1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 78 00 - Closeout Submittals.
.3 Section 01 91 13 - General Commissioning Requirements.
.4 Section 01 79 00 - Demonstration and Training.
.5 Section 25 05 01 - EMCS: General Requirements.

1.3 DEFINITIONS

.1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
.2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.
.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
  .1 Outage of main power supply in excess of back up power sources, provided that:
    .1 Automatic initiation of back up was accomplished.
    .2 Automatic shut down and re start of components was as specified.
  .2 Failure of communications link, provided that:
    .1 Controller automatically and correctly operated in stand alone mode.
    .2 Failure was not due to failure of any specified EMCS equipment.
  .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
    .1 System recorded said fault.
    .2 Equipment defaulted to fail safe mode.
    .3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.4 DESIGN REQUIREMENTS

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

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
.2 Final Report: submit report to Engineer.
  .1 Include measurements, final settings and certified test results.
  .2 Bear signature of commissioning technician and supervisor
  .3 Report format to be approved by Engineer before commissioning is started.
  .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments

and modifications to EMCS as set during commissioning and submit to Engineer in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.6 CLOSEOUT SUBMITTALS

.1 Provide documentation, O&M Manuals, and training of O&M personnel for review of Engineer before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.7 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - General Commissioning Requirements.
.2 Carry out commissioning under direction of Engineer and in presence of Engineer and Commissioning Manager.
.3 Inform, and obtain approval from, Engineer 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.
.4 Correct deficiencies, re test in presence of Engineer until satisfactory performance is obtained.
.5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
.6 Load system with project software.
.7 Perform tests as required.

1.8 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Engineer and Commissioning Manager.

1.9 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

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

2 Products

2.1 EQUIPMENT

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

3 Execution

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.
.2 Commission each system using procedures prescribed by the Commissioning Manager.

.3 Commission integrated systems using procedures prescribed by the Commissioning Manager.
.4 Debug system software.
.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDL's as required.
.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

3.2 FIELD QUALITY CONTROL

.1 Pre Installation Testing.
  .1 General: consists of field tests of equipment just prior to installation.
  .2 Testing may be on site or at Contractor's premises as approved by Engineer.
  .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:
  .6 DP transmitters.
  .7 VAV supply duct SP transmitters.
  .8 DP switches used for dirty filter indication and fan status.
  .9 In addition to test equipment, provide inclined manometer, digital micro manometer, milli amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli amp meter at source and to BECC.
  .10 After setting, test zero and span in 10% increments through entire range while both increasing and decreasing pressure.
  .11 Engineer to mark instruments tracking within 0.5% in both directions as "approved for installation".
  .12 Transmitters above 0.5% error will be rejected.
  .13 DP switches to open and close within 2% of setpoint.
.2 Completion Testing.
  .1 General: test after installation of each part of system and after completion of mechanical and electrical hook ups, to verify correct installation and functioning.
  .2 Include following activities:
    .1 Test and calibrate field hardware including stand alone capability of each controller.
    .2 Verify each A to D converter.
    .3 Test and calibrate each AI using calibrated digital instruments.
    .4 Test each DI to ensure proper settings and switching contacts.
    .5 Test each DO to ensure proper operation and lag time.
    .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    .7 Test operating software.
    .8 Test application software and provide samples of logs and commands.
    .9 Verify each CDL including energy optimization programs.
    .10 Debug software.
    .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
    .12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Engineer. This document will be used in final startup testing.
.3 Final Startup Testing: Upon satisfactory completion of tests, perform point by point test of entire system under direction of Engineer and Commissioning Manager and provide:

.1 2 technical personnel capable of re calibrating field hardware and modifying software.
.2 Detailed daily schedule showing items to be tested and personnel available.
.3 Engineer's acceptance signature to be on executive and applications programs.
.4 Commissioning to commence during final startup testing.
.5 O&M personnel to assist in commissioning procedures as part of training.
.6 Commissioning to be supervised by qualified supervisory personnel and Engineer.
.7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
.8 Operate systems as long as necessary to commission entire project.
.9 Monitor progress and keep detailed records of activities and results.

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

.5 Commissioning Manager to verify reported results.

3.3 ADJUSTING

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

3.4 DEMONSTRATION

.1 Demonstrate to Commissioning Manager, 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 01 79 00 - Demonstration and Training.

End of Section

1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

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

1.3 DEFINITIONS

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

1.4 SUBMITTALS

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

1.5 QUALITY INSURANCE

.1 Provide bilingual, competent instructors thoroughly familiar with aspects of EMCS installed in facility.
.2 Engineer reserves right to approve instructors.

1.6 INSTRUCTIONS

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

1.7 TIME FOR INSTRUCTION

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

1.8 TRAINING MATERIALS

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

1.9 TRAINING PROGRAM

.1 To be in 2 phases over 6 month period.

.2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor and Engineer.

- .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: 5 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.

- .1 Provide multiple instructors on pre arranged schedule. Include at least following:
  - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
  - .2 Equipment maintenance training: provide personnel with 2 days training within 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.
  - .3 Programmers: provide personnel with 2 days training within 5 day period in following subjects in approximate percentages of total course shown:
    Software and architecture: 10%
    Application programs: 15%
    Controller programming: 50%
    Trouble shooting and debugging:10%
    Colour graphic generation: 15%

1.10 ADDITIONAL TRAINING

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

1.11 MONITORING OF TRAINING

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

End of Section

1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS:

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 35 29 - Health and Safety Requirements.
.3 Section 01 74 22 - Construction/Demolition Waste Management And Disposal.
.4 Section 09 91 00 - Painting.
.5 Section 23 05 54 - Mechanical Identification.
.6 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
.7 Section 25 90 01 - EMCS: Systems Sequences of Operation.

