PART 1 - GENERAL

1.1 Related Sections

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

.2 Section 25 08 20 - EMCS: Commissioning.

1.2 Definitions

.1 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.2 Downtime: results whenever EMCS is unable to fulfil all required functions due to malfunction of equipment defined under the responsibility of EMCS contractor. Downtime is measured by duration, in time, between the time that the Contractor is notified of failure and the time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply more than 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.

1.3 Acronyms

.1 Acronyms Refer to Section 25 05 01 - EMCS: General Requirements.

1.4 System Description

.1 Work includes:
- .1 Start-up testing and verification of all systems.
- .2 Check out demonstration of proper operation of all components.
- .3 On-site operational tests.

.2 Perform work under direction of, and in presence of, the Departmental Representative and EMCS Commissioning personnel.

.3 Provide test equipment including two-way radios.

.4 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no later than one month prior to tests.

.5 Inform, and obtain approval from, the Departmental Representative in writing at least 14 days prior to each test. Indicate:
- .1 Location and part of system to be tested.
- .2 Testing procedures, anticipated results.
- .3 Names of testing personnel.

.6 Co-ordinate with other trades.

.7 Correct deficiencies, re-test in presence of the Departmental Representative until satisfactory performance is obtained.

.8 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.9 Load system with project software.

.10 Perform tests as required.

1.5 Quality Assurance

.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 the Departmental

Representative.

.3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including ECU's, MCU's, LCU's, TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 C.V. supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa w.c., to hold steady at any setting and with direct output to milli-amp meter at source.

.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.

.8 Controls Contractor and/or the Departmental Representative to mark instruments tracking within 5% in both directions as "approved for installation".

.9 Transmitters above 5% error will be rejected.

.10 DP switches to open and close within 10% of setpoint.

.2 Completion Testing:

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
.7 Test operating software.
.8 Test application software. 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 100psig.

.3 Final Start-up Testing:
.1 Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of the Departmental Representative and EMCS Commissioning Departmental Representative.
.2 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 Key document for recording procedures to be listing of system database, including keyname, English description, point type and address, engineering units, low and high limits. Include space on listing for remarks and signatures of commissioning technician and the Departmental Representative.
.4 Departmental Representative's acceptance signature to be on executive and applications programs.

.4 Final Operational Testing:
.1 Purpose: to demonstrate that EMCS functions in accordance with contract requirements.
.1 Prior to the commencement of 30 day test Contractor must demonstrate that operating parameters (setpoints, alarm limits and CDL's) have been implemented so as to ensure proper operation and

operator notification in event of off-normal operation. Repetitive alarm conditions to be resolved so as 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 item 1.2.2. 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.

1.6 Commissioning

.1 Do commissioning in accordance with Section 25 08 20 - EMCS: Commissioning.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

PART 1 - GENERAL

1.1 Training Proposal

.1 Provide training proposal complete hour-by-hour schedule including brief overview of content of each segment to Engineer 30 days prior to anticipated date of commencement of training.
  .1 List name of trainer, visual and audio aids to be used.
  .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

1.2 Instructors

.1 To be competent, thoroughly familiar with all aspects of EMCS installed in this facility.

.2 The Departmental Representative reserves right to approve instructors, based on qualifications.

1.3 Instruction

.1 Provide instruction to designated personnel in adjustment, operation, maintenance, pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

1.4 Time For Instruction

.1 A total of one person-day of instruction to be as specified in this section (1 person-day = 8 h including two 15 min breaks and excluding lunch time).

1.5 Training Program

.1 To be in 2 phases over 6 month period:
  .1 Phase 1: for 1/2 day before 30 day test period at time mutually agreeable to the Contractor and Departmental Representative. Train O&M personnel in functional operations and procedures to be employed for system operation. Supplement with continuous on-the-job training during 30 day test period. To include overview of system architecture, communications, operation of computer and peripherals, report generation; detailed training on operator interface

functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.2 Phase 2: 8 weeks after acceptance, for 1/2 day. For operators, equipment maintenance personnel and programmers. Use 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 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 for training of the following subjects in approximate percentages of total course shown:
Software 10 %, architecture:
Applications 15 %, program:
Controller 50 %, programming:
Trouble shooting 15 %, debugging:
Colour graphic 10 %, generation:

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

PART 1 - GENERAL

1.1 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 01 11 – EMCS: Start-up and Checkout.

.4 Section 25 08 20 – EMCS: Commissioning.

.5 Section 25 05 03 – EMCS: Project Record Documents.

.6 Section 25 01 12 – EMCS: Training.

.7 Section 25 05 54 – EMCS: Identification.

.8 Section 25 10 01 – EMCS: Local Area Network (LAN).

.9 Section 25 30 01 – EMCS: Building Controller Family of Controllers.

.10 Section 25 30 02 – EMCS: Field Control Devices.

.11 Section 25 05 60 – EMCS: Field Installation.

1.2 References

.1 American National Standards Institute (ANSI):
  .1 ANSI/ISA S5.5, Graphic Symbols for Process Displays.
  .2 ANSI/IEEE 260.1, Letter Symbols for SI and Certain Other Units of Measurements (SI Units, Customary Inch-Pound Units and Certain Other Units).

.2 Canadian Standards Association (CSA):
  .1 CAN/CSA-C22.2 No.0, General Requirements, Canadian Electrical Code, Part II.
  .2 CAN/CSA-Z234.1, Canadian Metric Practice Guide.

.3 Electrical and Electronic Manufacturers Association (EEMAC):
  .1 EEMAC 2Y-1, Light Gray Colour for Indoor Switch Gear.

1.3 Acronyms, Abbreviations and Definitions

.1 Acronyms used in EMCS.

.1 AI – Analog Input
.2 AO – Analog Output
.3 BACnet – Building Automation and Control Network
.4 CAB – Canadian Automated Building (CAB) Protocol
.5 CAD – Computer Aided Design
.6 CDL – Control Description Logic
.7 COSV – Change of State or Value
.8 CPU – Central Processing Unit
.9 DI – Digital Input
.10 DO – Digital Output
.11 ECU – Equipment Control Unit
.12 EMCS – Energy Monitoring and Control System
.13 HVAC – Heating, Ventilation, Air Conditioning
.14 IDE – Interface Device Equipment
.15 I/O – Input/Output
.16 ISA – Industry Standard Architecture
.17 LAN – Local Area Network
.18 LCU – Local Control Unit
.19 LonTalk – Echelon Corporation (proprietary protocol)
.20 MCU – Master Control Unit
.21 OS – Operating System
.22 O&M – Operation and Maintenance
.23 OWS – Operator Work Station
.24 PC – Personal Computer
.25 PCI – Peripheral Control Interface
.26 PCMCIA – Personal Computer Micro-Card Interface Adapter
.27 RAM – Random Access Memory
.28 ROM – Read Only Memory
.29 TCU – Terminal Control Unit
.30 USB – Universal Serial Bus
.31 UPS – Uninterruptible Power Supply

.2 Definitions:

.1 Point: a point may be logical or physical. Logical points are values calculated by system such as totals, counts, derived corrections i.e. as result of and/or statements in CDL's. Physical points are inputs or outputs which have hardware wired to controllers which are measuring or providing status

conditions of contacts or relays providing interaction with related equipment (stop, start) or valve or damper actuators.

