1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)
- .1 ANSI/ISA S5.5-1985, Graphic Symbols for Process Displays.
- .2 ANSI/IEEE 260.1-1993, 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-C22.2No.0-M91(R1997), General Requirements, Canadian Electrical Code, Part II.
- .2 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.

.3 Electrical and Electronic Manufacturers Association (EEMAC)
- .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

1.2 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 CAD - Computer Aided Design
- .5 CDL - Control Description Logic
- .6 COSV - Change of State or Value
- .7 CPU - Central Processing Unit
- .8 DI - Digital Input
- .9 DO - Digital Output
- .10 ECU - Equipment Control Unit
- .11 EMCS - Energy Monitoring and Control System
- .12 HVAC - Heating, Ventilation, Air Conditioning
- .13 IDE - Interface Device Equipment
- .14 I/O - Input/Output
- .15 ISA - Industry Standard Architecture
- .16 LAN - Local Area Network
- .17 LCU - Local Control Unit
- .18 LonTalk - Echelon Corporation (proprietary protocol)
- .19 MCU - Master Control Unit
- .20 OS - Operating System
- .21 O&M - Operation and Maintenance
- .22 OWS - Operator Work Station
- .23 POT - Portable Operator Terminal
- .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.

1.3 GENERAL DESCRIPTION

.1 Refer to specifications for system architecture.

.2 All new work and modifications to existing Andover EMCS system shall be performed by a control company qualified to perform this work. All work shall be done in accordance with OWNER building standards as established in former renovations. All new work must communicate through and be controlled through the existing EMCS system. Stand alone systems shall not be allowed.

.3 Maintain labeling conventions for all thermostats, controllers and sensors.

.4 EMCS contractor shall update graphics and front end to reflect as built conditions. CAD plans will be provided to the contractor for this purpose.

.5 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
.1 Building Controllers MCU, LCU.
.2 Control devices as listed in I/O Summaries.
.3 OWS and POT.
.4 Data communications equipment necessary to effect an EMCS data transmission system including gateway and LAN hardware and software for connection to BACnet network.
.5 Field control devices.
.6 Software complete with full documentation for software and equipment.
.7 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.
.8 Acceptance tests, technical support, full documentation.
.9 Wiring interface co-ordination of equipment supplied by others.
.10 Miscellaneous work as specified in these sections and as indicated.
.11 Full local and remote access through any standard Internet web browser. Access shall require username and password to log in. Building operator can limit any user's ability to make changes.

.6 Provide and install all necessary transducers, interposing relays, interface devices, contactors, and starters to perform control functions required.

.7 It is the responsibility of the contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

.8 Items required but not identified at the time of tender acceptance shall be the

Contractor's responsibility.

1.4 METRIC REFERENCES

.1 Conform to CAN/CSA-Z234.1.
.2 Provide required adapters between Metric and Imperial components.

1.5 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.
.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 Engineer, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by an organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

1.6 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 Engineer prior to installation.
.3 Location of controllers to be approved by Engineer prior to installation.
.4 Provide emergency power to controllers & controls devices from spare breakers in 120v emergency panels.

1.7 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 wherever possible. All other information to be in English.
.3 Operating system executive: primary hardware-to-software interface (specified as part of hardware purchase) 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 re-definements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points.

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

1.8 MATERIALS DELIVERY SCHEDULE

.1 Provide Engineer with "Materials Delivery Schedule" within 2 weeks after award of Contract.

1.9 WORK BY OTHER TRADES

.1 Electrical shall provide all wiring 120V and above.

.2 mechanical shall install thermal wells, control valves and devices on piping, duct mount air flow stations, furnished by EMCS Contractor.

.3 EMCS contractor shall provide all control wiring below 120V unless specifically noted otherwise. This includes wiring from dedicated breaker panels to control panels, LCUs, MCUs and OWS.

.4 EMCS Contractor shall provide all low voltage wiring from transformers to faucets for hands-free faucets. Division 16 shall provide wiring to transformers from panels.

.5 Unless noted otherwise in contract documents, control dampers integral with the air handling unit are supplied by air handling unit manufacturer. Damper operators are supplied and installed by EMCS Contractor. All other control dampers are supplied by EMCS Contractor.

.6 Electrical shall supply and install all controls and related wiring, accessories and programming associated with Utility Monitoring System specified in their respective specification sections.

.6 Fully co-operate with other trades for compatibility and installation location of all devices.

1.10 CUTTING AND PATCHING

.1 Submit written request in advance of cutting or alteration which affects:

.1 Structural integrity of any element of Project.

.2 Integrity of weather-exposed or moisture-resistant elements.

.3 Efficiency, maintenance, or safety of any operational element.

.4 Visual qualities of sight-exposed elements.

.5 Work of Owner or separate contractor.

.2 Perform cutting, fitting, and patching to complete the Work using qualified trades specified.

.3 Remove and replace defective and non-conforming work.

.4 At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated material, full thickness of construction element.

.5 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.

2 Products

2.1 CONTROL PANELS

.1 Provide control panels of unitized cabinet type construction. Mount relays, switches and controllers with control point adjustment in cabinet.

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

.3 Fabricate panels from 2.5 mm rolled sheet metal sheet with baked enamel finish, flush fitting, gasketted doors with three point latches and locking handles. CSA approved for line voltage applications.

.4 Mount panels on vibration-free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face, as per Specifications.

.5 All cabinets shall have identical key and lock sets.

.6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.

.7 Provide a separate fused disconnect for isolation of all panel mounted instruments requiring a 120 volt supply.

.8 Provide a separate fused disconnect for each PCU.

.9 Make all wiring connections for panel mounted devices to numbered terminal blocks.

.10 Identify all wiring by means of stamped markings on heat shrinkable tubing. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.

.11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.

.12 Provide emergency power to all DDC system panels that control or monitor systems.

.13 Control Panel UPS. Each Control Panel shall be complete with integral UPS. Acceptable unit: APC SMART series UPS- sized to provide 30 minutes of normal operation.

.13 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.

2.2 WIRING

.1 Control wiring for digital functions shall be 18 AWG minimum with 300 Volt insulation.
.2 Control wiring for analog functions shall be 18 AWG minimum with 300 Volts insulation, twisted 2 or 3 wire to match analog function hardware.
.3 Sensor wiring shall be 18 AWG minimum twisted 2 or 3 wire to match analog function hardware or 16 AWG as required by code.
.4 Power wiring shall be 16 AWG minimum.
.5 For other wiring conform to Electrical Specifications.
.6 All wiring shall be plenum-rated.

3 Execution

3.1 GENERAL INSTALLATION

.1 Installation to be to manufacturer's recommendations. Provide printed copies of recommendations with shop drawings or product data.
.2 The installation shall conform to the Canadian Electrical Code and all applicable codes and regulations to the approval of authorities having jurisdiction.
.3 Electrical wiring and devices shall be installed by trade-certified electricians.
.4 Install all equipment, accessories, conduit, interconnecting wiring and piping in a neat manner following building grid lines.
.5 Install equipment so that it is stable and fixed to wall or floor. Provide anti-vibration mounts for the proper isolation of the equipment.
.6 Install equipment to allow for easy maintenance access such that it does not interfere with access to adjacent equipment and personnel traffic in the surrounding space.
.7 Mount all field devices (i.e. relays, transducers, etc.) in a control panel.
.8 All equipment shall be installed in the ambient conditions for which it was designed.
.9 Verify location of temperature sensors and other exposed control sensors with drawings before installation. Locate space sensors 1500 mm above the floor.
.10 Install damper motors on outside of ducts. Do not locate in outside air stream.
.11 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.
.12 Install all outdoor air sensors on the North exposure of the building.
.13 Install all safety limits for easy access at the operators level.
.14 Provide hardwire interlocking capability for all mechanical systems operated from the fire alarm system. Capability shall include terminal box and damper control as well as freezestat override on operating air systems.
.15 Co-operate with the construction team to keep the job site clear of waste material and rubbish.
.16 Coordinate activities and co-operate at all times with the Owner and other contractors on the site.
.17 All points associated with a single zone or system shall be connected to the same stand-alone panel.
.18 Set control points and test safety devices immediately after start-up of systems.

.19 Locate Room Thermostats, Space Temperature sensors and Humidity sensors according to the following criteria:
- .1 All room thermostats to be located at the same height, 1500 mm above the floor.
- .2 On interior partitions or walls.
- .3 Away from direct exposure to sunlight and heat-producing sources.
- .4 Away from draughts or dead pockets of air.
- .5 The preferred location is near the light switch by the entrance door, if it is on an interior wall.
- .6 Coordinate exact height of thermostats with file cabinets, furniture and partitions to avoid covering of thermostats. General contractor shall be responsible for identifying

.6 Confirm the location of all thermostats and sensors with the Engineer.

3.2 EMERGENCY POWER

.1 Provide 120 V power to all EMCS components from extra panel space in 120V emergency power panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.