1.3 REFERENCES

.1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
- .1 ANSI/ISA 5.5 1985, Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
- .1 ANSI/IEEE 260.1 1993, 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-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).
- .1 CAN/CSA Z234.1 89(R1995), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).
- .1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).
- .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
- .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.7 Electrical and Electronic Manufacturers Association (EEMAC).
- .1 EEMAC 2Y 1 1958, 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), 1992, c. 34.

1.4 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.

1.5 DEFINITIONS

.1 Point: may be logical or physical.
  .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
  .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction 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 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 25 character field for each point identifier.
  .2 Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into

appropriate point expansion field. Database must provide 32 character field for each point expansion.

.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:

.1 AI (analog input).
.2 AO (analog output).
.3 DI (digital input).
.4 DO (digital output).
.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.
.2 Refer also to Section 23 05 54 - Mechanical Identification.

1.6 SYSTEM DESCRIPTION

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

.3 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 Engineer prior to installation.
.3 Location of controllers as reviewed by Engineer prior to installation.
.4 Provide utility power to EMCS and emergency power to EMCS as indicated.
.5 Metric references: in accordance with CAN/CSA Z234.1.

.4 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 specified as part of hardware purchase with associated documentation to be in English.
.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
.5 Include, in English.

.1 Input and output commands and messages from operator initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day to day operating functions and not related to system modifications, additions, or logic re definements).

.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 and to be able to operate one terminal in English. Point name expansions in both languages.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

.5 Standard of Acceptance: To match existing installation.

1.7 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Submit for review:

.1 Equipment list and systems manufacturers at time of bid tender within 48 h within 10 days after award of contract.

.2 List existing field control devices to be re-used included in bid tender, along with unit price.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: 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 Engineer, 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 Engineer.

.8 Existing devices intended for re-use: submit test report.

1.8 QUALITY ASSURANCE

.1 Have local office within 50 km of project 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 01 35 29 - Health and Safety Requirements.

.6 Sustainable Requirements:

.1 Construction requirements: in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

.2 Verification: contractor's verification in accordance with Section 01 74 22 - Construction/Demolition Waste Management and Disposal.

1.9 DELIVERY, STORAGE, AND HANDLING

.1 Material Delivery Schedule: provide Engineer with schedule within 2 weeks after award of Contract.

.2 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 22 - 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 paper, plastic, polystyrene, and corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse and recycling and place in designated containers Metal waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, 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 metal materials from landfill to metal recycling facility as approved by Engineer.
- .10 Fold up metal and plastic banding, flatten and place in designated area for recycling.

1.10 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate waste material and place in on site bin in accordance with Waste Management Plan.

2 Products

2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 ASHRAE STD 135.

.2 Complete list of equipment and materials to be used on project and forming part of bid tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

.1 Provide adapters between metric and imperial components.

3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 PAINTING

.1 Painting: in accordance with Section 09 91 00 - Painting, supplemented as follows:

- .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
- .2 Restore to new condition, finished surfaces too extensively damaged to be primed and

touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

End of Section

1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 25 05 01 - EMCS: General Requirements.
.3 Section 25 01 11 - EMCS: Start up and Check-out.

1.3 DEFINITIONS

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

1.4 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.
  .1 Location of local office.
  .2 Description and location of installing and servicing technical staff.
  .3 Location and qualifications of programming design and programming support staff.
  .4 List of spare parts.
  .5 Location of spare parts stock.
  .6 Names of sub contractors and site specific key personnel.
  .7 Sketch of site specific system architecture.
  .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  .9 Descriptive brochures.
  .10 Sample CDL and graphics (systems schematics).
  .11 Response time for each type of command and report.
  .12 Item by item statement of compliance.
  .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
.2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by Engineer.
.3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.
.4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross referenced to specification section and paragraph number.
.5 Soft copy to be in AutoCAD latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

1.6 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
  .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams,

performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

.10 Compressor schematic and sizing data.

1.7 DETAIL SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.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.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.

.7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.

.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.

.9 Listing and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.
.13 Full description of software programs provided.
.14 Sample of "Operating Instructions Manual" to be used for training purposes.
.15 Outline of proposed start up and verification procedures. Refer to Section - 25 01 11 EMCS: Start-up and Check-out.

1.8 QUALITY ASSURANCE

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

End of Section

1 General

1.1 GENERAL

.1 This specification is to cover a complete Variable Frequency Drive's (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor. The drive shall be manufactured specifically for variable torque applications.

.2 The drive manufacturer shall supply the AC drives and all necessary controls as herein specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten years.

1.2 REFERENCES

.1 Institute of Electrical and Electronic Engineers (IEEE)
- .1 Standard 519-1992, IEEE Guide for Harmonic Content and Control

.2 Underwriters laboratories
- .1 UL508C

.3 National Electrical Manufacturer's Association (NEMA)
- .1 ICS 7.0, AC Adjustable Speed Drives.

1.3 TESTING

.1 All printed circuit boards shall be completely tested and burned-in before being assembled into the completed VFD. The VFD shall then be subjected to a computerized systems test (cold), burn-in, and computerized systems test (hot). All testing and manufacturing procedures shall be ISO 9001 certified.

1.4 QUALIFICATIONS

.1 VFDs and options shall be UL and ULC listed as a complete assembly. VFDs and options shall be CE labeled as a component.

2 Products

2.1 GENERAL

.1 All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

.2 Furnish complete VFD controllers that convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.

.3 VFDs on air handling units and exhaust fans shall be supplied with bypass option.

.4 VFD manufacturer shall verify compatibility of motor furnished on equipment. One controller shall control the speed of one motor with the exception being a wall fan technology system.