.3 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISAS 5.5.
.1 Printouts: to ANSI/IEEE 260.
.2 Refer also to Section 25 05 54 – EMCS: Identification.

1.4 Permits and Fees

.1 In accordance with General Conditions of Contract.

1.5 General 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 indicated on the drawings.
.3 Data communications equipment necessary to affect an EMCS data transmission system for connection to the existing Delta network.
.4 Field control devices.
.5 Software complete with full documentation for software and equipment.
.6 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.
.7 Acceptance tests, technical support during commissioning, full documentation.
.8 Wiring interface co-ordination of equipment supplied by others.
.9 Miscellaneous work as specified in these sections and as indicated.
.10 New controls shall be provided complete with new dynamic graphic representation for each system and piece of equipment on the OWS using the existing EMCS and

software. Provide new stand-alone DDC panels. Co-ordinate locations prior to installation.

1.6 Metric References

.1 Conform to CAN/CSA-Z234.1.

.2 Provide required adapters between Metric and Imperial components.

1.7 Standards Compliance

.1 All equipment and material to be 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. Be responsible for all costs related thereto.

.3 Submit proof of compliance to specified standards with shop drawings and product data. Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by a licensed Engineer, certifying that item was tested in accordance with their test methods and that item conforms to their standard and/or code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.8 EMCS Contractor Qualifications

.1 **All controls shall integrate with the existing campus controls system.**

1.9 System Design Responsibility

.1 Design and provide all conduit and wiring linking all elements of system, including future capability.

.2 Supply sufficient programmable controllers of all types to meet project requirements. Quantity and points contents to be approved by the Departmental Representative prior to installation.

.3 Location of controllers to be approved by the Departmental Representative prior to installation.

.4 Provide utility power to controllers.

1.10 Language Operating Requirements

.1 Operator to interface to system in English through operator selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals. All other information to be in English.

.3 Operating system executive: primary hardware-to-software interface with associated documentation to be in English.

.4 System manager software: to include 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. These functions to be in English.

.5 EMCS operator: include, in English:

.1 All input and output commands and messages from operator-initiated

functions and/or field related changes and/or alarms as defined in CDL's or assigned limits (i.e. all commands relating to day-to-day operating functions and not related to system modifications, additions, or logic refinements).

.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 all specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.

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

1.11 Materials Delivery Schedule

.1 Provide the Departmental Representative with "Materials Delivery Schedule" within four (4) weeks after award of Contract.

PART 2 - PRODUCTS

2.1 Lockable Panels

.1 Panel to be NEMA rated to suit environmental requirements.

.2 To have hinged doors equipped with standard keyed-alike cabinet locks, keyed to same key.

.3 Identify using lamicoid labels.

PART 3 - EXECUTION

3.1 Manufacturer's Recommendations

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

3.2 Painting

.1 Painting to be in accordance with Section 09 91 23 – Painting.

.2 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.3 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.

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

.5 Paint all unfinished equipment installed indoors to CEMA 2Y.1.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

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

.2 Section 25 08 20 - EMCS: Commissioning.

1.2 Design Requirements

.1 Preliminary Design Review:

.1 Within thirty (30) working days after tender closing and before contract award, submit preliminary design document for review by the Departmental Representative, containing following contractor and systems information:

.1 Description and location of installing and servicing technical staff.

.2 Location and qualifications of programming design and programming support staff.

.3 Sketch of site-specific system architecture.

.4 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.

.5 Descriptive brochures.

.6 Sample CDL and graphics (systems schematics).

.7 Response time for each type of command and report.

.8 Item-by-item statement of compliance.

.9 Proof of demonstrated ability of system to communicate utilizing CAB Standard Communications Protocol and BACnet.

.2 Preliminary Design Review Meeting:

.1 Convene meeting within forty-five (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 The Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to the Departmental Representative.

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process and Section 01 33 00.

.2 Hard copy to be completely indexed and co-ordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.3 Preliminary Shop Drawing Review:
.1 Submit preliminary shop drawings within 30 working days of award of contract.
.2 Include:
.1 Specification sheets for each item. To include manufacturer's descriptive literature, specification, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
.2 Detailed system architecture showing all points associated with each controller including signal levels, pressures where new EMCS ties into existing control equipment.
.3 Spare point capacity of each controller by number and type. Minimum spare capacity shall be 20% of each point type.
.4 Controller locations.
.5 Auxiliary control cabinet locations.
.6 Single line diagrams showing cable routings, conduit sizes, spare

capacity between control centre, field controllers and systems being controlled.

.7 Complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drops, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque.

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

.4 Detail Shop Drawing Review:

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

.2 Include:

.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.

.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), signal range.

.6 Software and programming details associated with each point.

.7 Manufacturer's recommended installation instructions

and procedures.

.8 All signal levels, pressures where new system ties into existing control equipment.

.3 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.

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

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

.6 Listing and example of reports.

.7 Listing of time schedules.

.8 Detailed to-scale drawing of control room showing location of equipment and operator work space.

.9 Type and size of memory with statement of spare capacity.

.10 Full description of software programs provided.

.11 Sample of "Operating Instructions Manual" to be used for training purposes.

.12 Outline of proposed start-up and verification procedures. See also Section 25 01 11 - EMCS: Start-up and Check Out.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 Conform to requirements of Section 01 78 00 - Closeout Submittals, supplemented and modified by requirements specified in this section.

.2 Project records and O&M manuals specified in this section are to be completely separate entity from those specified in Section 01 78 00 - Closeout Submittals.

1.2 Acronyms

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

1.3 Final Control Diagrams

.1 Provide before acceptance in both hard and soft copy.

.2 Show:
- .1 Changes to contract documents as well as addenda and contract extras.
- .2 Changes to interface wiring.
- .3 Major routing of conduit and control air lines.
- .4 Signal levels, setpoints, reset curves, schedules.