3.3 PAINTING

.1 Painting to be in accordance with Interior Painting, supplemented as follows:
.2 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
.3 Restore to new condition, finished surfaces which have been damaged too extensively to be primed and touched up to make good.
.4 Clean and prime exposed hangers, racks, fastenings, and other support components.
.5 Paint all unfinished equipment installed indoors to CEMA 2Y.1.

3.4 CONDUIT AND CABLE TRAYS

.1 All wiring in mechanical rooms shall be in conduit or trays. Conform to Electrical Specification requirements for conduit and tray specifications.
.2 All power and communication wiring to be fire rated plenum cable to meet building fire and electrical code. Communication wiring in ceiling spaces shall be run in cable tray whenever possible. Cable shall be fastened to the structure and follow building grid lines. Cable left lying on the ceiling system is not acceptable.
.3 Seal conduit where such conduit leaves heated areas and enters unheated area.
.4 In field panels, run low level signal lines in separate conduit from high level signal and power transmission lines.
.5 Identify each cable and wire at every termination point.
.6 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.

.7 Identify all conductors and conduits with permanently applied color bands and labeling in accordance with Electrical Specifications.

3.5 WARRANTY PERIOD WORK

.1 Provide a minimum of four tuning service calls of a minimum of eight hours to tune the control loops and calibrate the control devices during the warranty period.
.2 Provide printed graphical trends of all analog points connected to the EMCS at the start of the first heating and the start of the first cooling season. Trends to be grouped and organized by system.
.3 Update the backup of the system after each system tune-up visit.
.4 Supply and install all system software and hardware updates occurring prior to the expiration of the warranty period.
.5 At the end of the warranty period update all documentation and provide a complete system backup.
.6 Refer to Commissioning specifications for additional Warranty period work.

3.6 RELATED ACCESSORIES

.1 Provide air gauges on all electronic/pneumatic transducer outputs.
.2 Provide stainless steel wells for domestic water, pool water and corrosive liquid applications.
.3 Provide brass wells for chilled and heating water applications.

End of Section

1 General

1.1 DESIGN REQUIREMENTS

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

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with EMCS: Shop Drawings, Product Data and Review Process.

.2 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

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

.4 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

.5 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 termination, signal levels, pressures where new EMCS ties into existing control equipment.
  - .3 Spare point capacity of each controller by number and type.
  - .4 Controller locations.
  - .5 Auxiliary control cabinet locations.
  - .6 Single line diagrams showing cable routings, conduit sizes, spare 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 drop, 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.

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

.10 Compressor schematic and sizing data.

.6 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 for equipment to be supplied by others.

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

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Pneumatic schematics and schedules.

.5 Complete Point Name Lists.

.6 Set points, curves or graphs and alarm limits (high and low, 3 types), signal range.

.7 Software and programming details associated with each point.

.8 Manufacturer's recommended installation instructions and procedures.

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

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

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

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

.9 Listing and example of reports.

.10 Listing of time schedules.

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

.12 Full description of software programs provided.

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

purposes.

.14 Outline of proposed start-up and verification procedures. See also EMCS: Start-up and Check Out.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED

.1 Not Used.

End of Section

1 General

1.1 GENERAL

.1 Conform to requirements of 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 Closeout Submittals

1.2 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, set points, reset curves, schedules.
- .5 Final Points list.

.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 1 non-fading "As-Built" copy showing control and/or adjustment procedures. Enclose in aluminum frame with non-glare glass cover.

1.3 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 4 soft copies and 4 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 1 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 or planned for implementation in automatic mode.

.6 System operation to include:
.1 Complete step-by-step procedures for operation of system including required actions at each OWS.
.2 Operation of computer peripherals, input and output formats.
.3 Emergency, alarm and failure recovery.
.4 Step-by-step instructions for start-up, back-up equipment operation, execution of 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.

1.4 PANEL MANUALS

.1 Provide a panel manual at each panel location with as-built control drawings, sequences of operation, points list, flowcharts, portable operator terminal user guide.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED.

.1 Not Used.

End of Section

1 General

1.1 GENERAL

.1 Provide identification for all control items in accordance with Identification.

1.2 REFERENCES

.1 Canadian Standards Association (CSA)
.1 CSA C22.1-1998, The Canadian Electrical Code, Part I.

1.3 SUBMITTALS

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

1.4 POINT NAMING CONVENTION

.1 Supplied equipment shall be labeled with a standardized naming convention. Mechanical, electrical and control equipment labels shall use the following nomenclature for EMCS system point descriptors, engineering drawings, sequences of operation, graphics and for program code.

.2 System:
.1 Format:

	Mnemonic	System
.1	B01	Boiler 1 System
.3	BF	Boiler Feed Water
.4	CR	Condensate Return
.5	HTG	Hot Water Heating System
.6	MUA	Make-up Air System
.7	CLG	Cooling Distribution System
.8	CT	Cooling Tower System
.9	AHU	Air Handling Unit
.10	CAV	Constant Air Volume Fan System
.11	VAV	Variable Air Volume Fan System
.12	DD	Dual Duct Fan System
.13	DHW	Domestic Hot Water System
.14	DCW	Domestic Cold Water System
.15	GEN	Emergency Generator
.16	FIRE	Fire Alarm/Sprinkler System
.17	CRV	Chiller Room Ventilation System
.18	STR	Sprinkler Tree Room System
.19	ASE	Atrium Smoke Exhaust System

.20	PSC	Pedway Pressurization System
.21	FP	Fountain Pump System
.22	LBY	Lobby System
.23	UTL	Utility System

.4 Equipment:

.1 Format:

	Mnemonic	Equipment
.1	CH	Chiller
.2	CT	Cooling Tower
.3	B	Boiler
.4	STB	Steam Boiler Humidifier
.5	P	Pump
.6	EW	Enthalpy Wheel
.7	CV	Control Valve
.8	DX	Direct Expansion Cooling Stage
.9	TK	Tank
.10	AS	Air Separator
.11	HX	Heat Exchanger
.12	SF	Supply Fan
.13	RF	Return Fan
.14	EF	Exhaust Fan
.15	FH	Fume Hood
.16	TB	Terminal Box
.17	FC	Fan Coil
.18	RTU	Roof Top Unit
.19	MAD	Mixed Air Dampers
.20	OAD	Outside Air Damper
.21	EAD	Exhaust Air Damper
.22	DMP	Damper and 2-Position Actuator
.23	CCV	Cooling Coil Valve
.24	HCV	Heating Coil Valve
.25	UH	Unit Heater
.26	VFD	Variable Frequency Drive
.27	DDB	Dual Duct Box
.28	SMP	Sump Pump
.29	HUM	Humidifier
.30	FF	Force Flow
.31	TF	Transfer Fan

.5 Digital Output (DO) Control Points:

.1 Format:

	Mnemonic	DO Point Type
.1	SF	Supply Fan

.2	RF	Return Fan
.3	EF	Exhaust Fan
.4	FH	Fume Hood
.5	TB	Terminal Box
.6	P	Pump
.7	B	Boiler
.8	DX	Direct Expansion Cooling Stage
.9	DMP	Damper and 2-Position Actuator
.10	FAN	Fan
.11	SMH	Sump Heater
.12	EN	Enable
.13	LOW	Low Speed Fan
.14	HI	High Speed Fan

.6 Digital Input (DI) Control Points:

.1 Format:

	Mnemonic	DI Point Type
.1	SF	Supply Fan Status
.2	RF	Return Fan Status
.3	EF	Exhaust Fan Status
.4	FAN	Fan Status
.5	CP	Cooling Coil Pump Status
.6	HP	Heating Coil Pump Status
.7	LL	Low Limit Status
.8	ALM	Alarm
.9	OCC	Occupancy Sensor
.10	UO	Unoccupied Override Switch
.11	SHH	Supply Air Humidity High Limit
.12	DMP	Damper Status
.13	FLW	Flow
.14	FC	Fan Coil Status
.15	HUM	Humidifier Status
.16	ERH	Electric Re-heat Status
.17	SMK	Smoke Detector Status
.18	FIRE	Fire Alarm Status
.19	SEF	Smoke Exhaust Fan Status
.20	TF	Transfer Fan Status
.21	DXF	DX Fan Status
.22	DXCP	DX Compressor Status
.23	DXCD	DX Condenser Status

.7 Analog Output (AO) Control Points:

.1 Format:

	Mnemonic	AO Point Type
.1	MAD	Mixed Air Dampers

.2	OAD	Outside Air Damper
.3	EAD	Exhaust Air Damper
.4	CV	Control Valve
.5	VFD	Variable Frequency Drive
.6	WS	ERW Wheel Speed
.7	FAN	Fan Speed

.8 Analog Input (AI) Control Points:

.1 Format:

