control valve to maintain space temperature setpoint.

- .5 Provide adjustable limits on the range of temperature adjustment available at the thermostat thru the New Building Automation System. Provide communicating thermostats that have an anti-tamper lockout code (adjustable) that can be enabled (if required) to prevent unauthorized adjustments/access.
- .6 Monitor/Control
 - .1 Space Temperature
 - .2 Space Temperature Setpoint
 - .3 Hydronic Heating Valve Position
 - .4 Heating Glycol Supply Temperature
 - .5 Provide High/Low Space Temperature Alarms
- .7 Provide the following spare points:
 - .1 Analog Output: 1 points
 - .2 Analog Input: 1 points
 - .3 Binary Output 1 points
 - .4 Binary Input: 1 points

1.2 BUILDING DOMESTIC COLD WATER MAIN RECIRCULATION PUMPS (RP-1 & RP-2)

- .1 Provide current sensing relays to monitor pump status and strap on temperature sensor to monitor incoming domestic cold water main temperature.
- .2 Controls Contractor shall connect to dry contacts in the existing domestic cold water recirculation pump control/alarm panel and alarm at the New Building Automation System.
- .3 Monitor incoming domestic cold water main temperature and provide low temperature alarm at the New Building Automation System.
- .4 Provide the following spare points:
 - .1 Analog Output: 1 points
 - .2 Analog Input: 1 points
 - .3 Binary Output 1 points
 - .4 Binary Input: 1 points

1.3 WEEPING TILE SUMP PIT HIGH LEVEL MONITORING

- .1 Provide a new control panel and monitor the Weeping Tile Sump Pit High Level Alarm Float.
- .2 The Mechanical Contractor shall install a new High Level Alarm Float in the existing weeping tile sump pit. The Controls Contractor shall coordinate the requirements with the Mechanical Contractor.
- .3 The Controls Contractor shall wire the new High Level Alarm Float to the new Weeping Tile Sump Pit High Level Alarm Monitoring Panel to provide an alarm to the New Building Automation System when the water level in the pit reaches the high water level.
- .4 Provide the following spare points:
 - .1 Analog Output: 1 points
 - .2 Analog Input: 1 points
 - .3 Binary Output 1 points
 - .4 Binary Input: 1 points

1.4 SANITARY WASTE STORAGE TANK HIGH LEVEL MONITORING

- .1 Provide a new control panel and monitor the Sanitary Waste Storage Tank High Level Alarm Float.
- .2 The Mechanical Contractor shall install a new explosion proof High Level Alarm Float in the existing Sanitary Waste Storage Tank. The Controls Contractor shall coordinate the requirements with the Mechanical Contractor.
- .3 The Controls Contractor shall wire the new High Level Alarm Float to the new Sanitary Waste Storage Tank High Level Alarm Monitoring Panel to provide an alarm to the New Building Automation System when the sewage level in the tank reaches the alarm level.
- .4 Provide the following spare points:
 - .1 Analog Output: 1 points
 - .2 Analog Input: 1 points
 - .3 Binary Output 1 points
 - .4 Binary Input: 1 points

1.5 UNIT HEATERS

- .1 Provide new line voltage controls.
- .2 When the space temperature falls below the setpoint of the space mounted thermostat start the unit heater's fan.
- .3 Monitor Space temperature and provide high/low temperature alarms at the New Building Automation System.

1.6 FORCE FLOW HEATERS

- .1 Provide new line voltage controls.
- .2 When the space temperature falls below the setpoint of the space mounted thermostat start the force flow heater's fan.
- .3 Provide strap on aquastat to disable the controls when the return glycol temperature falls below 5°C (41°F).
- .4 Monitor Space temperature and provide high/low temperature alarms at the New Building Automation System.

1.7 ELECTRICAL ROOM COOLING

- .1 Provide new line voltage controls.
- .2 When the space temperature rises above the setpoint of the space mounted thermostat, start the exhaust fan.
- .3 Monitor Space temperature and provide high/low temperature alarms at the New Building Automation System.

1.8 BASEMENT VENTILATION

- .1 Provide new line voltage controls.
- .2 When the space humidity rises above the setpoint of the space mounted humidistat, the exhaust air damper shall be energized and an end switch on the damper motor shall start the exhaust fan.
- .3 Provide a summer override switch to run the exhaust fan regardless of humidistat action.
- .4 Monitor Space temperature and provide high/low temperature alarms at the New Building Automation System.

PART 2 PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION 259001