.5 VFD shall convert 3 phase, 60 Hz utility power to adjustable voltage and frequency, 3 phase AC power for stepless motor speed control from 10 percent to 100 percent of the motor's 60 Hz speed. Input voltage characteristics are 575 volts, 3 phase, 60 Hz or as indicated in the field.

.6 VFD shall include a converter section. The converter section shall convert fixed frequency and voltage AC utility power to a variable DC voltage. VFD's that use silicon controlled rectifiers in the converter bridge shall also include 5 percent reactors. Isolation transformers are not acceptable in lieu of line reactors.

.7 VFD shall include an inverter section. The inverter section shall invert the variable DC voltage into a PWM wave form; adjustable voltage and frequency output for stepless motor speed control.

.8 Individual or simultaneous operation of VFD's shall not add more than 5 percent total harmonic voltage distortion and no more than 5 percent total harmonic current distortion (per IEEE 516-1992) to the normal bus.
  .1 VFD manufacturer shall perform harmonic analysis based on the electrical one-line diagram.
  .2 The VFD manufacturer shall provide calculations specific to this installation, showing total harmonic voltage distortion is less than 5 percent.
  .3 Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE Standard 519. All VFD's shall include a minimum of 5 percent impedance reactors, no exceptions.

.9 VFD shall include a coordinated AC transient protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5 percent impedance reactors.

.10 Alternate Harmonics Specification:
  .1 Input line reactors and DC Bus filtered chokes (factory installed and wired in the drive enclosure) shall be provided to allow reliable operation on a typical commercial power distribution system and to minimize harmonics reflected onto the input line.
    .1 Shall not interfere with computer and other electronic systems in the building.
    .2 If not inherently protected, provide a suitable isolation transformer.
    .3 The system shall not produce spikes on the incoming line.
  .2 Any inverter that generates sufficient electrical line noise to interfere with operation of sensitive building equipment shall be field modified or replaced by the inverter supplier at no additional cost to the Owner.

.11 EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product Standard EN 61800-3 for the First Environment restricted level.

.12 Low voltage logic and 115V control circuits shall be electrically isolated from the power circuits. Signal circuit common shall be grounded.

.13 VFD shall include a power ride through feature to allow continuous operation up to a three-cycle line loss.

.14 Two independently adjustable accel and decel ramps with 1 to 1800 seconds adjustable time ramps. Extended time periods are also acceptable.

.15 VFD shall have full function output current limit adjustable from 10 to 100 percent. At the factory with compatible motor, provide at least three lock-out ranges (50 rpm maximum each), two of which can be used to correct any run test problems.

.16 Components shall be pretested and complete VFD shall have full burn in under full load for a minimum of 12 hours. Provide at least three lockout ranges (50 rpm maximum), two of which can be used to correct run test problems.

.17 Ambient noise generated by the VFD shall be limited to an amount equal to the system noise level as designated by the latest ASHRAE noise level guidelines for such equipment at each octave band. Noise level criteria at different octave bands and mid frequencies shall be furnished with the submittal data.

.18 VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and audible motor noise.

2.2 ENCLOSURE

.1 VFD shall be enclosed in a NEMA Type 1 enclosure. The VFD tolerated voltage window shall allow operation from a line of +30 percent nominal, and -35 percent nominal voltage as a minimum.

.2 Environmental operating conditions: -30 to 40 degrees C continuous. VFD's that can operate at 40 degrees C intermittently (during a 24-hour period) are not acceptable and must be oversized. Altitude from 0 to 3300 feet above sea level, less than 95 percent humidity, non-condensing. VFD's without these ratings are not acceptable.

.3 The following operator controls shall be located on the front of the enclosure:

.1 Bypass Hand-Off-Auto.
.2 Drive mode selector.
.3 Bypass mode selector.
.4 Bypass fault reset.
.5 Provide the following indicating lights (LED type). In addition, provide test mode or push to test feature:
.1 Power-on (ready).
.2 Run enable (safeties) open.
.3 Drive mode select damper opening.
.4 Bypass mode selected.
.5 Drive running.
.6 Bypass running.
.7 Drive fault.
.8 Bypass fault.
.9 Bypass H-O-A mode.
.10 Automatic transfer to bypass selected.
.11 Safety open.
.12 Damper opening.
.13 Damper end-switch made.
.6 Provide the following relay (form C) outputs from the bypass:
.1 System started.
.2 System running.
.3 Bypass override enabled.
.4 Drive fault.
.5 Bypass fault (motor overload or underload - broken belt).
.6 Bypass H-O-A position.

.4 Digital inputs for the system shall accept 24V or 115VAC (selectable).
.5 Customer Interlock Terminal Strip: Provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in Hand, Auto, or Bypass modes (not functional in fireman's override 2). The remote start/stop contact shall operate in VFD and bypass modes.
.6 Dedicated digital input that will transfer motor from VFD mode to bypass mode upon dry contact closure for fireman's override. Two modes of operation are required:
.1 The first mode forces the motor to bypass operation and overrides both the VFD and bypass H-O-A switches and forces the motor to operate across the line (test mode). The system will only respond to the digital inputs and motor protections.
.2 The second mode operates as the first, but will also defeat the overload and single-phase protection for bypass and ignore all keypad and digital inputs to the system (run until destruction).
.7 Include a "run permissive circuit" that will provide a normally open contact whenever a run command is provided (local or remote start command in VFD or bypass mode). The VFD system (VFD or bypass) shall not operate the motor until it receives a dry contact closure from a damper or valve end-switch. When the VFD system safety interlock (fire detector, freezestat, high static pressure switch, etc) opens, the motor shall coast to a stop and the run permissive contact shall open, closing the damper or valve.
.8 Include Class 20 or 30 (selectable) electronic motor overload protection.