	Mnemonic	AI Point Type
.1	OAT	Outside Air Temperature
.2	MAT	Mixed Air Temperature
.3	SAT	Supply Air Temperature
.4	PHT	Preheat Air Temperature
.5	RAT	Return Air Temperature
.6	CDT	Cold Deck temperature
.7	HDT	Hot Deck Temperature
.8	VDH	Ventilation Duct Humidity
.9	ZT	Zone Temperature
.10	ZH	Zone Humidity
.11	ZSP	Zone Static Pressure
.12	DSP	Duct Static Pressure
.13	RDSP	Remote Duct Static Pressure
.14	CLP	Chilled Water Loop Pressure
.15	HLP	Heating Loop Differential Pressure
.16	RAH	Return Air Relative Humidity
.17	SAH	Supply Air Relative Humidity
.18	SRH	Space Relative Humidity
.19	DDVF	Dual Duct Ventilation Air Flow
.20	DDCF	Dual Duct Cooling Air Flow
.21	DDTF	Dual Duct Total Air Flow
.22	BHP	Boiler Header Pressure
.23	ETE	Exhaust Temperature Leaving
.24	ETL	Exhaust Temperature Leaving
.25	STE	Supply Temperature Entering
.26	STL	Supply Temperature Leaving
.27	EHE	Exhaust Humidity Entering
.28	EHL	Exhaust Humidity Leaving
.29	SHE	Supply Humidity Entering
.30	SHL	Supply Humidity Leaving
.31	CO2	Carbon Dioxide Level
.32	SWT	Supply Water Temperature
.33	RWT	Return Water Temperature
.34	CST	Condenser Supply Temperature
.35	CRT	Condenser Return Temperature
.36	SMP	Sump Temperature

.37	SMS	Space Moisture Sensor

.9 Virtual Points (VP) Calculated Values:

.1 Format:

	Mnemonic	VP Point Type
.1	FLOW	Flow Meter
.2	KW	Power Meter
.3	KWH	Power Consumption
.4	EFF	Efficiency
.5	EEE	Exhaust Enthalpy Entering
.6	EEL	Exhaust Enthalpy Leaving
.7	SEE	Supply Enthalpy Entering
.8	SEL	Supply Enthalpy Leaving
.9	RER	Wheel Rate of Energy Recovery

.10 Set points (SP):

.1 Format:

	Mnemonic	VP Point Type
.1	MAT.SP	Mixed Air Temperature Set point
.2	SAH.SP	Supply Air Humidity Set point
.3	SASP.SP	Supply Air Static Pressure Set point
.4	C.SP	Zone Cooling Set point
.5	CD.SP	Zone Cooling Differential Set point
.6	H.SP	Zone Heating Set point
.7	HD.SP	Zone Heating Differential Set point
.8	NSB.SP	Night Setback Set point
.9	ZT.SP	Zone Temperature Set point
.10	ZH.SP	Zone Humidity Set point

2 Products

2.1 NAMEPLATES FOR PANELS

.1 Identify faces with laminated plastic nameplates.
.2 Sizes: 25 x 67 mm minimum.
.3 Lettering: 7 mm minimum high, black.
.4 Inscriptions: machine engraved to identify function and, where applicable, fail-safe position.
.5 Nameplates: plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain.
.2 Sizes: 50 x 100 mm minimum.
.3 Lettering: 5 mm 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.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Interior: identify point name on face of cover using stick-on labels.
.2 Exterior: identify point name on face of cover using engraved nameplates.
.3 Sizes: to suit.
.4 Lettering: to suit. Clearly legible.

2.4 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 Engineer's approval.

2.5 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.

2.6 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, 25 mm wide, fluorescent orange. Confirm colour with Engineer during "Preliminary Design Review".

2.7 NAMEPLATES FOR PNEUMATIC TUBING

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

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.

3.2 EXISTING PANELS

.1 Correct existing legends to reflect changes made during work.

End of Section

1 General

1.1 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 BACnet and BACnet LAN/WAN network either directly or through gateway.

1.2 OWS/MCU PANEL SUPPORT

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

1.3 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.

1.4 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 OWS, 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 Acceptable technologies: Ethernet

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED

.1 Not Used.

End of Section

1 General

1.1 TERMS AND DEFINITIONS

.1 Terms used in this section.
- .1 Point Object Type - refers to all points as Object types - AI, AO, DI, DO, TCU, ECU.
- .2 Point Name - when used includes - Point Identifier and Point Expansion.

1.2 OPERATOR INTERFACE DEVICES

.1 Utilize existing system.

1.3 SUBMITTALS

.1 In accordance with EMCS: Shop Drawings, Product Data and Review Process.

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

1.4 ENVIRONMENTAL CONDITIONS

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

1.5 PROJECT RECORDS

.1 In accordance with Section 25 05 03 - EMCS: Project Records and "As-Built" Records.

1.6 OPERATOR INTERFACE

.1 Provide a graphical operator interface.

.2 The operator interface shall include a system of pictorial, flowchart and text graphics to provide the inexperienced user with all the information required to manage building systems, without the use of additional manuals.

.3 The system shall also include a menu driven interface for the experienced user, to enable fast and efficient monitoring and tuning of building systems.
.4 Provide a database back-up procedure, so the system can be easily reinstalled in the event of a hard drive failure. Provide details in shop drawing submission.
.5 Provide all software, firmware and manuals required for a fully functional BMS system.
.6 The owner shall have the capability to monitor and program the entire system without any additional software, information, hardware or interface devices.
.7 The Building Management System shall use a communication system architecture, which is compatible with the size and types of systems being controlled.
.8 Provide a graphical operator interface, with graphical screens designed in accordance with Departmental Representative's graphic standard.
.9 Provide trending for ALL points in the system.

2 Products

2.1 OWS HARDWARE

.1 Primary OWS to be IBM compatible PC with following as minimum configuration:
- .1 Processor:
  - .1 Intel Pentium IV micro-processor
  - .2 Operating at clock speed of 2.5 GHz
  - .3 Capable of supporting software necessary to perform functions specified in this section
  - .4 System backplane bus (100 Megahertz) to support PCI and ISA boards
- .2 Internal clock:
  - .1 Uninterruptible clock having accuracy of plus or minus 5 seconds/month, capable of deriving year/month/day/ hour/minute/second.
  - .2 Rechargeable batteries to provide minimum 48 h clock operation in event of power failure.
- .2 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.
- .3 Power supply unit to accept 120 V 60 Hz source and include line surge and low voltage protection for processor and its peripherals.
- .4 Include UPS to provide 5 minutes minimum operation of PC, CRT and communication and peripheral devices.
- .5 IDE Disk drive controller to support 4 drives.
- .6 40 GB 7200 rpm Ultra ATA Hard Drive.
- .7 8X/4X/32X Read/Write DVD RW Drive
- .8 1 3.5" 120 MB floppy disk drive.
- .9 1 8X/4X/32X CD-ROM drive.
- .10 256 MB RAM minimum.
- .11 Enhanced 101 key MS Windows keyboard.

.12 Microsoft Intellimouse.
.13 Colour monitor:
.1 19" high resolution
.2 Flat Screen LCD
.3 non-interlaced
.4 Super VGA
.5 1280x1024
.6 .28 dot pitch
.13 PCI graphic adapter, 32 MB NVIDIA TNT2 M64 AGP video card.
.14 2 Parallel Ports to support printers.
.15 2 USB ports and 2 serial ports.
.16 System shall have two 2 spare expansion slots for Departmental Representative's use.
.17 Internal Modem - V.90/56K PCI data fax modem.
.18 PCI Ethernet LAN Adapter to connect to local Ethernet LAN network.
.19 200 W minimum power supply.
.20 Backup storage device capable of storing entire database. (Can use DVD-RW if it provides sufficient space)
.21 Creative Labs Sound Blaster sound card.
.22 Harman/Kardon HK-195 speakers
.23 Microsoft Windows XP Professional Operating System software, Latest Edition
.24 Norton Antivirus, Latest Edition
.25 MS Office Latest Edition CD - Small business edition
.26 10/100 Network Adapter
.27 Energy Star compliant
.28 3 year limited warranty. First year to be next business day on site.

2.2 PRINTERS

.1 Report printer: Include features as follows:
.1 Laser printer.
.2 Colour graphics printer: to include following features:
.1 Ink-jet technology capable of printing high quality colour images at speed of 4 pages per minute.
.2 Black cartridge to be separate cartridge from red green blue cartridge.

2.3 CONTROL DESK CONSOLE

.1 Not used.

2.4 OPERATING SYSTEM (OS) OR EXECUTIVE

.1 To manage software operation of OWS.
  .1 OS to support complement of hardware terminals and software programs specified.
.2 Operating System to be true multitasking operating environment. Note: MS DOS or PC DOS based software platforms not permitted.
.3 OWS Software to operate in a "Windows" based operating environment, Windows 2000 Professional.