.3 Where possible, bind with specified Operating and Maintenance Manuals.

.4 Provide listing of alarm messages.

.5 Provide soft copy of updated drawings on system and soft copy back-up.

.6 Provide one non-fading "As-Built" copy showing control and/or adjustment procedures.

1.4 Language

.1 Provide record documents including Operation and Maintenance manuals in English.

1.5 O & M Manuals

.1 O & M Manuals (both hard and soft copy) to be custom designed and contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this section.

.2 Provide 3 soft copies and 3 hard copies in hard-back, 50 mm 3 ring, D-ring binders.
- .1 Binders to be 2/3 maximum full.
- .2 Provide index to full volume in each binder.
- .3 Identify contents of each manual on cover and spine.
- .4 Include names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
- .5 Provide Table of Contents in each manual. Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

.3 Furnish one complete set of hard and soft copies prior to system or equipment tests. Furnish remainder upon acceptance.

.4 Include complete coverage in concise language readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.5 Functional description to include:
- .1 Functional description of theory of operation.
- .2 Design philosophy.
- .3 Specific functions of design philosophy and system.
- .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
- .5 Explicit description of hardware and software functions, interfaces, requirements for components in functions and operating modes.
- .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented for implementation in automatic mode.

.6 System operation to include:
- .1 Operation of computer peripherals, input and output formats.
- .2 Emergency, alarm and failure recovery.
- .3 Step-by-step instructions for start-up, back-up equipment operation, execution of all systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.7 Software to include:
- .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
- .2 Detailed descriptions of program requirements and capabilities.
- .3 Data necessary to permit modification, relocation, reprogramming and to permit [new and existing] software modules to respond to changing system functional requirements without disrupting normal operation.
- .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
- .5 Complete program cross reference plus any linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
- .6 Software for each Controller and single section referencing all Controller common parameters and functions.

.8 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers,

Controller interface firmware's, plus diagnostics and repair/replacement of system hardware.

.9 Test procedures and reports: record implementation, description of test procedures. Provide for measurement or observation of results.

.10 System configuration document:
- .1 Basic system design and configuration.
- .2 Provisions and procedures for planning, implementing, recording hardware and software modifications required during installation, test and operating lifetime of system.
- .3 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .4 Full documentation of new system configurations.

.11 PROM programmer and test equipment manual: include full documentation on PROM's including as minimum PROM locations in system, stock number, Programmer/PROM unique considerations.

.12 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

PART 1 - GENERAL

1.1 General

.1 Provide identification for all control items.

1.2 References

.1 Canadian Standards Association (CSA):
.1 CSA C22.1, The Canadian Electrical Code, Part I.

1.3 Submittals

.1 Submit for approval samples of nameplates, identification tags and list of proposed wording.

PART 2 - PRODUCTS

2.1 Language

.1 Provide nameplates and identification tapes and tags in English.

2.2 Nameplates For Panels

.1 Identify faces with laminated plastic nameplates.

.2 Sizes: 25mm x 63mm minimum.

.3 Lettering: 6.35mm minimum high, black.

.4 Inscriptions: machine engraved to identify function and, where applicable, fail-safe position.

.5 Nameplates: plastic laminate, 3.2mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

2.3 Nameplates For Field Devices

.1 Identify by plastic encased cards attached by chain.

.2 Sizes: 50mm x 100mm minimum.

.3 Lettering: 6.35mm minimum high produced from laser printer in black.

.4 Data to include: point name, schematic designation number, model, capillary length, size, range, set point, other pertinent data, function, fail-safe position.

.5 Companion cabinet: identify interior components using plastic enclosed cards.

2.4 Nameplates For Room Sensors

.1 Interior: identify by stick-on labels.

.2 Exterior: identify point name on face of cover using plastic laminate nameplates.

.3 Sizes: to suit.

.4 Lettering: to suit. Clearly legible.

2.5 Warning Signs

.1 Equipment (e.g. motors, starters) under remote automatic control: provide orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" or equivalent to Consultant's approval.

2.6 Nameplates For Wiring

.1 Provide numbered tape markings on wiring at panels, junction boxes, splitters, cabinets, outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify at each panel.

2.7 Nameplates For Conduit

.1 Colour code all EMCS conduit.

.2 Locate coding on conduits, in exposed and concealed locations including removable suspended ceilings, tunnels, shafts, on both sides of walls, floors, and at 15 m intervals.

.3 Coding: use plastic tape or paint, 25mm wide, fluorescent orange. Confirm colour with Consultant during "Preliminary Design Review".

PART 3 - EXECUTION

3.1 Nameplates and Labels

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

END OF SECTION

PART 1 - GENERAL

1.1 References

.1 American National Standards Institute (ANSI):
- .1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
- .2 ANSI C2, National Electrical Safety Code.
- .3 ANSI/NFPA 70, National Electrical Code.

.2 Canadian Standards Association (CSA):
- .1 CSA C22.1, Canadian Electrical Code, Part 1.
- .2 CAN/CSA C22.3 No.1, Overhead Systems.

1.2 System Description

.1 Electrical:
- .1 Provide power wiring as required to EMCS field panels and field installed controls components. 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 Provide hard wiring between field control devices and EMCS field panels.

.2 Mechanical:
- .1 Installation of dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.

1.3 Personnel Qualifications

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

PART 2 - PRODUCTS

2.1 Special Supports

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

2.2 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. Run in EMT conduit.

.3 For wiring under 70 volts: use FT4 wiring run in conduit.

.4 Sizes:
- .1 120V Power supply: to match or exceed breaker, size #18 minimum.
- .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
- .3 Field wiring to digital device: #20 stranded twisted pair.
- .4 Analog inputs and outputs: #20 twisted pair, solid copper. Wiring must be continuous without joints.
- .5 More than 4 conductors: #22 minimum solid copper.
- .6 Communications wiring: #24 twisted shielded pair.

.5 Terminations:
- .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.3 Conduit

.1 As per requirements of Division 26 and the latest edition of the Canadian Electrical Code.

.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 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: 100mm 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° bends required for 25mm and larger conduits.

.8 Fittings for thin wall conduit:
.1 Connectors and couplings: steel, set screw type.

2.4 Wiring Devices, Coverplates

.1 Conform to CSA.

.2 Receptacles:
.1 Duplex: CSA type 5-15R.
.2 Single: CSA type 5-15R.
.3 Coverplates and blank plates: finish to match other plates in area.

2.5 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 manuals.

.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 Electrical General Requirements.

.2 Interior: white.

2.6 Supports For Conduit, Fastenings, Equipment

.1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.