2.3 BYPASS

.1 Furnish where indicated on the Drawings, a complete factory wired and tested bypass system consisting of an output contactor and bypass contactor. Overload protection shall be provided in both drive and bypass modes.
.2 Bypass to be furnished, built, and mounted by the VFD manufacturer.
.3 Provide an internal switch to select manual or automatic bypass.

.4 Provide an adjustable current sensing circuit for the bypass to provide loss of load indication (broken belt) when in the bypass mode.

.5 Door interlocked, pad-lockable disconnect that will disconnect all input power from the drive and all internally mounted options.

.6 Fused VFD only disconnect (service switch). Fast acting fuses exclusive to the VFD - fast acting fuses allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection, maintaining bypass capability. Bypass designs, which have no such fuses, or that incorporate fuses common to both the VFD and the bypass will not be accepted. The following contactor bypass schemes are not acceptable.

.1 Door interlocked main input disconnect switch.

.2 Power on light.

.3 "Drive-off-bypass" manual mode selector switch.

.7 The bypass shall incorporate an internally sourced power supply and shall not require an external power source.

2.4 DISPLAY / KEYPAD

.1 All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three (3) operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):

.1 Output frequency.

.2 Motor speed (RPM, percent, or engineering units).

.3 Motor current.

.4 Calculated motor torque.

.5 Calculated motor power (kW).

.6 DC bus voltage.

.7 Output voltage.

.2 Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). The keypad shall use the following assistants:

.1 Start-up assistants.

.2 Parameter assistants.

.3 Maintenance assistant.

.4 Troubleshooting assistant.

.3 VFD shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. Keypad shall be removable, capable of remote mounting and shall allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFD's.

.4 Keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.

.5 Provide a built-in time clock with battery back-up in the VFD keypad. The time clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. The time clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.

2.5 SERIAL COMMUNICATION

.1 VFD shall have the capability of communicating with the building automation system (BAS) via an RS-485 serial port.

.2 VFD shall be provided with protocol information specific to the selected BAS Provider and shall be pre-configured at the factory to provide automatic communications without the need for field

programming.

.3 VFD shall continue to provide serial communications regardless of how inverter is being controlled ("manual" mode via keypad, "automatic" mode via BAS, or "stopped" mode via either keypad or automatic BAS start/stop signal).

.4 Serial communications capabilities shall include, but not be limited to:
- .1 Run/stop control speed set adjustment.
- .2 Proportional/integral or PID control adjustments.
- .3 Current limit.
- .4 Accel/decel time adjustments.

.5 VFD shall have the capability of allowing the BAS to monitor the following feedback signals:
- .1 Process variable.
- .2 Output speed/frequency.
- .3 Current.
- .4 Torque.
- .5 Power (kW).
- .6 Operating hours.
- .7 Kilowatt hours (kWh).
- .8 Relay outputs.
- .9 Diagnostic warning and fault information.

.6 VFD shall allow the BAS to control the drive's digital and analog outputs and monitor all drive digital and analog inputs via the serial interface.

.7 VFD shall be capable of providing the BAS with status signals for bypass operation and external safety trips via serial interface.

2.6 SYSTEM OPERATION

.1 Selector switch in the "off" position: controller run circuit shall be open and the system shall not operate.

.2 Selector switch in the "manual" position: motor speed shall be controlled by the manual speed potentiometer.

.3 Selector switch in the "auto" position: operation shall be via input 0 to 10 VDC or 4-20 mA signal with strategy output speed proportional to the input signal. If required into the controls strategy, VFD manufacturer shall furnish a pressure transducer mounted in the drive enclosure to convert a 3 to 15 psi pressure signal to a 0 to 10 VDC signal or 4-20 mA signal.

3 Execution

3.1 INSTALLATION

.1 Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

.2 The electrical contractor shall complete power wiring. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.

3.2 START-UP

.1 Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, a copy kept on file at the manufacturer.

3.3 TRAINING

.1 Provide training as required to instruct maintenance/operating personnel on proper usage of drive and drive parameters. The amount of Training that the University receives should be adequate for staff to be able to properly operate and maintain the VFD with no dependence whatsoever on the instructors capabilities. All Training to be given by a factory trainer personnel.

3.4 PRODUCT SUPPORT

.1 Factory trained application engineering and service personnel that are thoroughly familiar with the drive products offered will be locally available at both the specifying and installation locations.

3.5 WARRANTY

.1 Warranty shall be 24 months from the date of shipment (with certified start-up).

End of Section

1 General

1.1 RELATED SECTIONS

.1 Section 01 10 10 - General Instructions.
.2 Section 23 05 01 - Common Work Results - Mechanical.
.3 Section 26 05 00 - Electrical General Instructions.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)
  .1 ANSI/ASME B16.22 1989, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
  .2 ANSI C2 1990, National Electrical Safety Code.
  .3 ANSI/NFPA 70 1990, National Electrical Code.
.2 Canadian Standards Association (CSA)
  .1 CSA C22.1 98, Canadian Electrical Code, Part 1.
  .2 CAN/CSA C22.3No.1 M87, Overhead Systems.

1.3 SYSTEM DESCRIPTION

.1 Electrical:
  .1 Provide power wiring from emergency power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
  .2 Hard wiring between field control devices and EMCS field panels.
  .3 Communication wiring between EMCS field panels and OWS including main control centre BECC.
  .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
  .5 Refer to wiring diagrams included as part of flow diagrams in section. Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by engineer before commencing work.
.2 Mechanical:
  .1 Pipe Taps required for EMCS equipment will be supplied and installed by Mechanical Piping Contractor.
  .2 Wells and Control Valves shall be supplied by EMCS Contractor and Installed by Mechanical Plumbing/Piping Contractor.
  .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Sheet Metal Contractor. Costs to be carried by designated trade.
.3 Constant Volume Reheat Terminal Units.
  .1 Air flow probe for valve boxes to be supplied and installed. Air flow dp sensor, actuator and associated valve controls to be supplied and installed by EMCS Contractor. Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS Contractor. Coordinate air flow adjustments with balancing trade.

