PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 09 91 23 - Interior Painting.

.2 Section 25 55 00 - EMCS: DDC Control

.3 Section 25 90 01 - EMCS: Field Installation.

1.2 REFERENCES

.1 Canadian Standards Association (CSA)
- .1 CAN/CSA-C22.2No.0-M91, Canadian Electrical Code, Part II, General Requirements.
- .2 CAN/CSA-Z234.1-89, Canadian Metric Practice Guide.

.2 American National Standards Institute (ANSI)
- .1 ANSI/ISAS5.5-1985, Graphic Symbols for Process Displays.
- .2 ANSI/IEEE260-1978, Letter Symbols for SI and Certain Other Units of Measurements.
- .3 CEMA2Y.1.

1.3 ACRONYMS, ABBREVIATIONS AND DEFINITIONS

.1 Acronyms used in this section include:
- .1 EMCS - Energy Monitoring and Control System
- .2 I/O - Input/Output
- .3 LAN - Local Area Network
- .4 LCU - Local Control Unit
- .5 MCU - Master Control Unit
- .6 O&M - Operating and Maintenance
- .7 OWS - Operator Workstation
- .8 PCU - Programmed Control Unit
- .9 TCU - Terminal Control Unit
- .10 AEL - Average Effectiveness Level
- .11 CDL - Control Description Logic.

.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/ISAS5.5.
.1 Printouts: to ANSI/IEEE260.

1.4 SUBMITTALS

.1 Submit in accordance with Section 01 33 00 - Submittal Procedures supplemented as specified herein.

.2 Shop Drawings to consist of three (3) hard copies and one (1) soft copy of design documents, shop drawings, product data and software. The soft copy and one (1) hard copy shall be for John M. MacLean Management, with the second copy for the Contractor and the third copy for Public Works & Government Services Canada.

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

.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.

1.5 PRELIMINARY DESIGN REVIEW

.1 Within 10 working days after tender award, submit preliminary design document for review by Departmental representative, containing following contractor and systems information:
.1 Location of local office.
.2 Description and location of installing and servicing technical staff.
.3 Location and qualifications of programming design and programming support staff.
.4 List of spare parts.
.5 Names of sub-contractors and site-specific key personnel.
.6 Sketch of site-specific system architecture.

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

1.6 SHOP DRAWING REVIEW

.1 Submit within 10 days of tender 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, all other data to establish compliance. Proposed model must be noted.
.2 Detailed system architecture showing all points associated with each controller, 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, and 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.

1.7 PERMITS AND FEES

.1 In accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit certificate of acceptance from authority having jurisdiction to Departmental representative.

1.8 GENERAL DESCRIPTION

.1 Refer to control schematics and Section 25 55 00 - EMCS: DDC Controls for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Programmable controllers PCU, MCU, LCU, TCU.

.2 Control devices as listed in I/O Summaries.

.3 Data communications equipment necessary to affect an EMCS data transmission system including gateway and LAN hardware and software for connection to LAN network.

.4 All field control devices.

.5 All software complete with full documentation for software and equipment.

.6 Complete operating and maintenance manuals and field training of operators, programmers and maintenance personnel.

.7 Acceptance tests, technical support during commissioning, full documentation.

.8 Wiring interface co-ordination of equipment supplied by others.

.9 Miscellaneous work as specified in these sections and as indicated.

1.9 METRIC REFERENCES

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

.2 Provide all required adapters between Metric and Imperial components.

1.10 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 departmental representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

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

1.11 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 departmental representative prior to installation.

.3 Location of controllers to be approved by departmental representative prior to installation.

.4 Provide utility and emergency power to controllers from circuits provided by Division 26. EMCS Contractor shall be responsible for power wiring from circuit breaker to controller.

1.12 LANGUAGE OPERATING REQUIREMENTS

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

.2 All displays on graphic terminal to use non-linguistic symbols 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 may 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 (ie. 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. To be in English at all specified OWS. Point name expansions in both languages.

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

1.13 MATERIALS DELIVERY SCHEDULE

.1 Provide departmental representative with "Materials Delivery Schedule" within 20 days after tender award of Contract.

1.14 LANGUAGE

.1 French and English.