.1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.

.2 Exposed conduits or cables:

.1 50mm diameter and smaller: one-hole steel straps.

.2 Larger than 50mm diameter: two-hole steel straps.

.3 Suspended support systems:

.1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.

.2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

PART 3 - EXECUTION

3.1 Installation

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

3.2 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 C22.3 No.7, except where otherwise specified.

.4 Conform to manufacturer's recommendations for storage, handling and installation.

.5 Check factory connections and joints. Tighten where necessary to ensure continuity.

.6 Install electrical equipment between 1000 mm 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.

3.3 Conduit System

.1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.

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

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

.4 Locate conduits at least 150mm 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 30.4m.

.8 Use conduit outlet boxes for conduit up to 32mm 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 the Departmental Representative.

.10 Install polypropylene fish cord in empty conduits for future use.

.11 Where conduits become blocked, remove and replace blocked sections.

.12 Pass conduits through structural members only after receipt of the Departmental Representative 's written approval.

.13 Conduits may be run in flanged portion of structural steel.

.14 Group conduits wherever possible on suspended or surface channels.

.15 Pull boxes:

.1 Install in inconspicuous but accessible locations.

.2 Support boxes independently of connecting conduits.

.3 Fill boxes with paper or foam to prevent entry of construction material.

.4 Provide correct size of openings. Reducing washers not permitted.

.5 Mark location of pull boxes on record drawings.

.6 Identify AC power junction boxes, by panel and circuit breaker.

.16 Install terminal blocks or strips indicated in cabinets to Division 26.

.17 Install bonding conductor for 120 volt and above in conduit.

3.4 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 the Departmental Representative with test results showing locations, circuits, results of tests.

.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.

.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.

.8 Do not allow wiring to come into direct physical contact with compression screw.

.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.5 Wiring Devices, Coverplates

.1 Receptacles:

.1 Install vertically in gang type outlet box when more than one receptacle is required in one location.

.2 Coverplates:

.1 Install suitable common cover plate where wiring devices are grouped.

.2 Use flush type cover plates only on flush type outlet boxes.

3.6 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.

3.7 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.

3.8 Tests

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

Departmental Representative in writing.

.6 Preliminary tests:

.1 Conduct as directed to verify compliance with specified requirements.

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.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 the Departmental Representative and authority having jurisdiction.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 01 78 00 - Closeout Submittals.

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

1.2 System Description

.1 Commissioning to be carried out under general direction of the Departmental Representative and in presence of the Commissioning Departmental Representative.

.2 Approvals:
.1 Obtain approval to start commissioning from the Departmental Representative in writing at least 14 days prior to start. Information to include:
.1 Systems to be commissioned.
.2 Procedures, anticipated results.
.3 Names of commissioning personnel.

.3 Purpose:
.1 To ensure that facility is fully commissioned by Commissioning process includes assurance that systems meet design criteria, design intents and requirements of specifications.

1.3 Design Requirements

.1 Commissioning personnel to confirm with the Departmental Representative that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.4 Co-Ordination

.1 Co-ordinate commissioning procedures with other Divisions and with all Contractors.

1.5 Timing

.1 Commissioning to commence only after satisfactory completion of start-up, verification of performance and thirty (30) day test period as specified above.

.2 Commissioning of occupancy-, weather-, and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied, except as follows:

.1 Commission systems considered as life safety systems before affected parts of facility are occupied.

1.6 Instrumentation

.1 Provide sufficient permanent and temporary instrumentation. Verify locations, access, illumination for readings.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment, or system, being tested.

.3 Locations to be approved, readily accessible and readable.

.4 Application: to conform to normal industry standards.

1.7 Operation of Systems

.1 Operate systems as long as necessary to commission entire project.

1.8 Supervision and Monitoring

.1 Commissioning to be supervised by qualified supervisory personnel.

.2 Monitor progress. Keep detailed records of activities, results.

1.9 Documentation

.1 Documentation, O & M Manuals, training of O&M personnel to be complete to satisfaction of the Departmental Representative before starting commissioning. Refer to Section 01 78 00 - Closeout Submittals.

1.10 Use of O&M Personnel

.1 O & M personnel to assist in commissioning procedures as part of training.

1.11 Procedures

.1 Test each system independently and then in unison with other related systems.

.2 Test weather-sensitive systems twice - once at near winter design conditions and again under near summer design conditions.

.3 Commission each system using following procedures prescribed by the Departmental Representative.

.4 Commission integrated system using procedures prescribed by the Departmental Representative.

.5 Debug system software.

.6 Optimize operation, performance of systems by fine-tuning PID values and modifying CDL's as required.

.7 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under Normal Power conditions as applicable.

1.12 Verification of Results

.1 The Departmental Representative may verify 10% of reported results.

1.13 Demonstrations

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

1.14 Final Settings

.1 Upon completion of commissioning to satisfaction of the Departmental Representative, set and lock devices in final position, permanently mark settings.

1.15 Final Report

.1 Submit report to the Departmental Representative. Report to:
.1 Include measurements, final settings, certified test results.
.2 Bear signature of commissioning

technician and supervisor.
.3 Be subject to verification by the Departmental Representative.

.2 Report format to be approved by the Departmental Representative before commissioning started.

1.16 Commissioning Activities During Warranty Period

.1 Continue system debugging and optimization.
.1 Perform two (2) checks of environmental conditions. Submit written report to the Departmental Representative for review.

.2 Revise "As-built" documentation, commissioning reports to reflect changes, adjustments, modifications to EMCS as set during commissioning.

.3 Recommend additional changes, modifications deemed advisable in order to improve performance, environmental conditions, energy consumption.

1.17 Maintenance Activities During Warranty Period

.1 Provide services, materials, equipment and maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components.

.2 Perform as minimum three (3) minor inspections and one major inspections (more often if required by manufacturer) per year. Provide detailed written report to the Departmental Representative.

.3 Major inspections to include, but not limited to:
.1 Minor inspection.
.2 Clean 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 Provide mechanical adjustments, new ribbons or cartridges, and necessary maintenance on printers.

.5 Run system software diagnostics as required.

.6 The following inspections will be considered minimum requirements, and shall not be interpreted to mean satisfactory performance. Calibrations will be performed using test equipment having traceable, certifiable accuracy at minimum 50% greater than the accuracy of system displaying or logging the value. Check and/or calibrate each field input/output device. Provide dated, maintenance task lists to the Departmental Representative as proof of execution of complete system verification. Maintenance task lists to include the following sensor and output point detail; point name, location, device type and range, measured value, system displayed value, calibration detail, indication if adjustment required, and any other action taken of recommended.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability. Perform network analysis and provide report of results with detailed recommendations to correct any problems found.