2.5 OPERATOR'S CONTROL SOFTWARE

.1 OWS Software to consist of the following functional modules as minimum:
  .1 Time Synchronization Module 2.6.2.
  .2 User Display Interface Module 2.6.3.
  .3 General Event Log Module 2.6.4.
  .4 Operator Control Software Module 2.6.5.
  .5 Dial-up Host Module 2.6.6.
  .6 Message Handling Module 2.6.7.
  .7 Access Control Module 2.6.8.
  .8 Trend Data Module 2.6.9.
  .9 Report Generator Module 2.6.10.
  .10 Graphics Display Module 2.6.11.
  .11 Event/Alarm Module 2.6.12.
  .12 Archiving and Restoration Module 2.6.13.
  .13 CDL Generator and Modifier Module 2.6.14.
.2 Time Synchronization Module:
  .1 System to provide Time Synchronization of real-time clocks in Controller's panels. System to perform this feature on a regular scheduled basis and on operator request.
.3 User Display Interface Module:
  .1 OWS software to support "Point Names" as defined for Controller's (MCU, LCU) in section 13848. Each point name shall 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 must include additional point identifier expansion fields of equal capacity for each point name for the second language. The system shall support the use of numbers and readable characters including blanks, periods or underscores to enhance user readability for the above strings.
  .2 Upon operator's request in either text graphic or table mode, system to present condition of any single point, system, area, or connected points on a system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. Refresh rate of screen data not to exceed 5 seconds from time of field change. For systems

supporting (COSV) system to execute supervisory background scan (every 20 seconds) to verify point data value. For other methods, time not to exceed 4 second for points displayed. Initial display of new system graphic display (with up to 30 active points), including the presentation of associated dynamic data not to exceed 8 seconds.

.4 General Event Log Module: to record system activities occurring at OWS or elsewhere in the system including:
- .1 Operator Log-in from any user interface device.
- .2 Communication messages - such as errors and failures and recovery.
- .3 Event notifications and Alarms by category.
- .4 Record of Operator initiated commands.

.5 The General Event Log to be archived as necessary to prevent loss of information. Archiving to occur automatically.

.6 Operator Control Software Module: To support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user to be through use of; Dynamic displays, Textual displays, and Graphic displays to display logging and trending of system information and following tasks:
- .1 Automatic logging of digital alarms and change of status messages.
- .2 Automatic logging of analog alarms.
- .3 System changes (such as alarm limits, set-points, alarm lockouts).
- .4 Display specific point values, states as selected.
- .5 Provide reports as requested and on scheduled basis when required.
- .6 Display graphics as requested, and on alarm receptions (user's option).
- .7 Display list of points within system.
- .8 Display list of systems within building.
- .9 Direct output of information to selected device.
- .10 On-line changes:
  - .1 Alarm limits.
  - .2 Set points.
  - .3 Dead bands.
  - .4 Control and change of state changes.
  - .5 Time, day, month, year.
  - .6 Control loop configuration changes for controller-based CDLs.
  - .7 Control loop tuning changes.
  - .8 Schedule changes.
  - .9 Changes, additions, or deletions, of points and/or graphics, for installed and future systems.
- .11 According to assigned user privileges (password definition) the following functions to be supported:
  - .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or setting to remain in effect until returned to automatic (logic based) control by the operator.
  - .2 Requests for status, analog, graphic displays, logs, controls to be through user interface screens. Use mouse or pointing device to "point and click" for menu selections so as to minimize use of keyboard.
- .12 Data linking software

.1 The Workstation shall incorporate the Microsoft DDE dynamic data exchange function to provide an on-line dynamic link between non-proprietary WINDOWS based software packages i.e. WORD, EXCEL, dBase, etc. and the data base in the PCU's, so all the data base information including trends, summaries, logs, etc. is available for use in these software packages.

.2 The PCU Workstation screen shall be able to operate in background concurrently while the PC is being used for other WINDOWS programs. Any alarm condition shall provide for a 'pop-up' window with choices to be offered.

.3 The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. The mouse shall be used to quickly select the switch between multiple applications. This shall be accomplished through the use of Microsoft Windows NT.

.1 Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows:

- Dynamic colour graphics and graphic control
- Alarm management
- Time-of-day scheduling
- Trend data definition and presentation
- Graphic definition
- Graphic construction
- Split screen - dual graphics

.2 Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:

- Weekly schedules
- Zone schedules
- Monthly calendars

.3 Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller. Similarly, changes made at the DDC Controllers shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

.4 The control system shall be supplied with the following samples to demonstrate the data linking software:

.1 Word - provide two (2) sample logs or summaries that actively link the database.

.2 Excel - provide sample logs to summarize terminal

box readings for design vs. measured volume.

.7 Dial-up host Module for Off site OWSs

.1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.

.2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.

.3 A local OWS may serve as a dial-up host for remotely connecting OWSs , remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.

.4 Communications taking place with remote control systems or OWS over telephone lines to be completely transparent to operator, both local and remote.

.8 Message Handling Module - and Error Messages: Message Handling Module to provide message handling for the following conditions:

.1 Message and alarm buffering to be provided to prevent any loss of information.

.2 Error detection correction and retransmission to be included to guarantee data integrity.

.3 Provide informative messages to operator for errors occurrences of data, errors in keyboard entry, failure of equipment to respond to requests or commands, failure of communications between EMCS devices.

.4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event that designated OWS does not respond.

.9 Access Control to Field Equipment

.1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. The following is preferred format of progression of password levels:

.1 Guest: No password data access and display only.

.2 Operator Level: Full operational commands including automatic override.

.3 Technician: Data base modifications.

.4 Programmer: Data base generation.

.5 Highest Level : System Administration - Password assignment addition, modification.

.2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.

.10 Trend Data Module: Includes Historical data collection utility, Trend data utility, Control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.

.1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate 30-480 minutes. Historical

Data collection samples shall include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 72 h capacity.

.2 Trend data utility to be capable of continuously collecting point object data variables for variables selected by operator, including at minimum; present value of the following point object types - DI, DO, AI, AO, AO set points value, calculated values, and present value of other point objects types; such as terminal control unit controllers eg VAV. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of every 15 seconds over a 24 hour period or every 15 minutes over a seven day period, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum seven day basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available. The graph shall be selected and shown when the point information screen is accessed.

.3 Control Loop Plots: For AO Points provide for the concurrent plotting of the Measured value input - present value, present value of the output, and AO set point. The operator selectable sampling interval to be selectable between 1 second to 20 seconds. The plotting utility to scroll to left as the plot reaches right side of display window. Systems not supporting Control Loop Plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.

.4 Trend data Module to include display of Historical or Trend Data to OWS screen in X Y plot presentation. Plot utility to display 1 Historical or up to 4 selectable points concurrently or 1 Control Loop Plot. For display output of active trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

.5 Provide separate reports for each Trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using Report Generator Module. Trend data to be available in delimited file form for use in third party spreadsheet or database applications for PCs.

.6 Trend graphs shall contain points that are logically related. For example each of the following should be on individual trend graphs:

- All points on the air handling unit associated with temperature.
- All points on the air handling unit associated with humidity.
- All points associated with the hot water heating system.
- All points associated with the chilled water system.
- All points associated with an individual VAV/FCU including AHU supply air temperature and all points associated with wall fin radiation located in the same space should be on the same trend graph.

.7 All points on the systems, including set points shall be trended and set up to record data for seven days.

.8 Trend data shall automatically be archived on the hard drive of the operator workstation.

.11 Report Generator Module

.1 General: The OWS to include special reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at the MCU level. Refer also to Section 25 30 01 - EMCS: Building Controller Family.

.2 Reports to include time, day, month, year, report title, operator's initials.

.3 Software to provide capability to create, to generate, to format for graphic display or printing or temporary and permanent storage. To be able to select and assign points used in such reports. Sort output by Area, System, as minimum. Provide user options for report presentation.

.4 Periodic/automatic report:

.1 To generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.

.2 Reports to include:

.1 Power demand and duty cycle summary: see application program for same.

.2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.

.3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.

.4 Summary of run time alarms: include point name, run time to date, alarm limit.

.5 Summary of start/stop schedules: include start/stop times and days, point name.

.6 Motor status summary.

.5 Report types:

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

.2 Points in accessible from this OWS (total connected for this location), multiple "areas".

.3 Area (points and systems in Area).

.4 Area, system (points in system).

.5 System (points by system type).

.6 System point (points by system and point object type).

.7 Area point (points by system and point object type).
.8 Point (points by point object type).

.6 Summary report: printout or display of any point objet data value selected by operator. Report header to indicate status at time of request. Reports to be available on same basis as Dynamic reports. Provide option as to report type, point name, output device.

.7 Include preformatted reports as listed in Event/Alarm Module 12.3.

.12 Graphics Display Module:

.1 Graphics software utility to permit user to create, modify, delete, file, and recall all graphics required by Section 13846 - Systems Sequences of Operation. System capacity for 100% expansion of system graphics shall be provided. The graphic interface shall provide the user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlaid with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from the graphic system displays by use of mouse or similar pointing device.