1.15 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.

1.16 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.

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

1.17 WARNING SIGNS

.1 Equipment (e.g. motors, starters) under remote automatic control: provide orange coloured signs warning of automatic starting under control of EMCS (e.g. "Caution: This equipment is under automatic remote control of EMCS"). Signs shall be in French and English.

1.18 WIRING

.1 Numbered tape markings on all wiring at panels, junction boxes, splitters, cabinets, outlet boxes.

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

.3 Power wiring: identify at each panel.

1.19 MANUFACTURER'S NAMEPLATES, CSA LABELS

.1 To be visible and legible at all times.

1.20 TRAINING

.1 Provide instruction to designated personnel in adjustment, operation, maintenance, pertinent safety requirements of EMCS installed for a period of six, 4-hour days.

.2 Training to be project-specific.

1.21 TRAINING MATERIALS

.1 Provide all equipment, visual and audio aids, and materials for classroom training.

.2 Provide manual for each trainee, describing in detail data included in each training program.

1.22 TRAINING PROGRAM

.1 To be in 3 phases over 11 month period:

.1 Phase 1: for one, 4-hour periods before test period at time mutually agreeable to Contractor, departmental representative and EMCS commissioning manager. Train O& M personnel in functional operations and procedures to be employed for system operation. Supplement with continuous on-the-job training during test period. To include overview of system architecture, communications, operation of computer and peripherals, report generation; detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.2 Phase 2: 6 months after acceptance, for one, 4-hour periods. For operators, equipment maintenance personnel and programmers. Include at least following:
  .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
  .2 Equipment maintenance training: in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
  .3 Programmers: provide personnel with at least 2 days training within 5 day period.
.3 Phase 3: 11 months after acceptance, for one, 4-hour period, day total review of EMCS, Programming and Operation and Maintenance.

1.23 ACCEPTABLE MATERIALS

.1 Where materials are specified by trade name, refer to the Project Specific Instruction to Bidders for procedure to be followed in applying for approval of alternatives.

.2 All material shall be low in V.O.C. (Volatile Organic Compound) emissions.

.3 Standard of acceptance: Delta Orca View 3.33 (Controls & Equipment).

PART 2 - PRODUCTS

2.1 LOCKABLE PANELS

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

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

PART 3 - EXECUTION

3.1 MANUFACTURER'S RECOMMENDATIONS

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

3.2 PAINTING

.1 Painting to be in accordance with Section 09 91 23 - 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, etc.

.5 Paint all unfinished equipment installed indoors.

3.3 PRE-INSTALLATION TEST

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Departmental representative.

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

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

.5 Additional instruments to include:
.1 DP transmitters.
.2 DP switches used for dirty filter indication and fan status.

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

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

.8 Departmental representative to mark all instruments tracking within 5% in both directions as "approved for installation".

.9 Transmitters above 5% error will be rejected.

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

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

.2 Include following activities:

.1 Test and calibrate all field hardware including stand-alone capability of each controller.
.2 Verify each A-to-D converter.
.3 Test and calibrate each AI using calibrated digital instruments.
.4 Test each DI to ensure proper settings and switching contacts.
.5 Test each DO to ensure proper operation and lag time.
.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
.7 Test all operating software.
.8 Test all application software. Provide samples of all logs and commands.
.9 Verify each CDL including energy optimization programs.
.10 Debug all software.
.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

3.5 FINAL START-UP / CHECK-OUT TESTS

.1 Upon satisfactory completion of all tests, perform point-by-point test of entire system under direction of departmental representative and EMCS Commissioning Departmental representative.

.2 Provide:
- .1 Technical personnel capable of re-calibrating field hardware and modifying software.
- .2 Detailed schedule showing items to be tested and personnel available.
- .3 Key document for recording all procedures to be listing of system database, including key name, English description, point type and address, engineering units, low and high limits. Include space on listing for remarks and signatures of commissioning technician and departmental representative.
- .4 Departmental representative's acceptance signature to be on all executive and applications programs.

3.6 FINAL OPERATIONAL ACCEPTANCE TESTS

.1 Purpose: to demonstrate that EMCS functions in accordance with all contract requirements.