.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 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding legal holidays.

.4 Review system performance with Operations Supervisor and/or the Director and discuss suggested or required changes.

.5 Emergency Service Calls:

.1 Service calls will be initiated when there is indication that EMCS is not functioning correctly. Have qualified

control personnel available during contract period to provide service to "CRITICAL" components whenever required at no extra cost. Furnish the Departmental Representative with telephone number where service personnel may be reached at any time. Service personnel to be on site ready to service EMCS within 2 h after receiving request for service. Perform work continuously until EMCS restored to reliable operating condition.

.6 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and to be as recommended by manufacturer.

.7 Records and logs: maintain records and logs of each maintenance task. Organize cumulative records for each major component and for entire EMCS chronologically. Complete forms and submit after inspection indicating that planned and systematic maintenance has been accomplished.

.8 Work requests: record each service call request, when received separately on approved form. Form to include serial number identifying component involved, its location, date and time call received, nature of trouble, names of personnel assigned, instructions of work to be done, amount and nature of materials used, time and date work started, time and date of completion.

.9 System modifications: provide in writing. No system modification, including operating parameters and control settings, to be made without prior written approval of the Departmental Representative.

.10 Rectify deficiencies revealed by maintenance inspections and environmental checks.

1.18 Completion of Commissioning

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved to full satisfaction of the Departmental

Representative.

1.19 Issuance of Final Certificate of Completion

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

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

EMCS LOCAL AREA NETWORK (LAN)

PART 1 - GENERAL

1.1 Acronyms

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

1.2 System Description

.1 LAN to network OWS's and MCU's as indicated. To be able to expand or modify network either via LAN, auto-dial telephone line router connections or combination of both.

.2 LAN to be capable of communicating with LAN/WAN network either directly or through gateway.

1.3 OWS/MCU Panel Support

.1 MCU to reside directly on LAN so that communications may be executed directly between work-stations and controllers on peer-to-peer basis.

1.4 Dynamic Data Access

.1 LAN to provide capabilities for OWS devices to be able 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 or building equipment.

1.5 General Network Design

.1 To include:

.1 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 Megabit minimum.

.2 Support of any combination of MCU controllers and OWS directly connected to LAN. Each LAN to be capable of supporting at least 50 devices.

.3 Detection and accommodation of single or multiple failures of either MCU panels or network media. To reconfigure itself automatically to allow operational equipment to perform designated functions effectively in event of single or multiple failures.

.4 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications such as office automation.

.2 System shall be Ethernet based.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

PART 1 – GENERAL

1.1 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 08 20 – EMCS: Commissioning.

.4 Section 25 05 03 – EMCS: Project Records Documents.

.5 Section 25 10 01 – EMCS: Local Area Network (LAN).

.6 Section 25 30 02 – EMCS: Field Control Devices.

1.2 References

.1 Canadian Standards Association (CSA):
.1 C22.2 No.205, Signal Equipment.

.2 Institute of Electrical and Electronics Engineers:
.1 IEEE C37.90.1, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

1.3 Maintenance Procedures

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 – EMCS: Project Records Documents.

1.4 Acronyms

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

1.5 Submittals

.1 In accordance with Section 25 05 02 – EMCS: Shop Drawings, Product Data and Review Process submit product data sheets for each product item proposed for this project.

PART 2 – PRODUCTS

2.1 System Description

.1 General: A network of Controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be

provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient Controllers to meet intents and requirements of this section.

.2 Controllers quantity, and point contents to be approved by the Departmental Representative at time of preliminary design review.

.2 Controllers to be stand-alone intelligent Control Unit. Controllers to:

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface port for communication to Local Controller's LAN to exchange information with other Controllers.

.3 Be capable of interfacing with operator interface device.

.4 Interface with field sensors via input output termination board to be part of Controllers or located remotely.

.5 Execute its logic and control (direct digital or closed loop process) having primary inputs (input or outputs which have direct interaction with logic processing) connected directly to its onboard input/output field terminations or slave devices, and without need to interact with another processor. Secondary input used for reset such as outdoor air temperature to be located in other Controller(s).

2.2 Basic Functional Requirements

.1 To include:

.1 Scanning of AI=s and DI=s connected inputs for detection of change of value and processing the detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including the resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with

adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.6 Spare capacity min. 25% - all point types.

.2 Field Termination and Interface Devices:

.1 To conform to CSA C22.2 No.205.

.2 To electronically interface sensors and control devices to processor unit.

.3 To 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 with tamper alarm (unless housed in processor unit 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 shall use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 12 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE 472 surge with stand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.3 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment to:

.1 Convert digital data from controller processor to acceptable analog output signals using 12 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE 472 surge withstand capability.

.6 DI interface equipment to:

.1 Be able to reliably detect contact change of sensed field contact and feed condition to controller logic processor.

.2 Meet IEEE 472 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment to:

.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.

.3 Controller's and associated hardware and software to operate in conditions of 0EC to 43.3EC and 20% to 90% non-condensing RH.

.4 Controllers (MCU, LCU) to be mounted in wall mounted cabinet with hinged, keyed-alike locked door. Provide for conduit entrance from top, bottom or sides of panel. ECUs to be mounted in equipment enclosures and TCU's in ceiling space. Mounting details to be as approved by the Departmental Representative for ceiling mounting.

.5 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.6 Provide surge and low voltage protection for interconnecting wiring connections.

2.3 Master Control Unit (MCU)

.1 Primary function of MCU is to provide co-ordination and supervision of subordinate devices. Supervisory role shall include coordination of subordinate devices in the execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices. Include support for Open System Protocols.

.3 MCU shall have local I/O capacity as follows;
- .1 To have at least 16 I/O points of which minimum to be 2AO, 6AI, 4DI, 4DO.
- .2 LCU's to be added to support system functions as indicated in I/O Summary List.
- .3 MCU to have 25% spare input and 25% output point capacity without addition of cards, terminals, etc.

.4 Central Processor Unit (CPU)
- .1 Processor to consist of at minimum a 16 bit microprocessor capable of supporting software to meet specified requirements.
- .2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.
- .3 Minimum addressable memory to be at manufacturer's discretion but to support at least all performance and technical specifications. Memory to include:
  - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
  - .2 Battery backed (72 hr minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) RAM to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through

operator panel or remote operator's interface. RAM to be downline loadable from OWS, CAB-Gateway, or locally installed floppy disk.