.2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). To include capability to call up and cancel display of any graphic picture.

.3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols. Graphic displays shall be consistent with Departmental Representative standard system graphics.

.4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:

.1 Modify portion of graphic picture/schematic background.
.2 Delete graphic picture.
.3 Call up and cancel display of graphic picture.
.4 Define symbols.
.5 Position and size symbols.
.6 Define background screens.
.7 Define connecting lines, curves.
.8 Locate, orient, size descriptive text.
.9 Define, display colours of all elements.
.10 Establish co-relation between symbols or text and associated system points or other graphic displays.

.5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.

.6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

.7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.

.8 Contractor to utilize graphics package to generate system schematic diagrams as required in Section 13846 - Systems Sequences of Operation, and as directed by Engineer. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and , flow sensor. Diagram to be single line schematic of ductwork as well as any associated heating coil or radiation valve. CAD floor layouts to be provided by Engineer. Contractor to provide display of TCU - VAV's in table form, include the following values as minimum; Space Temp, Set point, mode, actual flow, min flow set point, max flow set point, cooling signal value, and heating signal value. Table to be organized by rooms and floor groupings.

.9 Provide complete directory of system functions, list of system graphics, and other pertinent information. Utilize mouse or pointing device to "point and click" to activate selected function.

.10 Manual or automatic display of graphics. Automatic display to occur as a result of user-definable events:

.1 Alarm occurrence.

.2 Change of state.

.3 Specific time, day or date.

.13 Event/Alarm Module :Alarms as received are stored in General Event Log and to be displayed in Event/Alarm Window.

.1 Alarms to be classified as "critical", "cautionary", "maintenance". Personnel having required password level to be able to designate alarms and alarm classifications.

.2 Presentation of alarms to include features identified under applicable report definitions of report program paragraph.

.3 Alarm reports to include:

.1 Summary of points in critical alarm. Include at least point name, alarm type, current value, limit exceeded.

.2 Summary of points in maintenance alarm. Include at least point name, alarm type, current value.

.3 Analog alarm limit summary: include point name, alarm limits, deviation limits.

.4 Summary of alarm messages: include associated point name, alarm description.

.4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.

.5 EMCS to notify operator of occurrence of alarms originating at any field device within the following time periods of detection:

.1 Critical - 5 seconds.
.2 Cautionary - 10 seconds.
.3 Maintenance - upon operator's request.

.6 Display alarm messages in English.

.7 Primary alarm message to include as minimum: location of alarm, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide operator-editable secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

.8 System reaction to alarms: alarm annunciation to be by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Steady state to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of any type of alarm not to impede notification of subsequent alarms or the function of Controller's/CDL. Random occurrence of alarms must not cause loss of any alarm or over-burden system. Acknowledgement of one alarm not to be considered as acknowledgement of any other alarms.

.9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
.1 Controller not responding - where possible delineate between controller and communication line failure.
.2 Controller responding - return to normal.
.3 Controller communications bad - high error rate.
.4 Controller communications normal - return to normal.

.10 Digital/alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.

.14 Archiving and Restoration Module

.1 Primary OWS to include services to store back-up copies of controller databases. Complete backup of OWS software and data files shall performed at time of system installation and at time of final acceptance. Backup copies to be made before and after Controller's revisions or major modifications.

.2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of the need to download copy data base to restore proper operation.

.3 Data base back-up and downloading to occur over LAN without specialized operator technical knowledge. Operator to be able to manually download entire controller data base, or parts thereof as required.
.1 Complete saving of the entire database. In the case of a hard drive failure the operator shall be able to re-load all the information required to bring up the system from a single back-up media, excluding the operating system.

.15 CDL Generator and Modifier Module

.1 CDL Generator module to permit generation and modification of CDL's in use on the Automation network.

.2 For text based systems, module to include standard reference modules to permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.

.3 For systems using graphical environment for creation of downloadable code for AC devices, the module to include a full library of symbols used by manufacturer for system product installed accessible to the staff of Departmental Representative. Module to include graphic tools required to generate and create new object code for downloading to AC devices.

.4 Module to permit testing of code before downloading to AC device.

.16 PCU SOFTWARE

.1 Operator access

.1 The OWS shall provide full system access to the networked PCU panels through a split screen formatted, self-prompting, menu driven English language interface.

.2 The menu format shall consist of a main menu and as many sub-menus as required to provide full system access and control.

.3 Each menu layer shall be capable of being security protected as defined under the operator access levels.

.4 After system sign-on has been completed correctly with user ID and password at the access level the main menu shall automatically appear.

.5 From the main menu the operator shall be allowed to the level of access approval:

.1 Determine the operating condition of all PCU's on the system.

.2 Define critical and non-critical alarms for the purpose of having critical alarms designated to the modem for remote annunciation.

.3 Alarm summaries to automatically print point descriptor, time of alarm, type of alarm, and value or status at alarm condition.

.6 All required operational changes such as modify, edit, delete, add, and save shall be available through the split screen format on each individual menu and sub-menu.

.2 Operator access levels

.1 Provide a minimum of four operator access levels to the system through the use of user-defined passwords.

.3 Database creation and modification

.1 Provide software for full programming and database creation and modification on the operator workstation.

.2 Provide the capability to assign a wide variety of custom engineering units for each type of point.

.3 Provide links in the database and DDC programs such that if a point name is changed in the database that all occurrences of that point will be changed automatically.

.4 Provide override capability for all physical and virtual points in the system.

.4 Point control loops

.1 Provide analog point control loops, resident in each PCU including a three term, proportional, integral, derivative, (PID) control algorithm.

.2 Provide, in each control loop, the ability to tune the system.

.5 User control language

.1 Provide a system with a high-level control language that is capable of executing complex control routines, logic and mathematical relationships.

.2 The system shall have a large library of built-in control routines and modules.

.3 The system shall allow the user to add, delete and modify the user control language, in any PCU on the network, at any terminal including from a remote location via modem.

.4 The final control programs and point database shall reside in the PCU.

.6 Monitoring functions

.1 System Initiated.

.1 Alarm Processing and Reporting: Provide alarm processing and reporting to user-defined peripherals.

.2 Digital Alarms: Define which contact state is alarm state. Provide automatic disabling of alarm at shut down and adjustable time delay during start-up. Equipment control points shall have a DI status point associated with them to check for successful control actions. Each control/status pair may have a unique, operator selected, time delay assigned to it. If the status point has not reached the correct state within the delay period, an alarm shall be raised.

.3 Analog Alarms: Provide for each analog point user-definable high and low alarm limits which can be programmed to automatically adjust with a change in set point. Provide automatic disabling of alarm at shut down and adjustable time delay during start-up.

.4 Critical vs. Non-Critical: Alarms shall be designated as Notification, Maintenance, Critical or Security and are annotated as such when transmitted. All transmitted

annunciated alarm messages are logged with time tag, point label, current value, and alarm value that was exceeded.

.5 When the point goes into alarm, a user defined alarm message of not less than 50 characters in length shall be sent to an OWS monitor and printer.

.6 Provide alarm points as shown in the points list complete with required initiating equipment for signaling to the operator workstation and printer.

2.6 WEB SERVER

.1 General

1. The Controls Systems shall support multiple remote Web based User Interfaces through a Web Server.
2. The Web Server shall support an unlimited number (non simultaneous) of remote Web based User Interface(s) utilizing a mix of local Intranet, the Internet, telephone and cable modem connections.

.2 Web Server

1. The Web Server shall be provided with all required and installed operating system, Browser, management, end user, and application specific software and database support facilities, including the associated original manufacturer software licenses. All software shall be to the original manufacturer's latest revision level at the time of delivery to Project site.
2. The Web Server hardware and software configuration shall be selected to support the number of installed Network and Application Nodes.
3. The Web Server shall include either a software or hardware firewall.

.3 Web Based User Interface

1. The Web Interface(s) shall be provided to operate through an IT industry standard Web Browser such as Internet Explorer or Netscape.
2. The Web Interface(s) provided shall incorporate complete tool sets, operational information displays, multi-Window displays and other interactive aids to assist interpretation and ease of use.
3. The Web Interface(s) provided shall not require the procurement or licensing of any special or proprietary software from the Controls Contractor or its suppliers. In the event that specialized proprietary software is required, the Controls Contractor shall provide to the owner under this contract 10 licensed copies of the proprietary software.
4. The Web Interface(s) shall support the following functions at a minimum:
   a. User Name and Password restricted access
   b. Fully transparent access to GRAPHICAL OPERATOR INTERFACE as described in 3.2

2.7 ADDITIONAL UTILITY SOFTWARE

.1 Supply and install the following CAD software products by Autodesk Inc. to include:
- .1 Auto CADL latest version.
- .2 Auto shade software. CAD packages by other software manufacturers not acceptable.
- .3 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Delivered system to be complete with full set of User Manuals.
- .4 Enter soft copy submissions, including "Record" drawings specified in EMCS: Shop Drawings, Product Data and Review Process in OWS.
- .5 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Engineer.