.2 Test to last at least 10 consecutive 24 hour days.

.3 Tests to include:
- .1 Demonstration of correct operation of all monitored and controlled points.
- .2 Operation and capabilities of all sequences, reports, special control algorithms, diagnostics, software.

.4 System is accepted if:
- .1 Equipment operates at AEL of at least 99 % for test period.
- .2 All other requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.

.6 Correct all defects when they occur and before resuming tests.

3.7 COMMISSIONING: COORDINATION

.1 Co-ordinate commissioning procedures with disciplines and trades involved.

.2 Refer to Section 01 91 13 - General Commissioning (CX) Requirement.

3.8 OPERATION OF SYSTEMS

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

.2 Refer to Section 01 91 13 - General Commissioning (CX) Requirement.

3.9 USE OF O & M PERSONNEL

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

.2 Refer to Section 01 91 13 - General Commissioning (CX) Requirement.

3.10 COMMISSIONING: PROCEDURES

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

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

.3 Commission each system.

.4 Debug systems.

.5 Optimize operation, performance of each system.

.6 Test full scale emergency evacuation procedures including operation and integrity of smoke management systems.

.7 Refer to Section 01 91 13 - General Commissioning (CX) Requirement.

3.11 DEMONSTRATIONS

.1 Demonstrate to Owner, User/Occupant, departmental representative, the operation of each system including sequence of operations in regular and emergency modes, under all normal and emergency conditions, start-up, shut-down, interlocks, lock-outs.

3.12 COMMISSIONING: FINAL SETTINGS

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

.2 Refer to Section 01 91 13 - General Commissioning (CX) Requirement.

3.13 WARRANTY PERIOD FOR EMCS

.1 Warranty specified in Section 01 78 00 - Closeout Submittals to include system and application software.

3.14 COMMENCEMENT OF EMCS WARRANTY PERIOD

.1 EMCS Warranty Period to start upon receipt of written approval of successful completion of commissioning activities specified herein.

3.15 MAINTENANCE ACTIVITIES DURING EMCS WARRANTY PERIOD

.1 Provide services, materials, equipment and maintain EMCS for warranty period.

.2 Perform one minor inspection per quarter and two major inspections per year. Provide fully detailed report in writing to Departmental representative.

.3 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to all PCU's, peripheral equipment, interface and other panels, FID's.

.2 Check fan all PCU's, peripheral equipment, as required.

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

.4 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean BECC, all peripheral equipment, PCU's, all interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of all PCU's, peripherals, all interface and other panels.

.4 Provide mechanical adjustments, new ribbons, and necessary maintenance on printers.

.5 Check and/or calibrate each field input/output device. Provide dated, all-point log to Departmental representative as proof of executed point-to-point system check. Log to indicate binary input change of state which shall be generated by activation of point sensor. Check analog span and zero calibration against test instrumentation with certified accuracy of 50% greater than displayed or logged output variable of network.

.6 Run system software diagnostics as required.

.5 Emergency service:

.1 Service calls will be initiated when there is indication that EMCS is not functioning correctly. Have qualified control personnel available during contract period to provide service to "CRITICAL" components whenever required at no extra cost. Furnish Departmental representative with telephone number where service personnel may be reached at any time. Service personnel to be on site ready to service EMCS within 4 h after receiving request for service. Perform work continuously until EMCS restored to reliable operating condition.

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

.7 Records and logs: maintain records and logs of each maintenance task. Organize cumulative records for each major component and for entire EMCS chronologically. Complete forms and submit monthly, by 10th day of succeeding month, indicating that planned and systematic maintenance has been accomplished.

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

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

.10 Software: implement all software maintenance updates. To be accomplished as required. Maintain co-ordination with EMCS supervisory personnel.

END OF SECTION

PART 1 - GENERAL

1.1 WORK INCLUDED .1 Provide a native BACnet™ based system to all areas of the building in this contract, including. All controllers, including unitary controllers, shall be native BACnet™ devices. No gateways shall be used for communication to existing systems or to systems installed under other sections. Items of work included are as follows:

.1 Provide all necessary BACnet™-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for every controller in system, including unitary controllers. All direct digital logic hardware is to comply with BACnet™.