.4 Include uninterruptable clock accurate to plus or minus 5 secs/month, capable of deriving month/day/hour/minute/second, with rechargeable batteries for minimum 72 hr operation in event of power failure.

.5 Local Operator Terminal (OT):

.1 OT to:

.1 Have integral access/display panel where immediate access to OWS is not available.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs additions and modifications.

.3 Simultaneously display minimum of 16 points with full English identification to allow operator to view single screen dynamic displays depicting entire mechanical systems.

.2 Functions to include, but not be limited to, following:

.1 Start and stop points.

.2 Modify setpoints.

.3 Modify PID loop setpoints.

.4 Override PID control.

.5 Change time/date.

.6 Add/modify/start/stop weekly scheduling.

.7 Add/modify setpoint weekly scheduling.

.8 Enter temporary override schedules.

.9 Define holiday schedules.

.10 View analog limits.

.11 Enter/modify analog warning limits.

.12 Enter/modify analog alarm limits.

.13 Enter/modify analog differentials.

.3 OT to provide access to real and calculated points in controller to which it is connected or to any other controller in network. This capability

not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and any other controller in network.

.4 Operator access to OTs to the same as OWS user password. Password changes to automatically be downloaded to controllers on network.

.5 OT to provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.6 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.4 Local Control Unit (LCU)

.1 Design to provide control functions for typical HVAC or Hydronic systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 Dos.

.3 Points of one Building System to be connected to one controller as listed in I/O Summary designations.

.4 To comprise of microprocessor capable of supporting necessary software and hardware to meet specified requirements. As per MCU requirements (section 2.4.4) above with the following additions:

.1 Include as minimum 2 interface ports for connection local computer terminal.

.2 Design so that shorts, opens or grounds on any input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (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.

.7 LCU to have 25% spare input and 25% output point capacity without addition of cards, terminals, etc.

2.5 Equipment Control Unit (ECU)

.1 To consist of microprocessor capable of supporting necessary software and hardware to meet ECU functional specifications. ECU definitions to be consistent with those defined in ASHRAE HVAC Applications Handbook, section 45.

2.6 Software

.1 General:

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 To include "firmware" or instructions which are programmed into ROM or EPROM, EEPROM other non-volatile memory.

.3 Include initial programming of all Controllers, for entire system.

.2 Program and data storage:

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

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

.3 Programming languages:

.1 CDL Control Description Logic software to be programmed using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GOTO constructs not allowed.

.4 Operator interface:

.1 MCU to perform operating and control functions specified Section 13841 - EMCS: Operator Work Stations (OWS), including:
.1 Multi-level password access protection to allow user/manager to limit workstation control.
.2 Alarm management: processing and messages.
.3 Operator commands.
.4 Reports.
.5 Displays.
.6 Point identification.

.5 Pseudo or calculated points:
.1 Software to have access to any value or status in controller or other networked controller so as to define and calculate pseudo point from other values/status of controller. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
.2 Inputs and outputs for any process to be able to include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to any number of other processes (eg. cascading).

.6 Control Description Logic (CDL):
.1 Capable of generating on-line project-specific control loop algorithms (CDLs). CDLs to be software based, programmed into RAM or EEPROM and backed up to OWS. The Departmental Representative must have access to these algorithms for modification or to be able to create new ones and to integrate these into sequence of operation descriptions on MCU, LCU from any OWS.
.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (eg. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS or MCU and to tune control loops.
.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of all points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines such as enthalpy control, supply temperature reset, etc. to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional plus integral plus Derivative (PID) control.

.3 Automatic control loop tuning.

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

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

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

.7 Event and Alarm management: The system to use a management by exception concept for Alarm Reporting. This is a system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as a direct result of the primary event to be suppressed by the system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which

are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. The exception is, when an air handler which is supposed to stop or start fails to do so under the event condition.

.8 Energy management programs: The following programs shall include specific summarizing reports, to include the date stamp indicating sensor details which activated and or terminated the feature.

.1 MCU in co-ordination 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).
.8 Peak demand limiting.
.9 Temperature compensated load rolling.
.10 Fan speed/flow rate control.
.11 Night purge.

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

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

.9 Function Totalization: Totalizing 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 Totalization routine to have sampling resolution of one min or less.

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

.10 Analog/pulse Totalization: Totalizing features to provide reports which show daily,

weekly monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 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.

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

.3 Totalization routine to have sampling resolution of one min or less.

.4 User to be able to define warning limit and generate user-specified messages when limit is reached.

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

.1 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

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

.3 User to be able to define warning limit and generate user-specified messages when limit is reached.

2.7 Levels of Address

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

2.8 Point Name Support

.1 Each point name to include; an identifier field for "area", "system", "point" which has at minimum a 25 character string entry, and, point identifier expansion fields which at minimum support 32 character strings for each "system" and "point" identifier. Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for the second language. System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

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

PART 3 - EXECUTION

3.1 Location

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

3.2 Installation

.1 Install Controllers in secure enclosures as indicated.

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

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

.4 DDC controllers and stand-alone DDC control panels shall be connected to emergency power supply circuits as indicated. Co-ordinate with Division 26.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Section 25 05 03 - EMCS: Project Records Documents.

1.2 References

.1 American National Standards Institute (ANSI):
  .1 ANSI C12.7, Requirements for Watthour Meter Sockets.
  .2 ANSI/IEEE C57.13, Requirements for Instrument Transformers.

.2 National Electrical Manufacturer's Association (NEMA):
  .1 NEMA 1.
  .2 NEMA 12.

1.3 Submittals

.1 Submit eight (8) copies of shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 Include:
  .1 Information as specified for each device.
  .2 Manufacturer's detailed installation instructions.

.3 Pre-Installation Tests:
  .1 Submit samples at random from equipment shipped, as requested by the Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.4 Manufacturer's Instructions:
  .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 Closeout Submittals

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

PART 2 - PRODUCTS

2.1 General

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

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, or heat resistant assembly as required by the application.

.3 Operating conditions: 0-32°C with 10 - 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters to be unaffected by external transmitters (eg. walkie talkies).

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in EEMAC 12 enclosures.

.8 Devices to be installed in user occupied space must not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Provide room temperature sensors c/w set point adjust feature (+/- 3 degrees C) and pushbutton override.

2.2 Temperature Sensors

.1 General: except for heat pump control to be resistance or thermocouple type to following requirements:

.1 Thermocouples: to be limited to temperature range of 93°C and over.
.2 RTD's: 100 ohm at 0°C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Co-efficient of resistivity: 0.00385 ohms/ohm °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°C.
.6 Immersion wells: 19mm, (brass) or stainless-steel spring loaded construction, with heat transfer compound compatible with sensor and ABS housing with conduit entrance. Insertion length as required, min. 20% of pipe diameter complete with 6.25mm s.s. probe.