2.8 GRAPHICAL OPERATOR INTERFACE

.1 Provide a graphical and menu driven operator interface for all mechanical and electrical systems and points connected to the DDC system in accordance with the design parameters.

.2 Provide graphics and/or customized help screens for technical support, point naming conventions, symbol library and procedures for database saving and loading.

3 Execution

3.1 INSTALLATION REQUIREMENTS

.1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment. Install tamper locks on breakers of circuit panels. See UPS requirements item 2.1.6

.2 OWS to be located in control post office.

.3 The OWS hard drive will be partitioned as follows:

- .1 C:\ Operating system, Microsoft Office, BMS operating system and application programs.
- .2 D:\ System database and trend reports.

3.2 GRAPHICAL OPERATOR INTERFACE

.1 Provide graphical display screens for all hardware points and calculated values contained in the system including all software points required to monitor, control and tune the entire system.

.2 Provide graphics in a standardized format. Submit sample copies of the proposed interface for approval prior to development of the entire package.

.3 Provide consistency in graphic layout according to the following requirements.
- .1 The graphic title shall be located at the top center of each screen.
- .2 Provide a menu bar at the bottom of each screen for access to sub-graphics associated with the current system.

.3 Contractor logo shall not occupy more than 1% of viewing screen.
.4 Graphics must be sized to fit on the OWS monitor without having to use scroll bars to view the entire screen.

.4 Provide consistency in the method for moving between graphics.
.1 A return to the main start graphic icon shall be located at the top left of all graphics.
.2 A return arrow icon shall be located at the bottom left of each graphic to return to previous graphic.
.3 A forward arrow icon shall be located at bottom right to forward to the next graphic.
.4 Provide a menu bar at the bottom of each graphic to provide links to an index graphic, a system architecture network graphic, a floor plan graphic, a systems summary graphic, a legend graphic, a technical support graphic and operator notes.
.5 Provide button access links to provide the operator direct access to time schedules associated with the current graphic.
.6 Graphics screens shall load in a reasonable time.
.1 When navigating through the graphics, the average time to load the page can be no longer than 5 seconds.

.5 Provide a Start Graphic that displays a digital picture of the facility with the following information and functionality:
.1 Outside air temperature.
.2 Outside air humidity.
.3 Button access (or side index tree) to the mechanical and electrical room graphics system architecture graphic and floor plans..
.4 Clicking on the picture of the building provides access to the floor plan graphics.
.5 Bottom menu bar access (or side index tree) to a vendor contact list graphic that lists technical support names, address, fax, cellular and phone numbers.
.6 Bottom menu bar access (or side index tree) to a point naming text graphic that describes the naming convention for the control system and a symbol library. For new installations the controls contractor shall adopt the standard Point Naming Convention.

.6 Provide an Index Graphic that provides one click access to every graphic screen, organized by system.
.7 Provide a System Architecture Network Graphic that shows the relationship between the OWS and all the EMCS components.
.1 Provide a text graphic or help menu, which explains the network and the most common trouble shooting procedures.
.2 All devices shall indicate communication status. Flashing red for failure or non-communication mode.
.3 A click on the device shall bring up the device address, systems being controlled, load and save database options.
.4 Include the phone number next to the remote access modem and IP address

next to the OWS or server.

.8 Provide a summary Floor Plan Graphic. This graphic shall:
- .1 Provides clickable access to detailed Floor Plan Graphics
- .2 Provide button access to each system summary graphic.

.9 Provide detailed Floor Plan Graphics for each wing of the building. These graphics shall represent the as-built space, show the location of all sensors and shall:
- .1 Provide all information required to trouble shoot and tune the zone controller.
- .2 Show each zone with a background colour indicating the temperature of the zone.
  - .1 Dark Blue = Very Cold
  - .2 Blue = Cold
  - .3 Neutral = At Set point
  - .4 Red = Hot
  - .5 Dark Red = Very Hot
- .3 Display all the zone temperatures, air flows and outputs of all other devices.
- .4 Provide clickable access to individual Fan Coil, VAV and other associated Graphics.

.10 Provide a summary system graphic that provides access to each main system graphic.

.11 Provide a main system graphic for each system (e.g. heating system, cooling system, air handling units etc.) to demonstrate the physical system layout and all the hardware and software points associated with the system. For larger systems this may require more than one graphic.
- .1 Provide access to the main system set points.
- .2 Locate measured variable next to graphic symbol
- .3 Locate set points below measured variables.
- .4 Provide a system hand-off-auto button to energize each system.
- .5 Provide an icon for direct access to the system start/stop schedule.
- .6 Provide sub-graphics for complex systems.
- .7 Provide button access to other main system graphics.
- .8 Provide button access to Flowchart sub-graphic for each control loop.
- .9 Provide button access to a Single Sequence of Operation Graphic for each system.

.12 Provide control loop sub-graphics for each control loop associated with the main system graphic.
- .1 Separate graphics for temperature, pressure, flow and humidity control.

  Control loop sub-graphics shall link to bottom menu bar of the main system graphic.

.13 Provide dynamic flow chart sub-graphics for each control loop to demonstrate the control logic and provide access to tuning parameters, set points and reset schedules.
- .1 Provide a flowchart graphic for each different type of control routine.
- .2 The flowchart graphic shall link to the control loop sub-graphics by the forward arrow and to the main graphic by the bottom menu bar.

.14 Provide a sequence of operation sub-graphic for each control loop.
- .1 Provide a sequence of operation graphic for each different type of control routine.
- .2 The sequence of operation sub-graphic shall link to the flowchart sub graphic

by the forward arrow and to the main system graphic by the bottom menu bar

.15 Provide the following space temperature control graphics.
- .1 A floor plan graphic for each wing of the building. This graphic shall display all the zone temperatures, total air flow and static pressure.
- .2 Provide individual zone and terminal unit graphics with all information required to trouble shoot and tune the zone controller. The graphic shall represent the as-built space with the location of the box and temperature sensor.
- .3 Provide a flowchart and sequence of operation graphic for each different type of space temperature control routine.
- .5 Provide a Radiant Panel summary graphic that displays space temperature and Set points for each panel zone.

.16 Provide a systems run time graphic.
- .1 The graphic shall display runtimes of the following systems, along with any other run times required by the building operators or consultants:
  - .1 Fans
  - .2 Boilers
  - .4 Hot Water Heating System Pumps
  - .5 Air Handling unit cooling

.17 Provide a Legend Graphic that describes the naming convention for the EMCS system and a symbol library.

.18 Provide a Technical Support Graphic that indicates the names of the technical support personnel together with their address, fax, cellular and telephone numbers.

.19 Apply the following standards to all graphic displays.
- .1 All analog outputs shall indicate 0% for closed representing no flow and 100% for open or full flow through a damper or coil. This shall be independent of whether the controlled device is a normally open or a normally closed device.
- .2 Each graphic shall have a small nc or no beside controlled device to indicate the fail safe position of the end device. If a device is not fail safe no label is required.
- .3 Point names are not normally required beside each input/output devices. The point name and descriptor shall be available by right clicking on the point value.
- .4 Steam lines shall be displayed in dark red, hot water in medium red and chilled water in blue.
- .5 Graphics to be in a two-dimensional format using professionally developed symbols. Three-dimensional graphics to be considered if they enhance the effectiveness of information display.

.20 Ana log input devices shall indicate status by a change in device color and/or display mode:
- .1 Yellow in normal mode.
- .2 Flashing red in high alarm condition.
- .3 Flashing blue in low alarm condition.
- .4 Black outline in override mode.

.21 Digital output device shall indicate status by a change in color and/or display mode.
- .1 Animation shall be used to indicate the status (digital input) of controlled

equipment.

.2 Green to indicate a normal on mode with the device under DDC control.

.3 White to indicate a normal off mode with the device under DDC control.

.4 Flashing red to indicate an alarm when the device status is opposite to the DDC control command.

.5 Green with black outline when device is in override on mode and device status matches the override command.

.6 White with black outline when device is in override off mode and device status matches the override command.

.7 Flashing black when device is in override mode and status is opposite to the override command.

.8 Each digital output shall have an off-on-auto or off-on command that matches the control options at the motor control center. The device symbol or right click menu option shall be used to command the equipment into either off, override or automatic DDC control mode.

End of Section

1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)
  .1 C22.2 No.205-M1983(R1992), Signal Equipment.
.2 Institute of Electrical and Electronics Engineers
  .1 IEEE C37.90.1-84, Surge Withstand Capabilities Test for Protective Relays and Relays Systems.

1.2 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion in EMCS: Project Records Documents.