.2 Prepare individual hardware layouts, interconnection drawings and software configuration from project design data.

.3 Implement the detailed design for all system-standard analog and binary objects, distributed control and system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data and bid documents.

.4 Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.

.5 Provide and install all interconnecting cables between supplied cabinets, logic controllers and input/out devices.

.6 Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.

.7 Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, start-up and commissioning.

.8 Provide a comprehensive operator and technician training program as described herein.

.9 Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.

.10 Provide new valves, and damper actuators. No used components shall be used as any part or piece of installed system.

.11 Provide dynamic colour graphics for all systems.

.12 The control system shall include all as indicated on the drawings and as specified including but not limited to the following:

.1 All AI's, A0's, DI's, D0's, temperature, sensors and transmitters, control dampers, actuators, relays, transformers, transducers, all control wiring and conduit, current sensing relays, calibration, etc. required to operate and make operable all equipment in accordance with the sequences of operation

.13 Provide all connections between D.D.C. points and new equipment including all transducers, relays, etc. required to interface this equipment with the stand alone microprocessor based controller.

.14 Furnish and load all software programming required to implement a complete and operational control system.

.15 The contractor shall provide all necessary software, hardware and assistance to the TAB Agency for completion of the TAB.

.16 Supply and installation of variable frequency drives, as detailed in Section 23 05 13.01 – Variable Frequency Drives.

.17 Remove existing pneumatic controls in crib area with new DDC controls, including all valves, controllers, dampers, sensors and devices.

1.2 SYSTEM DESCRIPTION

.1 General Requirements

.1 All logic controllers for terminal units, fan, central mechanical equipment, and Microsoft Windows-based operator's terminal(s) shall communicate and share data, utilizing only BACnet™ communication protocols.

.2 All logic controllers shall be fully programmable. That is, programmable controllers for every terminal unit, air handlers, all central plant equipment, and any other piece of controller equipment shall be provided. Programming tools shall be provided as part of operators workstation for every controller supplied for the project.

.2 Basic System Features

.1 Zone by zone direct digital logic control of space temperature, scheduling, optimum start, equipment alarm reporting, and override timers for after hours usage. A zone is the area serviced by one HVAC logic controller unit.

.2 The complete system, including but not limited to terminal unit controllers, global controllers and operator's terminals shall auto-restart, without operator intervention, on resumption of power after a power failure. Database stored in global controller memory shall be battery backed up for a minimum of 1 year. Logic controllers for all air handlers and unitary equipment shall utilize EEPROM for all variable data storage. Batteries on unitary controllers shall not be allowed.

.3 System design shall be modular and of proven reliability.

.4 All software and/or firmware interface equipment for connection to remote monitoring station from field hardware or the operator's terminal shall be provided.

.5 Communication wiring for field controllers shall not be run in star patterns.

.6 All controllers shall communicate using protocols and LAN types contained in the ANSI/ASHRAE Standard 135-1995, BACnet™.

.7 All DDC hardware and software shall be designed and manufactured by US and Canadian Corporations. All hardware shall be Listed Underwriters Laboratory for Open Energy Management Equipment (PAZX) under the UL Standard for Safety 916 in both the US and Canada, with integral labels showing rating.

.8 All hardware shall be in compliance with FCC Part 15, Subpart J, Class A.

.9 All hardware shall be in compliance with European Directive 89/336/EEC (European CE Mark).

1.3 QUALITY ASSURANCE

.1 Responsibility: The supplier of the HVAC digital logic control system shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished by him.

.2 Component Testing: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every controller, sensor and all other DDC components shall be individually tested by the manufacturer prior to shipment.

.3 Tools, testing and calibration equipment: The control system supplier shall provide all tools, testing and calibration equipment necessary to ensure reliability and accuracy of the control system.

.4 The system control contractor shall have been in business a minimum of five years and be the authorized installing contractor for the manufacturer of the BACnet™ components.