1.4 PERSONNEL QUALIFICATIONS

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

1.5 EXISTING CONDITIONS

.1 Repair all surfaces damaged during execution of work.
.2 Turn over to Engineer existing materials removed from work not identified for re use.

2 Products

2.1 WIRING

.1 As per requirements of Division 26.
.2 For 70V and above copper conductor with chemically cross linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
.4 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 20AWG stranded twisted pair.
  .4 Analog input and output: shielded #18 minimum solid copper #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.

2.2 CONDUIT

.1 As per requirements of Division 26.
.2 Electrical metallic tubing to CSA C22.2 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 56. Rigid steel threaded conduit to CSA C22.2 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.

2.3 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.

2.4 STARTERS, CONTROL DEVICES

.1 Across the line magnetic starters:
- .1 Enclosures: CSA Type 1, except where otherwise specified.
- .2 Size, type and rating: to suit motors.

.2 Starter diagrams:
- .1 Provide copy of wiring and schematic diagrams mount one copy in each starter with additional copies for operation and maintenance manual.

.3 Auxiliary Control Devices:
- .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
- .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
- .3 Hand Off Automatic switch: heavy duty type, knob lever operator.
- .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

.4 Finish for starters:
- .1 Exterior: in accordance with Section 26 05 00 - Electrical General Instructions.
- .2 Interior: white.

2.5 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.

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 MECHANICAL PIPING

.1 Install piping straight, parallel and close to building structure with required grades for drainage and venting.
.2 Ream ends of pipes before assembly.
.3 Copper tubing not to come into contact with dissimilar metal.
.4 Use non corrosive lubricant or Teflon tape on male screwed threads.
.5 Clean ends of pipes, tubing and recesses of fittings to be brazed or soldered. Assemble joints without binding.
.6 Install di electric couplings where dissimilar metals joined.
.7 Sleeves:
- .1 Installation:
  - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc rich paint.

.2 Caulking:

.1 Foundation walls and below grade floors: fire retardant, waterproof non hardening mastic.

.2 Elsewhere: provide space for firestopping. Maintain fire rating integrity.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

.8 Pressure tests:

.1 Pressure test all piping systems modified under this contract to 1 1/2 times maximum working pressure or 860 kPa (whichever is greater) for 4 h without loss of pressure. Test all piping systems modified under this contract by means of visual inspection of each connection.

.2 Isolate equipment, components, not designed to withstand test pressure.

.9 Introduce system pressure carefully into new piping.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:

.1 Division 26, this specification.

.2 CSA 22.1 Canadian Electrical Code.

.3 ANSI/NFPA 70.

.4 ANSI C2.

.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.

.3 Do underground installation to CAN/CSA C22.3No.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.

3.4 CONDUIT SYSTEM

.1 FT6 cable shall be allowed in lieu of conduit above ceilings. Cables installed in exposed ceiling and inside walls must be in conduit.

.2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

.3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Engineer Consultant before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.

.4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.

.5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.

.6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.

.7 Limit conduit length between pull boxes to less than 30 m.

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
.9 Fastenings and supports for conduits, cables, and equipment:
  .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
  .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
  .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Engineer Consultant.
.10 Install polypropylene fish cord in empty conduits for future use.
.11 Where conduits become blocked, remove and replace blocked sections.
.12 Pass conduits through structural members only after receipt of Engineer=s Consultant=s written approval.
.13 Conduits may be run in flanged portion of structural steel.
.14 Group conduits wherever possible on suspended or surface channels.
.15 Pull boxes:
  .1 Install in inconspicuous but accessible locations.
  .2 Support boxes independently of connecting conduits.
  .3 Fill boxes with paper or foam to prevent entry of construction material.
  .4 Provide correct size of openings. Reducing washers not permitted.
  .5 Mark location of pull boxes on record drawings.
  .6 Identify AC power junction boxes, by panel and circuit breaker.
.16 Install terminal blocks or strips as specified by Division 26.
.17 Install bonding conductor for 120 volt and above in conduit.

3.5 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 Engineer Consultant 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.

3.6 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.

3.7 STARTERS, CONTROL, DEVICES

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

3.8 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.

3.9 TESTS

.1 General:
  .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
  .2 Give 14 days written notice of intention to test.
  .3 Conduct in presence of Engineer Consultant and authority having jurisdiction.
  .4 Conceal work only after tests satisfactorily completed.
  .5 Report results of tests to Engineer Consultant 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 Engineer Consultant and authority having jurisdiction.

3.10 IDENTIFICATION

.1 Refer to Section 23 05 54 - Mechanical Identification.

End of Section

1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.
.2 Section 01 78 00 - Closeout Submittals.
.3 Section 25 05 01 - EMCS: General Requirements.
.4 References.
  .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
  .2 Canadian Standards Association (CSA International).
    .1 CSA Z204-94(R1999), Guidelines for Managing Indoor Air Quality in Office Buildings.