1.3 SUBMITTALS

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

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 Engineer 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 other processor. Secondary input used for reset such as outdoor air temperature to be located in other

Controller(s).

.3 Interface to include provisions for use of dial-up modem for interconnection with remote LAN modem. Dial-up communications to use Hayes compatible 14.4/28.8/56 Kbit modems and voice grade telephone lines. Each stand-alone panel may have its own modem or a group of stand-alone panels may share modem.

2.2 BASIC FUNCTIONAL REQUIREMENTS

.1 To include:
- .1 Scanning of AIs and DIs connected inputs for detection of change of value and processing the detection of alarm conditions.
- .2 Perform On-Off digital control of connected points, including the resulting required states generated through programmable logic output.
- .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
- .4 Control of systems as described in sequence of operations.
- .5 Execution of optimization routines as listed in this section.

.2 Field Termination and Interface Devices.
- .1 To conform to CSA C22.2No.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. Where the failsafe has not been indicated, the failsafe shall maintain occupant safety first, and secondly protect the building.
  - .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 0ºC to 44ºC 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 Engineer 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 BACnet Open System Protocol & other project requirements.

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

.4 Include uninteruptable 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 set points.
.3 Modify PID loop set points.
.4 Override PID control.
.5 Change time/date.
.6 Add/modify/start/stop weekly scheduling.
.7 Add/modify set point 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 do 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 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 non-volatile memory.

.2 Maintain CDL and operating data such as set points, 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. Departmental Representative must have access to these algorithms 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. Set points) 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. EMCS shall allow staged restart of equipment after a power failure.

.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 insures that only principal alarms are reported to OWS. Events which occur as a direct result of the primary event to be suppressed by the system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. The exception is, when an air handler which is supposed to stop or start fails to do so under the event condition.

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

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling.
.2 Calendar based scheduling.
.3 Holiday scheduling.
.4 Temporary schedule overrides.
.5 Optimal start stop.
.6 Night setback control.
.7 Economizer switchover.
.8 Peak demand limiting.
.9 Temperature compensated load rolling.
.10 Fan speed/flow rate control.
.11 Cold deck reset.
.12 Hot deck reset.
.13 Hot water reset.
.14 Condensing unit scheduling.
.15 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

Engineer.

.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 1 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 1 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 operator'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 operator. Display analog values digitally to 1 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 Refer also to Section 25 05 01 - EMCS: General Requirements.

2.8 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support point naming convention as defined in section 13836. 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. 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 operator'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 operator. Display analog values digitally to (1) 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.

.3 Refer also to Section 25 05 01 - EMCS: General Requirements.

3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Engineer.

3.2 INSTALLATION

.1 Install Controllers in secure enclosures as indicated.

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

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

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

End of Section

1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)
- .1 ANSI C12.7-1993, Requirements for Watt hour Meter Sockets.
- .2 ANSI/IEEE C57.13-1978(R1987), Requirements for Instrument Transformers.

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

1.2 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with 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 Engineer, 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.

1.3 CLOSEOUT SUBMITTALS

.1 Submit operating and maintenance data for inclusion in operation and maintenance manual in accordance with EMCS: Project Records Documents.

2 Products

2.1 GENERAL

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

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 - 32 ºC 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 clear lockable covers on all stats, sensors.

2.2 TEMPERATURE SENSORS

.1 General: except for VAV box control to be resistance or thermocouple type to following requirements:

.1 Thermocouples: to be limited to temperature range of 200 ºC and over.

.2 RTD's: 100 ohm at 0 ºC (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored lead wires. Coefficient of resistivity: 0.00385 ohms/ohmºC.

.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 ºC.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.

.2 Sensors:

.1 Space type - wall mounting, in slotted type plastic covers having brushed aluminum finish, with guard as indicated. Element 10-50 mm long with ceramic tube or equivalent protection.

.2 General purpose duct type: suitable for insertion into ducts at any angle, insertion length to suite duct area.

.3 Averaging duct type: continuous filament with minimum immersion length 6000 mm. Bend probe at field installation time to 100 mm radius at any point along probe without degradation of performance.

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

.5 Duct temperature sensors for radiant floor heating / cooling zones: Shall contain an RTD sensing element to monitor room exhaust air temperatures. The transmitter shall be factory calibrated to an accuracy of + 1%. The output shall be compatible with the device it serves. Set points adjustable at OWS to actuate 24V manifold thermal zone control valves.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 ohm at 0 deg 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 deg C per volt change.

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

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

.5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.
.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.
.7 Maximum current to 100 ohm RTD sensor: not to exceed 25 mA.
.8 Integral zero and span adjustments.
.9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 ºC.
.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 ºC to plus 50 ºC, plus or minus 0.5 ºC.
.2 0 to 100 ºC, plus or minus 0.5 ºC.
.3 0 to 50 ºC, plus or minus 0.25 ºC.
.4 0 to 25 ºC, plus or minus 0.1 ºC.
.5 10 to 35 ºC, plus or minus 0.25ºC.

2.4 THERMOSTATS

.1 To match existing thermostats.
.2 Space Temperature Transmitters shall contain an RTD sensing element to monitor room air temperatures in the range of 0 degrees C to 32 degrees C, unless indicated otherwise. The transmitter shall be factory calibrated to an accuracy of + 1%. The output shall be compatible with the panel it serves. Transmitter shall be factory calibrated to an accuracy of + 1% over the full range.
.3 Space temperature thermostats to include set point adjustment with set point range programmable by operator. Provide after-hours override buttons on all thermostats in Administration or Staff-Only areas.
.4 Space temperature sensors in public or general common areas to be flat SS plate style with tamper-proof screws.

2.5 PRESSURE/CURRENT (P/I) TRANSMITTERS

.1 Requirements:
.1 Range: as indicated in I/O summaries.
.1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.
.2 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
.2 Output signal: 4 - 20 mA 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 ºC.
.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.
.9 Pressure ranges: see I/O Summaries.
.10 Accuracy: plus or minus 1% of Full Scale.

2.6 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 ºC.
.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 12.5 mm N.P.T. conduit connection. The enclosure shall be an integral part of the unit.

2.7 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 12.5 mm N.P.T. conduit connection. The enclosure shall be an integral part of the unit.
.7 Pressure ranges: see I/O Summaries.

2.8 FAN SYSTEM STATIC PRESSURE SENSORS

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

2.9 FAN SYSTEM STATIC PRESSURE TRANSMITTERS

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

2.10 CURRENT/PNEUMATIC (I/P) TRANSDUCERS

.1 Requirements:
- .1 Input range: 4 to 20 mA.
- .2 Output range: proportional 20-104 kPa or kPa as applicable.
- .3 Housing: dustproof or panel mounted.
- .4 Internal materials: suitable for continuous contact with industrial standard instrument air.
- .5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2 % of full scale over entire range.
- .6 Integral zero and span adjustment.
- .7 Temperature effect: plus or minus 2.0 % full scale/ 50 ºC or less.
- .8 Regulated supply pressure: 206 kPa maximum.
- .9 Air consumption: 16.5 ml/s maximum.
- .10 Integral gauge manifold c/w gauge (0-206 kPa).

2.11 ELECTRICAL RELAYS

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

2.12 CURRENT TRANSDUCERS

.1 Requirements:
- .1 Range: as indicated on I/O Summaries.

.2 Purpose: measure line current and produce proportional signal in one of following ranges:
- .1 4-20 mA DC.
- .2 0-1 volt DC.
- .3 0-10 volts DC.
- .4 0-20 volts DC.

.3 Frequency insensitive from 10 - 80 hz.
.4 Accuracy to 0.5% full scale.
.5 Zero and span adjustments. Field adjustable range to suit motor applications.
.6 Current transducer to be panel mounted with remote current sensor donut.

2.13 CURRENT SENSING RELAYS

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

2.14 CONTROL VALVES

.1 Requirements:
- .1 NPS 2 and under: to match existing valves in building: Johnson Controls VG 7000 control valve with V-3801-8001 Pneumatic control valve actuator.
- .2 NPS 2 1/2 and over: cast iron with flanged ends.
- .3 Trim: type 316 stainless steel.
- .4 Leakage: 0.5 % of rated flow maximum.
- .5 Two or three port as indicated. Normally Open or Normally Closed, as indicated.
- .6 Flow characteristics: linear or equal percentage as indicated.
- .7 Rangeability: 50:1 minimum.
- .8 Performance: Refer to scheduled equipment flow rates.

2.15 ELECTRONIC/ELECTRIC VALVE ACTUATORS

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

2.16 SURFACE WATER DETECTORS

.1 Requirements:
- .1 Provide alarm on presence of water on floor.
- .2 Expendable cartridge sensor.
- .3 Internal waterproof switch.
- .4 One set of dry contacts 2 amps at 24 V.
- .5 Unaffected by moisture in air.
- .6 Self-powered.

2.17 PANELS

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

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

.3 Panels to be lockable with same key.