.2 Sensors:
.1 Room type: wall mounting 1500mm above the finished floor, in slotted type covers having brushed stainless steel finish, with guard (where indicated). Element 10-50 mm long with ceramic tube or equivalent protection. Accuracy shall be 0.5°C. Wall mounted box (100 x 50mm) by Division 26.
.2 Room type for heat pumps: as for room type, above.
.3 General purpose duct type: suitable for insertion into ducts at any angle, insertion length 460 mm or as indicated to suit duct dimensions.
.1 6.35mm stainless steel probe of length between one-third and two-thirds of the duct width.
.2 Thermistor or RTD compatible with BMS, sealed in probe with three-part moisture protection system.
.3 BMS shall report the monitored temperature with an accuracy of 0.5°C.
.4 Duct mounted ABS plenum rated housing with conduit entrance.
.4 Averaging duct type: continuous filament with minimum immersion length 6.10 m Bend probe at field installation time to 100mm radius at any point along probe without

degradation of performance.

.1 Probe length of 3.66m minimum or 3.25m per m^2 of duct cross-sectional area, whichever is greater.

.2 Copper sheathed or plenum rated flexible construction.

.3 Thermistor or RTD compatible with BMS.

.4 BMS shall report the monitored temperature with an accuracy of 1.0°C.

.5 Duct mounted ABS plenum rated housing with conduit entrance.

.6 Suitable supports at all bends and at intermediate points to prevent movement in the air systems.

.5 Outside air type: complete with probe length 100mm - 150mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13mm conduit, weatherproof construction in EEMAC 12 enclosure.

2.3 Temperature Transmitters

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 ohm at 0°C, platinum resistance detectors type sensors.

.2 Power supply: 575 ohms at 24 V DC into load of 575 ohms. Power supply effect less than 0.01 °C per volt change.

.3 Output signal: 4 - 20 mA into 500 ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.

.7 Maximum current to 100 ohm RTD sensor: not to exceed 25 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50°C.

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

.11 Transmitter ranges: Select narrowest range to suit application from

following:
.1 Minus 50°C to plus 50°C, plus or minus 0.5°C.
.2 0 to 100°C, plus or minus 0.5°C.
.3 0 to 50°C, plus or minus 0.25°C.
.4 0 to 25°C, plus or minus 0.1°C.
.5 10 to 35°C, plus or minus 0.25°C.

2.4 Humidity Sensors

.1 Requirements:
.1 Range: 0 - 100% RH.
.2 Operating temperature range: 0 – 70°C.
.3 Absolute accuracy:
.1 Duct sensors: plus or minus 2%. Provide 60 micron NDPE filter.
.2 Room sensors: plus or minus 2%.
.4 Sheath: stainless steel with integral shroud for specified operation in air streams of up to 10 m/s.
.5 Maintenance: by simple field method such as washing with solvent or mild detergent solution so as to remove anticipated airborne contaminants.
.6 Maximum sensor non-linearity: plus or minus 2% RH with defined curves.
.7 Room sensors: wall mounted as indicated.
.8 Duct mounted sensors: locate so that sensing element is between 2/3 distance across any duct dimension.
.9 Sensors to be unaffected by external transmitters such as walkie-talkies. Demonstrate to the Departmental Representative.
.10 Reverse voltage protected and output limited. 4 - 20 mA, 2 wire, 0 - 10V DC and 0 - 5V DC output capability. 24V power supply.

2.5 Combination Relative Humidity and Temperature Sensors

.1 Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, the BMS Contractor has the option to provide a combination relative humidity sensor and temperature sensor. The individual sensors must each meet the specification details above.

2.6 Static Pressure Sensor - Duct Mounted

.1 Provide duct mounted static pressure sensors as indicated within the field termination schedules and/or control diagrams. Static pressure sensors shall meet, at minimum, the following requirements:

.1 Input range shall be appropriate for the application. Select range such that it covers from zero duct static pressure relative to the exterior of the duct up to a static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered in the duct relative to the duct exterior. Typically, for low pressure commercial duct consider using a range of 0 to 500 Pa, for medium pressure duct use a range of 0 to 1500 Pa and for high pressure duct use a range of 0 to 2500 Pa.

.2 4 - 20 mA, 0-5 or 0-10V DC output proportional to pressure input range compatible with BMS system.

.3 1% full scale output accuracy.

.4 Operating temperature range of 0°C to 60°C.

.5 Easily accessible, integral non-interacting zero adjustment.

.6 Minimum over pressure input protection of two times rated input or 7 kPa whichever is greater.

2.7 Low Limit Temperature Cutout

.1 Minimum 6.10m vapour pressure type sensing element.

.2 Two circuit type with SPST switch action for each circuit.

.3 One circuit to fan shutdown. Other circuit to DDC system.

.4 Manual reset.

.5 Minimum contact rating of 15 amps at 120V AC.

2.8 Damper End Switches

.1 Activated by damper blade movement and mounted securely on damper frame.

.2 Rotary action steel slotted lever with plastic roller.

.3 Two electrically isolated single pole changeover micro switches.

.4 Contact rating of 10 amperes at 120V AC.

.5 CSA approved and bear a ULC label.

2.9 Control Transformers

.1 Indoor type MC enclosed style, single phase 50 VA - 5000 VA.

.2 Features:
- .1 Rugged split side covers provide easy access to wiring compartments and allow installation with either solid or flexible conduit.
- .2 Attractive aluminum side supports enhance heat dissipation capability.
- .3 Many multi-voltage primary and secondary models increase range of applications per unit.
- .4 Solidly fixed terminals with standard combination screw connections facilitate wiring.
- .5 All terminals clearly identified with additive polarity markings.
- .6 Every coil bobbin wound for greater efficiency and superior heat evacuation capability.
- .7 All models built with heat-proof insulation for compact size and long life.
- .8 Standard electrical knockouts and double “D” fuse knockouts are provided on all units.
- .9 All units can be mounted either vertically or horizontally.
- .10 All units CSA certified.

2.10 Pressure/Current P/I) Transmitters

.1 Requirements:
- .1 Range: to suit application. Operating point ideally at mid span of range.
  - .1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.
  - .2 Internal materials: suitable for

continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA 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°C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Accuracy: plus or minus 1% of Full Scale.

2.11 Differential Pressure (kPa) Transmitters

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.