1.3 DEFINITIONS

.1 BC(s) - Building Controller(s).
.2 OWS - Operator Work Station.
.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
.2 Submit detailed preventative maintenance schedule for system components to Engineer.
.3 Submit detailed inspection reports to Engineer.
.4 Submit dated, maintenance task lists to Engineer and include the following sensor and output point detail, as proof of system verification:
  .1 Point name and location.
  .2 Device type and range.
  .3 Measured value.
  .4 System displayed value.
  .5 Calibration detail
  .6 Indication if adjustment required,
  .7 Other action taken or recommended.
.5 Submit network analysis report showing results with detailed recommendations to correct problems found.
.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
  .1 Maintain records and logs of each maintenance task on site.
  .2 Organize cumulative records for each major component and for entire EMCS chronologically.
  .3 Submit records to Engineer, after inspection indicating that planned and systematic maintenance have been accomplished.
.7 Revise and submit to Engineer in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.5 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 Engineer with telephone number where service personnel may be reached at any time.
- .4 Service personnel to be on site ready to service EMCS within 2 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 Engineer.

1.6 SERVICE CONTRACTS

.1 Provide in depth technical expertise and assistance to Owner's Representative and Commissioning Manager in preparation and implementation of service contracts and in house preventive maintenance procedures during warranty year.

.2 Warranty year Service Contracts to include:

- .1 Quarterly verification of field points for operation and calibration.
- .2 4 visits per year during warranty year.
- .3 Responses to emergency calls on 24 hour basis.

2 Products

2.1 NOT USED

.1 Not used.

3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum two minor inspections and two major inspections during warranty period. Provide detailed written report to Engineer 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 Canada Labour Code - Part I and 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 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
- .4 Review system performance with Operations Supervisor 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

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

1.2 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
- .2 CSA T530-99(R2004), 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-2002, 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-March 2004, 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-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.

1.4 DEFINITIONS

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

1.5 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529 TIA/EIA-568 and CSA T530 TIA/EIA-569-A and 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 EMCS-LAN.
- .2 Modems.
- .3 Network interface cards.
- .4 Network management hardware and software.
- .5 Network components necessary for complete network.

1.6 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, shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings.

End of Section

1 General

1.1 SUMMARY

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

1.2 RELATED SECTIONS

.1 Section 25 05 01 - EMCS: General Requirements.
.2 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
.3 Section 25 30 02 - EMCS: Field Control Devices.
.4 Section 25 90 01 - EMCS: Systems Sequences of Operation.

1.3 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
- .1 ASHRAE 2003, Applications Handbook, SI Edition.

.2 Canadian Standards Association (CSA International).
- .1 C22.2 No.205 M1983(R1999), Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).
- .1 IEEE C37.90.1 02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

1.4 DEFINITIONS

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

1.5 SYSTEM DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence (s) of operations as detailed in these specifications.
- .1 Provide sufficient controllers to meet intents and requirements of this section.
- .2 Controller quantity, and point contents to be approved by Engineer 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 KB 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.

1.6 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 25 % 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 with 10 bit analog to digital resolution.
  - .2 Provide for following input signal types and ranges:
    - .1 4 20 mA;
    - .2 0 - 10 V DC;
    - .3 100/1000 ohm RTD input;
- .5 Meet IEEE C37.90.1 surge withstand capability.
- .6 Have common mode signal rejection greater than 60 dB to 60 Hz.
- .7 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .8 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital to analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 4 20 mA.
    - .2 0 10 V DC.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
- .9 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.
- .10 DO interface equipment:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
  - .2 Switch up to 5 amps at 220 V AC using optional interface relay.

.4 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.
  .3 Mounting details as approved by Engineer for ceiling mounting.
.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
.7 Provide surge and low voltage protection for interconnecting wiring connections.

1.7 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
  .1 Submit product data sheets for each product item proposed for this project.

1.8 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 01 78 00 - Closeout Submittals.

2 Products

2.1 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.

2.2 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.
.3 VAV Terminal Controller.
  .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE

HVAC Applications Handbook.

.2 Controller to support point definition; in accordance with Section 25 05 01 - EMCS: General Requirements.

.3 Controller to operate independent of network in case of communication failure.

.4 Controller to include damper actuator and terminations for input and output sensors and devices.

2.3 SOFTWARE

.1 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.

.2 Program and data storage.

.1 Store executive programs and site configuration data in ROM, EEPROM or other non volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery backed RAM or EEPROM for display and modification by operator.

.3 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 unless approved by Engineer.

.4 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.

.5 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.

.2 Inputs and outputs for process: 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).

.6 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:

.7 Two position control.

.8 Proportional Integral and Derivative (PID) control.

.9 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.10 Provide protection against excessive electrical demand situations during start up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.11 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: 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.

.8 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 Enthalpy (economizer) switchover.

.8 Peak demand limiting.

.9 Temperature compensated load rolling.

.10 Fan speed/flow rate control.

.11 Cold deck reset.

.12 Hot deck reset.

.13 Hot water reset.

.14 A/C Units sequencing.

.15 Night purge.

.16 Morning warm-up.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Engineer.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user selected analog or binary pulse input type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily,

weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user specified messages when limit reached.

2.4 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change of value (COV) driven or if polled not exceeding 2 second intervals.

2.5 POINT NAME SUPPORT

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

3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Engineer.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as indicated or as directed by Engineer.

.2 Provide necessary power from local 120 V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co ordinating mode.

End of Section

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, and low voltage current transformers.

1.2 RELATED SECTIONS

.1 Section 23 05 54 - Mechanical Identification
.2 Section 23 33 15 - Dampers - Operating.
.3 Section 25 01 11 - EMCS: Start-up and Check-out.
.4 Section 25 05 01 - EMCS: General Requirements.
.5 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
.6 Section 25 90 01 - EMCS: Systems Sequences of Operation.
.7 Section 26 05 00 - Electrical General Instructions.
.8 Section 26 27 26 - Wiring Devices.