1.4 REFERENCE STANDARDS

.1 The latest edition of the following standards and codes in effect and amended as of supplier's contract date, and any applicable sub-sections thereof, shall govern design and selection of equipment and material supplied:

.1 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
.2 ANSI/ASHRAE Standard 135-1995, BACnet™.
.3 Uniform Building Code (UBC), including local amendments.
.4 UL 916 Underwriters Laboratories Standard for Energy Management Equipment, Canada and the US.
.5 National Electrical Code (NEC).
.6 FCC Part 15, Subpart J.
.7 EMC Directive 89/336/EEC
.8 National Building Code
.9 Canadian Electrical Code.

.2 City, county, provincial and federal regulation and codes in effect as of contract date.

.3 Except as otherwise indicated the system supplier shall secure and pay for all permits, inspections, and certifications required for his work and arrange for necessary approvals by the governing authorities.

1.5 SUBMITTALS

.1 Drawings

.1 The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
.2 Drawings shall be submitted in the following standard sizes: 280 mm x 432 mm, ANSI B.
.3 Ten complete sets (copies) of submittal drawings shall be provided.
.4 Drawings shall be available on floppy disk or CD-ROM as specified.

.2 System Documentation
System documentation by the vendor shall include the following as a minimum:
.1 System configuration diagrams in simplified block format.
.2 All input/output object listings and alarm point summary listing.
.3 Electrical drawings that show all system internal and external connection points, terminal block layouts, and terminal identification.
.4 Manufacturer's instructions and drawings for installation, maintenance, and operation of all purchased items.
.5 Overall system operation and maintenance instructions - including preventive maintenance and troubleshooting instructions.
.6 For all system elements - operator's terminal(s), global controller(s), logic controllers, routers, repeaters, and converters - provide BACnet™ Protocol Implementation Conformance Statements (PICS), as per ANSI/ASHRAE Standard 135-1995, BACnet™ recommendations.
.7 Provide complete description and documentation of any proprietary services and/or objects used in the system.

1.6 SCHEDULING AND COORDINATION

.1 The vendor shall provide a detailed project design and installation schedule with time markings and details for hardware items and software development phases.

.2 The schedule shall show all the target dates for transmission of project information and documents and shall indicate timing and dates for system installation, debugging and commissioning.

1.7 WARRANTY

.1 Warranty shall cover all costs for parts, labour, associated travel, and expenses for a period of one year from completion of system acceptance.

.2 Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

.3 This warranty shall apply equally to both hardware and software.

PART 2 - PRODUCTS

2.1 WIRING

.1 Standards
- .1 Chemically cross-linked thermosetting polyethylene wire and cable to CSA C22.2 No. 38 Latest Edition.
- .2 Wire connectors to CSA C22.2 No. 65 Latest Edition.
- .3 Armoured cables to CSA C22.2 No. 51 Latest Edition.
- .4 Grounding and bonding equipment to CSA C22.2 No. 41 Latest Edition and C22-1-1986 Section 10.

.2 Provide copper conductors sized as indicated, with cross-linked thermosetting polyethylene insulating material rated RW90 and 600 V as follows:
- .1 Size all power supply wiring per Code to match or exceed breaker size, minimum No. 12.
- .2 Field wiring for each digital device shall be two conductor No. 18 AWG. For multi-conductor wire having four or more conductors, wire size shall be not less than No. 22 AWG solid copper. Analog devices shall be wired with shielded, solid copper wire not less than 18 AWG.
- .3 All wires shall be terminated with pressure type connectors suitable for wire size and materials as well as terminal connection. Wire in physical contact with compression screw shall not be acceptable.
- .4 Acceptable wiring standard in concealed accessible spaces is FT-6, fastened at maximum 1200 mm intervals.

2.2 CONDUIT SYSTEM

.1 Provide a complete conduit system for all EMCS wiring in Mechanical Rooms 335 and 336, together with all exposed wiring. All concealed accessible wiring shall be type FT-6 wiring, supported every 1000mm.

.2 Standards
- .1 Electrical metallic tubing (E.M.T.) with couplings to CSA C22.2 No. 83 Latest Edition.
- .2 Junction, pull boxes, and cabinets to CSA C22.2 No. 40 Latest Edition.
- .3 Outlet boxes, conduit boxes and fittings to CSA C22.2 No. 18 Latest Edition.