.2 Output signal: 4 - 20 mA 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°C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 The unit to have a 13 mm N.P.T. conduit connection. The enclosure shall be an integral part of the unit.

2.12 Differential Pressure (Pa) Transmitters

.1 Requirements:
- .1 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .2 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
- .3 Integral zero and span adjustment.
- .4 Temperature effects: not to exceed plus or minus 1.5% full scale/ 50°C.
- .5 Output short circuit and open circuit protection.
- .6 The unit to have a 13mm N.P.T. conduit connection. The enclosure shall be an integral part of the unit.
- .7 Pressure ranges: To suit application, operating point ideally at mid span of range.

2.13 Electrical Relays

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

2.14 Current Transducers

.1 Requirements:
- .1 Range: to suit application. Operating point ideally at mid span of range.

.2 Purpose: measure line current and produce proportional signal in one of following ranges:
- .1 4-20 mA DC.
- .2 0-1volt 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 the MCC.

2.15 Current Sensing Relays

.1 Requirements:

.1 Complete with metering transformer ranged to match load, plug-in base and shorting shunt to protect current transformer when relay is removed from socket.

.2 Suitable for single or 3 phase metering into single relay.

.3 To have adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level.

.4 3-Phase application: provide for discrimination between phases.

.5 To have adjustable latch level to allow detection of worst case selection. To be powered from control circuit of motor starter being metered. Relay and base to be mounted in adjacent auxiliary cabinet only if control circuit power to be brought into auxiliary cabinet. Adjustments to be acceptable from auxiliary cabinet. Self-powered with no insertion loss; dust proof housing.

.6 Relay contacts: capable of handling 10 amps at 240V AC.

.7 Unit complete with LED indication of relay status.

2.16 Control Dampers

.1 Refer to Specification Section 23 33 15, Dampers - Operating. All control dampers shall be supplied by the Controls Contractor and installed by the Ventilation Contractor.

2.17 Electronic Control Damper Operators

.1 Requirements:

.1 Push-pull proportional type as indicated.

.2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.

.3 Operator: size so as to control dampers

against maximum pressure or dynamic closing pressure (whichever is greater).

.4 Power requirements: 5 VA maximum at 24V AC.

.5 Operating range: 0 - 20 V DC.

.6 Isolation room damper actuators shall be fast-acting type.

2.18 Panels

.1 Either free-standing or wall-mounted enamelled steel cabinets with hinged and key-locked front door.

.2 To be modular multiple panels as required to handle requirements with additional space to accommodate future capacity as required by the Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.19 Quality Assurance

.1 Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of laboratory systems and shall be the manufacturer's latest standard design that complies with the specification requirements.

.2 Standard one year warranty period, starting on the date of the Departmental Representative's acceptance. Any materials or system performance problems within that one-year period shall be corrected by the manufacturer at no cost to the Departmental Representative.

.3 Supplier shall have an in-place support facility within 500 km of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

.4 Installation, as well as the start-up, checkout and commissioning shall be by full time employees of the control system manufacturer and shall be fully trained by the system manufacturer.

PART 3 - EXECUTION

3.1 Installation

.1 This contractor shall install and terminate all low voltage control wiring between each controller and all control and sensing devices, and provide 24 VAC power where required by the controllers and control devices.

.2 The controls contractor shall provide the 120 volt power circuits from the electrical panels to the ceiling spaces for connection to the controls equipment. Refer to the electrical drawings for electrical panel locations. Spare circuits have been allocated for the controls within each electrical panel.

3.2 System Start-up

.1 System start-up shall be provided by factory certified and trained employees of the laboratory and animal ventilation control system manufacturer. Start-up shall include the following:

.1 Determine when the HVAC equipment and physical space is ready for operational testing.

.2 Verify heat pump system performance.

.3 Verify room airflow tracking performance.

.2 All steps of system start-up shall be formally recorded when performed and provided to the Departmental Representative as part of the as built documentation.

3.3 Training

.1 The contractor shall provide competent instructors to give complete and specific on site instruction to the Departmental Representative in the adjustment, operation and maintenance of the installed system, in lieu of a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter and the installed system. All training shall be held on weekdays during the normal work hours of 8:00 a.m. to 4:30 p.m.

.2 Training shall consist of not less than 16 hours for the Departmental Representative. Training shall include:

.1 Explanation of as built drawings, overall system operation and user required maintenance.
.2 A thorough walk-through of the job to locate control components.
.3 Explanation of adjustment, calibration and replacement procedures.

.3 Since the Departmental Representative may desire that specific personnel have more comprehensive understanding of the system and its components; additional training shall be available from the Contractor at a future agreeable date.

3.4 Building Automation System Interface

.1 Information may be transmitted electronically through protocol translators, seamless LAN connection, or through a direct connection (hard wire). If the direct connection approach is used, this contractor shall be responsible for all wiring and any additional building automation and laboratory/animal systems control panels required. If the electronic approach is used, this contractor shall be responsible for all network wiring and any protocol translators required by the building automation and laboratory/animal systems.

.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 all cases when dissimilar metals make contact.

.4 Support field-mounted transmitters, sensors on pipe stands or channel brackets.

.5 Install sensors in accordance with the manufacturers recommendations to sense the variables specified.

.6 Mount sensors securely. Mountings shall be suitable for the environment within which the sensor operates.

.7 Install sensors as required to properly sense the controlled medium. Sensor locations shall be such that access to the instruments can be obtained for service and removal. If the installation location is found to be unacceptable by the Departmental Representative, then the sensors shall be re-located as directed at no additional cost to the Departmental Representative.

.8 Sensors mounted on water lines shall have isolation valves that shall enable the sensor to be easily removed without the need to drain any lines or portions of lines.

3.5 Temperature and Humidity Sensors

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 To be readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:
- .1 Protect from solar radiation and wind effects by stainless steel shields.
- .2 Install in NEMA 12 enclosures.

.4 Duct installations:
- .1 Do not mount in dead air space.
- .2 Location to be within sensor vibration and velocity limits.
- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors:
- .1 Sensor length to be not less than 1000 mm per square metre of duct cross-sectional area.
- .2 Use multiple sensors where single sensor

does not meet minimum length ratio. Wire multiple sensors in series for freeze protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.

.5 Thermowells: install for piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.

3.6 Panels

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Use modular multiple panels if necessary to handle all requirements, with space for additional 25% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).

.3 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.4 Identify wiring and conduit clearly.

3.7 Pressure and Differential Pressure Switches

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

3.9 Identification

.1 Identify field devices properly.

3.10 Testing

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

END OF SECTION