1.3 REFERENCES

.1 American National Standards Institute (ANSI).
  .1 ANSI C12.7 1993(R1999), Requirements for Watthour Meter Sockets.
  .2 ANSI/IEEE C57.13 1993, Standard Requirements for Instrument Transformers.
.2 American Society for Testing and Materials International, (ASTM).
  .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.
.3 National Electrical Manufacturer's Association (NEMA).
  .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
.4 Air Movement and Control Association, Inc. (AMCA).
  .1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.
.5 Canadian Standards Association (CSA International).
  .1 CSA-C22.1 02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.4 DEFINITIONS

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

1.5 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
.2 Pre Installation Tests.
  .1 Submit samples at random from equipment shipped, as requested by Departmental Representative Engineer Consultant, for testing before installation. Replace devices not meeting specified performance and accuracy.
.3 Manufacturer's Instructions:
  .1 Submit manufacturer's installation instructions for specified equipment and devices.
  Part 2 Products

2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration proof, heat resistant, assembly.
.3 Operating conditions: 0 32 degrees C with 10 90% RH (non condensing) unless otherwise specified.
.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
.5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
.8 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.
.9 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: System Sequences of Operation.

2.2 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.
  .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 150 mm as indicated.
.2 Room temperature sensors and display wall modules.
  .1 Temperature sensing and display wall module.
  .2 LCD display to show space temperature ed and temperature setpoint.
  .3 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
  .4 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit contractor supplied palm compatible handheld device for access to zone bus.
  .5 Integral thermistor sensing element 10,000 ohm at 24 degrees.
  .6 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
  .7 Stability 0.02 degrees C drift per year.
  .8 Separate mounting base for ease of installation.
.3 Room temperature sensors.
  .1 Sensor specified in 2.2.2.1 shall be used in all locations.
.4 Duct temperature sensors:
  .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm or as indicated.
  .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 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 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 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.

2.4 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: locate in air stream near RA grille 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.

2.5 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.

2.6 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.

2.7 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.

2.8 STATIC PRESSURE SENSORS

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

2.9 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

2.10 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.
- .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.
- .7 Switches on steam and high temperature hot water service: provide pigtail siphon.

2.11 TEMPERATURE SWITCHES

.1 Requirements:
- .1 Operate automatically. Reset automatically, except as follows:
  - .1 Low temperature detection: manual reset.
  - .2 High temperature detection: manual reset.
- .2 Adjustable setpoint and differential.
- .3 Accuracy: plus or minus 1 degrees 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 without protective guard as indicated.
  - .2 Duct, general purpose: insertion length = 460 mm.
  - .3 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100 mm.
  - .4 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.

2.12 TANK LEVEL SWITCHES

.1 Requirements:
- .1 Indicate high/low water level and to alarm.
- .2 For mounting on top of tank.
- .3 Maximum operating temperature: 120 degrees C.
- .4 Snap action contacts rated 15 amp at 120 V.
- .5 Adjustable setpoint and differential.

2.13 SUMP LEVEL SWITCHES

.1 Requirements:
- .1 Liquid level activated switch sealed in waterproof and shockproof enclosure.
- .2 Complete with float, flexible cord, weight. Instrument casing to be suitable for immersion in measured liquid.
- .3 N.O./N.C. Contacts rated at 15 amps at 120V AC. CSA approval for up to 250 volt 10 amps AC.

2.14 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.

2.15 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.

2.16 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.

2.17 CONTROL DAMPERS

.1 Construction: blades, 152 mm wide, 1219 mm long, maximum. Modular maximum size, 1219 mm wide x 1219 mm high. Three or more sections to be operated by jack shafts.

.2 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: maintenance free, synthetic type of material.
- .4 Linkage and shafts: aluminum, zinc and nickel plated steel.
- .5 Seals: synthetic type, mechanically locked into blade edges.

.6 Frame seals: synthetic type, mechanically locked into frame sides.

.3 Performance: minimum damper leakage meet or exceed AMCA Standard 500-D ratings.
- .1 Size/Capacity: refer to damper schedule
- .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.

.4 Arrangements: dampers mixing warm and cold air to be parallel blade, mounted at right angles to each other, with blades opening to mix air stream.

.5 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.

2.18 ELECTRONIC CONTROL DAMPER ACTUATORS

.1 Requirements:
- .1 Direct mount proportional type as indicated.
- .2 Spring return for "fail safe" in Normally Open or Normally Closed position as indicated.
- .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 For VAV box applications floating control type actuators may be used.
- .7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.19 CONTROL VALVES

.1 Body: globe style, characterized ball.
- .1 Flow characteristic as indicated on control valve schedule: linear, equal percentage, quick opening.
- .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
- .3 Normally open Normally closed, as indicated.
- .4 Two Three port, as indicated.
- .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .6 Packing easily replaceable.
- .7 Stem, stainless steel.
- .8 Plug and seat, stainless steel.
- .9 Disc, replaceable, material to suit application.
- .10 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.
- .11 NPS 2½ and larger:
  - .1 Flanged connections.
  - .2 Valves to ANSI Class 150 or 250 as indicated, valves to bear ANSI mark.
  - .3 Rangeability 100:1 minimum.

.2 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 steam and 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, aluminum bronze to ASTM B148.
.6 Seat: for service on chilled water PTFE (polytetrafluoroethylene), EPDM (ethylene propylene diene monomer). For service on steam and heating water PTFE, RTFE (reinforced PTFE).
.7 Stem: 316 stainless steel.
.8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
.9 Flow characteristic linear.
.10 Maximum flow requirement as indicated on control valve schedule.
.11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.
.12 Normally open Normally closed, as indicated.
.13 Valves are to be provided complete with mounting plate for installation of actuators.