.3 Junction and Pull Boxes
- .1 Junction and pull boxes of welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush mounted pull and junction boxes.
- .3 Provide pull boxes so as not to exceed 30 meters of conduit run between pull boxes.
- .4 Fittings for Thin Wall Conduit
  - .1 Set screw type steel connectors and couplings.
  - .2 In mechanical room use insulated bushings on conduit in sheet metal boxes without lockouts to allow for expansion.

2.3 TEMPERATURE SENSORS

.1 General: Temperature Sensors shall be Resistance temperature sensors (RTDs).

.2 The following shall apply to resistance temperature sensors RTDs:
- .1 The RTDs shall be 100 ohm at 0°C (± .2 ohm) or 1000 ohm platinum element with strain minimizing construction and 3 integral anchored leadwired coefficient of resistivity of 0.000693 ohms/ohm/°F.
- .2 Sensing element to be hermetically sealed.
- .3 Stem and tip construction to be copper.

.4 Sensors shall have a time constant response of less than 3 seconds to a temperature change of 10°C.

.5 Sensors shall operate over the following ranges with the accuracies over the noted range of the sensor.
0°C to 48.9°C plus or minimum 0.2°C
0°C to 25°C plus or minimum 0.1°C

.3 Temperature sensors shall be of the following type:

.1 Spring-loaded Thermowell type - spring loaded construction with compression fitting for 20 mm NPT well mounting. Lengths of 100 mm or 150 mm as required.

.2 General Purpose Duct Type - suitable for insertion into air ducts at any angle, insertion lengths 450 mm on ducts 600 mm and smaller in width or diameter and 750 mm on ducts over 800 mm in width or diameter. Temperature sensor probe material shall be 304 stainless steel.

.3 Averaging duct type - continuous filament of 6.35 mm) bendable copper tubing with its end capped and sealed. Immersion length of 6 meters minimum. Probe to be bent, at field installation time, to a minimum radius of 100 mm at any point along the probe length without degradation in performance.

.4 Outside Air type - complete with non-corroding shield designed to minimize solar and wind effects, threaded fitting for mating to 12.7 mm conduit, probe length of 100 mm to 150 mm. Temperature sensor material will be of 304 stainless steel with its end capped and pressure tested to 68.47 kPa (100PSI).

.5 Space temperature sensors shall be thermistors with setpoint adjustment.

.1 Room temperature sensor with setpoint adjustment.

.2 In corridors and unsupervised public areas – tamper-proof plate type temperature sensor.

.6 Thermowells for temperature sensors shall be brass for installation in copper piping and shall be stainless steel for steel piping installation.

2.4 TEMPERATURE TRANSMITTERS

.1 As applicable, RTD temperature transmitter shall have the following minimum specifications:

.1 Input circuit to accept 3-lead, 100 ohm at 0EC platinum resistance detectors as specified in 2.5 above.

.2 Output signal of 4-20 mA into maximum of 500 ohm load if required.

.3 Output short circuit and open circuit protection.

.4 Input short circuit and open circuit protection.

2.5 CURRENT SENSING RELAYS

.1 Provide double voltage DPDT relays for status indication of electrical starters as indicated.

.2 Relay coils shall be rated for 120 V or 24 V. Where other voltages occur, provide transformer.

.3 Contacts rated at a minimum of 5 amps at 120 VAC. Relays shall be rated for applicable load.

.4 Relays to be plug in type with termination base.

.5 Relays shall be in a dust proof housing.

.6 Accuracy shall be less than 2% of full scale max.

.7 The relay shall have an accessible trip adjustment over its complete operating range.

.8 Relay shall be self-powered with no insertion loss.

.9 Operating temperature: -15°C to 60°C.

2.6 CONTROL DAMPERS AND ACTUATORS

.1 Provide dampers in accordance with Section 23 33 15 - Dampers: Operating.

.2 Mixing damper shall be parallel blade.

.3 Shut-off dampers shall be opposed blade.

.4 Dampers exposed to weather shall be insulated.

.5 Damper actuators shall be 24-volt spring return, electronic. All dampers, which receive analog input signals from the DDC Control, shall be capable of receiving 0-10 VDC signals. All dampers and damper banks shall have sufficient number of actuators to ensure tight shut off.