3 Execution

3.1 INSTALLATION

.1 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.2 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.

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

.4 Install wall mounted devices on plywood panel properly attached to wall.

.5 Where sensors are wall-mounted in public or secure areas, provide perforated security-style stainless steel guards with locking covers over sensors.

.6 All existing control valves for radiation shall all be replaced. Install by contractor.

3.2 TEMPERATURE TRANSMITTERS

.1 Requirements:
- .1 Input circuit: to accept 3-lead, 100 ohm at 0 deg 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 deg C per volt change.
- .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
- .4 Input and output short circuit and open circuit protection.
- .5 Output variation: less than 0.2 % of full scale for supply voltage variation of

plus or minus 10 %.

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

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

.8 Integral zero and span adjustments.

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

.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 ºC to plus 50 ºC, plus or minus 0.5 ºC.

.2 0 to 100 ºC, plus or minus 0.5 ºC.

.3 0 to 50 ºC, plus or minus 0.25 ºC.

.4 0 to 25 ºC, plus or minus 0.1 ºC.

.5 10 to 35 ºC, plus or minus 0.25ºC.

3.3 PANELS

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

.2 Use modular multiple panels if necessary to handle all requirements, with space for additional 20% PCU or FID if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller (ECU, LCU, MCU, PCU, TCU).

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

.4 Identify wiring and conduit clearly.

3.4 THERMOSTATS

.1 Locate all room thermostats according to the following criteria:

.1 All room thermostats to be located at the same height, 1500 mm above the floor.

.2 On interior partitions or walls.

.3 Away from direct exposure to sunlight and heat-producing sources.

.4 Away from draughts or dead pockets of air.

.5 The preferred location is near the light switch by the entrance door, if it is on an interior wall.

.6 Verify location of thermostats with Departmental Representative before installation

.2 In undefined tenant areas leave 20 meters of coiled wire with stats hanging loose from fan coils.

3.5 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

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

3.6 I/P TRANSDUCERS

.1 Install air pressure gauge on outlet.

3.7 FIELD MOUNTED TRANSMITTERS AND SENSORS

.1 Support properly on pipe stands or channel brackets.
.2 Install wall mounted devices on plywood panel attached properly to wall.

3.8 IDENTIFICATION

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

3.9 TESTING

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

End of Section

1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)
- .1 ANSI/ASME B16.22-1989, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
- .2 ANSI C2-1990, National Electrical Safety Code.
- .3 ANSI/NFPA 70-1990, National Electrical Code.

.2 Canadian Standards Association (CSA)
- .1 CSA C22.1-98, Canadian Electrical Code, Part 1.
- .2 CAN/CSA C22.3No.1-M87, Overhead Systems.

1.2 SYSTEM DESCRIPTION

.1 Electrical:
- .1 Provide power wiring from emergency power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
- .2 Hard wiring between field control devices and EMCS field panels.
- .3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
- .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
- .5 Trace existing control wiring installation and provide updated wiring schematics including additions and/or deletions to control circuits for approval by engineer before commencing work.

.2 Pneumatic:
- .1 Pneumatic tubing, valves and fittings for field control devices.

.3 Mechanical:
- .1 Pipe Taps Required For EMCS equipment to be supplied and installed by Mechanical
- .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Mechanical
- .3 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be mounted by Mechanical. Costs to be carried by designated trade.

.4 VAV Terminal Units.
- .1 Air flow probe for VAV boxes to be supplied and installed with VAV box. Air flow dP sensor, actuator and associated VAV controls to be supplied and installed by EMCS contractor. Tubing from air probe to dP sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.

.5 Structural:
- .1 Special steelwork as required for installation of work.

1.3 PERSONNEL QUALIFICATIONS

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

1.4 EXISTING CONDITIONS

.1 Cutting and Patching: refer to specifications.
.2 Repair all surfaces damaged during execution of work.
.3 Turn over to Departmental Representative existing materials removed from work not identified for re-use.

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 16.
.2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
.3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
.4 Sizes:
  .1 120V Power supply: to match or exceed breaker, size #12 minimum.
  .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
  .3 Field wiring to digital device: #18AWG.
  .4 Analog input and output: shielded #18 minimum solid copper. Wiring must be continuous without joints.
  .5 More than 4 conductors: #22 minimum solid copper.
.5 Terminations:
  .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.3 CONDUIT

.1 As per requirements of Division 16.
.2 Electrical metallic tubing to CSA C22.2 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 56. Rigid steel threaded conduit to CSA C22.2 45.
.3 Junction and pull boxes: welded steel.
  .1 Surface mounting cast FS: screw-on flat covers.
  .2 Flush mounting: covers with 25 mm minimum extension all round.
.4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys,

complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.

.5 Outlet boxes: 100 mm minimum, square.

.6 Conduit boxes, fittings:

.1 Bushings and connectors: with nylon insulated throats.

.2 With push pennies to prevent entry of foreign materials.

.7 Fittings for rigid conduit:

.1 Couplings and fittings: threaded type steel.

.2 Double locknuts and insulated bushings: use on sheet metal boxes.

.3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.

.8 Fittings for thin wall conduit:

.1 Connectors and couplings: steel, set screw type.

2.4 WIRING DEVICES, COVER PLATES

.1 Conform to CSA.

.2 Receptacles:

.1 Duplex: CSA type 5-15R.

.2 Single: CSA type 5-15R.

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

2.5 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 manual.

.3 Auxiliary Control Devices:

.1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.

.2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.

.3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.

.4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.

.4 Finish for starters:

.1 Exterior: in accordance with Electrical Specifications.

.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 50 mm diameter and smaller: one-hole steel straps.
  .2 Larger than 50 mm diameter: two-hole steel straps.
.3 Suspended support systems:
  .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.

3 Execution

3.1 INSTALLATION

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

3.2 SUPPORTS

.1 Install special supports as required and as indicated.

3.3 ELECTRICAL GENERAL

.1 Do complete installation in accordance with requirements of:
  .1 Division 16, this specification.
  .2 CSA 22.1 Canadian Electrical Code.
  .3 ANSI/NFPA 70.
  .4 ANSI C2.
.2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
.3 Do underground installation to CAN/CSA C22.3No.7, except where otherwise specified.
.4 Conform to manufacturer's recommendations for storage, handling and installation.
.5 Check factory connections and joints. Tighten where necessary to ensure continuity.
.6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
.7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
.8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
.9 Install conduits, and sleeves prior to pouring of concrete.
.10 Holes through exterior wall and roofs: flash and make weatherproof.
.11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 CONDUIT SYSTEM

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

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

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

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

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

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

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

.8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.

.9 Fastenings and supports for conduits, cables, and equipment:

.1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.

.2 Provide adequate support for raceways and cables, sloped vertically to equipment.

.3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Engineer.

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

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

.12 Pass conduits through structural members only after receipt of Engineer's 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 Section 16 ___ - ___.

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

3.5 WIRING

.1 Install multiple wiring in ducts simultaneously.
.2 Do not pull spliced wiring inside conduits or ducts.
.3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
.4 Tests: use only qualified personnel. Demonstrate that:
  .1 Circuits are continuous, free from shorts, unspecified grounds.
  .2 Resistance to ground of all circuits is greater than 50 Megohms.
.5 Provide Engineer with test results showing locations, circuits, results of tests.
.6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
.7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
.8 Do not allow wiring to come into direct physical contact with compression screw.
.9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 WIRING DEVICES, COVER PLATES

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

3.7 STARTERS, CONTROL DEVICES

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

3.8 GROUNDING

.1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
.2 Install separate grounding conductors in conduit within building.
.3 Install ground wire in all PVC ducts and in tunnel conduit systems.

.4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.9 TESTS

.1 General:

.1 Perform following tests in addition to tests specified Section 01810 - EMCS: Commissioning.

.2 Give 14 days written notice of intention to test.

.3 Conduct in presence of Departmental Representative and authority having jurisdiction.

.4 Conceal work only after tests satisfactorily completed.

.5 Report results of tests to Engineer in writing.

.6 Preliminary tests:

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

.2 Make needed changes, adjustments, replacements.

.3 Insulation resistance tests:

.1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.

.2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Engineer and authority having jurisdiction.

3.10 IDENTIFICATION

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

End of Section

1 General

1.1 NOT USED

.1 Not Used.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 VARIABLE AIR VOLUME BOXES

.1 Box shall normally remain in minimum position.
.2 Damper shall modulate to maintain space set point without exceeding maximum box settings at EMCS.

3.2 DX system – condensing unit

.1 Controller shall be packaged with unit. Contractor to mount thermostats supplied with unit.
.2 Thermostats shall be hardwired, wall mounted in clear plastic locking cabinet.
.3 Evaporator fans and compressor shall modulate to maintain respective space temperature.
.4 Humidistat shall be hardwired, wall mounted in clear plastic locking cabinet.

End of Section