2.20 ELECTRONIC/ELECTRIC VALVE ACTUATORS

.1 Requirements:
.1 Construction: steel, cast iron, aluminum.
.2 Control signal: 0 10V DC or 4-20 mA DC.
.3 Positioning time: to suit application. 90 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.
.8 Minimum shut off pressure: refer to control valve schedule.

2.21 VARIABLE FREQUENCY DRIVES

.1 Provide variable frequency drives according to Section 25 05 14.

2.22 PANELS

.1 Free standing wall mounted enamelled steel cabinets with hinged and key locked front door.
.2 Multiple panels as required indicated to handle requirements with additional space to accommodate 25% additional capacity as required by Engineer without adding additional cabinets.
.3 Panels to be lockable with same key.

2.23 WIRING

.1 In accordance with Section 26 27 26 - Wiring Devices.
.2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
.3 Wiring must be continuous without joints.
.4 Sizes:
.1 Field wiring to digital device: #18AWG 20AWG stranded twisted pair.
.2 Analog input and output: shielded #18 minimum solid copper #20 minimum stranded twisted pair.

3 Execution

3.1 INSTALLATION

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

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
.3 Temperature transmitters, humidity transmitters, current to pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
.4 Support field mounted panels, transmitters and sensors on pipe stands or channel brackets.
.5 Fire stopping: provide space for fire stopping in accordance with Section 23 05 01 - N.I.T.C. Maintain fire rating integrity.
.6 Electrical:
  .1 Complete installation in accordance with Section 26 05 00 - Electrical General Instructions.
  .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
  .3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Systems Sequences of Operation on drawings. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Engineer before beginning Work.
  .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
  .5 Install communication wiring in conduit.
    .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
    .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
    .3 Maximum conduit fill not to exceed 40%.
    .4 Design drawings do not show conduit layout.
  .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Engineer to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.
.7 VAV Terminal Units: supply, install and adjust as required.
  .1 Air probe, actuator and associated valve controls.
  .2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.
  .3 Co-ordinate air flow adjustments with balancing trade.

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.
.5 Averaging duct type temperature sensors.
  .1 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.
  .2 Wire multiple sensors in series for low temperature protection applications.

.3 Wire multiple sensors separately for temperature measurement.
.4 Use software averaging algorithm to derive overall average for control purposes.

.6 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 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.

3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
.1 Protect sensing elements on steam and high temperature hot water service with pigtail siphon between valve and sensor.
.2 Install pressure gauge on output of auxiliary cabinet pneumatic devices.

3.5 IDENTIFICATION

.1 Identify field devices in accordance with Section 23 05 54 - Mechanical Identification.

3.6 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up and Check-out.

End of Section

1 General

1.1 AIR SYSTEMS

.1 Exhaust Fan - continuous
- .1 Run Conditions - continuous:
  - .1 The fan shall run continuously.
- .2 Fan Status:
  - .1 The controller shall monitor the fan status.
  - .2 Alarms shall be provided as follows:
    - .1 Fan Failure: Commanded on, but the status is off.
    - .2 Fan in Hand: Commanded off, but the status is on.
    - .3 Fan Runtime Exceeded: Fan status runtime exceeds a user definable limit (adj.).

.2 AHU-1 - Variable Volume Air Handling Units - 100% Outdoor Air Supply Systems:
- .1 When the supply fan is off:
  - .1 Outdoor air damper is closed.
  - .2 Heating is off.
  - .3 Mechanical cooling is off.
  - .4 Steam humidifier is off.
  - .5 Supply fan is off.
  - .6 Heat recovery pump is off.
- .2 When the exhaust fan is off:
  - .1 Exhaust air damper is closed.
  - .2 Exhaust Fan is off.
- .3 Normal Mode:
  - .1 The AHU is controlled by time schedule program in EMCS.
  - .2 The supply fan is started after the exhaust fan status is confirmed. If either fan fails to start, or stops, both fans are stopped and an alarm is generated.
- .4 Duct Static Pressure Monitoring:
  - .1 Supply fan is variable speed.
  - .2 Locate static pressure sensors in supply ductwork, to monitor duct static pressure.
  - .3 Locate pressure differential sensor between Room 229 and corridor. Vary fan speed incrementally to maintain pressure set point (adj.).
  - .4 Static pressure setpoints shall be determined during air balancing.
  - .5 Provide Alarm to EMCS when static pressure falls outside of range.
- .5 Temperature Control:
  - .1 The supply air temperature is step controlled to maintain room temperature setpoint by sequencing the steam heating valve, face & bypass damper and cooling valve.
  - .2 Control of heating is overridden to maintain a minimum heating coil discharge temperatures of 10ºC (50ºF).
  - .3 Provide high limit alarm.
- .6 Humidity Control:
  - .1 The steam humidifier is controlled to maintain minimum return air humidity of 40% RH.
  - .2 Control of steam humidifier is overridden to maintain supply air humidity below 80% RH.
  - .3 Supply air temperature control is overridden to maintain return air humidity below 50% RH.
  - .4 Each humidifier shall have an air flow switch in its duct to prevent operation when the air handling unit is off.
- .7 Alarm Mode:

.1 When low limit thermostat senses a supply air temperature of 3ºC or less, supply fan and return fan are stopped and an alarm is generated.

.2 On signal from the fire alarm system. The unit shall go into smoke control mode.

.8 Face and Bypass Dampers:

.1 Controls to modulate both face and bypass damper and heating coil valve when outdoor temperature is above 40°F to achieve air temperature setpoint. Controls to modulate bypass damper only with coil valve at 100% open when outdoor temperatures are less than 40°F.

.3 Room 229 Exhaust Air Damper

.1 When exhaust fan status is off or commanded off, exhaust air damper for Room 229 shall be commanded open.

End of Section