.6 Dampers shall be installed by the Air Distribution Contractor.

2.7 VALVES

.1 Provide valves pressure-rated in accordance with general valve pressures specified elsewhere in this Specification.

.2 Water:

.1 2-way valves shall have equal percentage characteristics, rated at 860 kPa.

.3 All valves shall have stainless steel stems and spring loaded self-adjusting Teflon or rubber packing.

.4 Valves 50 mm and under shall be screwed, 65 mm valves and larger shall be flanged.

2.8 ELECTRONIC VALVE ACTUATORS

.1 Actuator shall be fully modulating, floating (tri-state), two position, and/or spring return as indicated in the control sequences. Specified fail-safe actuators shall require mechanical spring return.

.2 Modulating valves shall be positive positioning, responding to a 1-10 VDC or 4-20mA signal. There shall be a visual valve position indicator.

.3 The actuator shall have the capability of adding auxiliary switches or feedback potentiometer if specified.

.4 Actuator shall provide minimum torque required for proper valve close-off. The actuator shall be designed with a current limiting motor protection. A release button-clutch or handle on the actuator-shall be provided to allow for manual override (except when actuator is spring return type).

.5 Actuator shall be UL listed.

2.9 SAFETY HIGH LIMIT

.1 Safety High Limit - shall be manual reset, line voltage type with bi-metal actuated switches. Switch shall have an adequate rating for the applied load.

2.10 DIFFERENTIAL PRESSURE GAUGES

.1 Differential Pressure Gauges: Magnehelic, or approved equal, scale range 0 to 50 mm wc, installed across filter banks.

2.11 DIFFERENTIAL PRESSURE SWITCH

.1 Differential Pressure Switch: Greystone, two wire, AFS 222, SPDT contacts.

2.12 SMOKE DETECTORS

.1 Smoke Detectors: By Division 26.

.2 Coordinate smoke detector status with Division 26.

2.13 HUMIDITY SENSOR

.1 Humidity Sensor: shall be bulk polymer sensor, range shall be 5 to 95%, operating temperature range to be 0 to 70°C (32 to 158°F) for the electronics and -40 to 82°C (-40 to 180°F) for sensor.

.2 The output signal shall be 2-wire loop-powered, 4 to 20 mA, 0 to 100% linear, proportional. The accuracy at 25°C (77°F) shall be 2% RH, 5 to 95% RH. The temperature effect to be less than 0.2% RH per °C.

.3 Supply voltage shall be 12 to 35 VDC.

.4 For duct installation, the probe shall be of 304 Stainless steel. Probe shall be capped with replaceable porous Polyethylene filter.

.5 For outside installation, the enclosure shall be of non-rust PVC.

.6 For room installation, the enclosure shall be constructed of non-rust material and will have an attractive vented decorator look. The enclosure must match the space temperature sensor enclosures.

.7 Standard of acceptance: PH-200 AO3 Greystone, 4 to 20 MA, 3% accuracy, two-wire.

2.14 ELECTRICAL RELAYS

.1 To following requirements:
- .1 Double voltage, DPDT, plug-in type with termination base.
- .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
- .3 Contacts: rated at minimum 5 amps at 120 V AC. Relays shall be rated for applicable load.

2.15 LOW LIMIT THERMOSTATS

.1 Low-limit thermostats shall be vapor pressure type with an element 6 m minimum length. Element shall respond to the lowest temperature sensed by any 30 cm section. The low-limit thermostat shall be manual reset only and be supplied as DPST.

2.16 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 all requirements with space to accommodate additional capacity (to be approved by Departmental representative without adding additional cabinets).

.3 All panels to be lockable with same key.

2.17 AIR FLOW PROVING SWITCH FOR HUMIDIFIER

.1 Supplied with humidifier. Refer to section 23 84 13 - Humidifiers. Installed by this section.

2.18 TIMER

.1 Time intervals range from 5 minutes to 12 hours.

.2 SPST relay.

.3 Easy to read graduated dial.

.4 Heavy duty switching, rated for 15 amps at 120 volts.

2.19 VARIABLE FREQUENCY DRIVE

.1 To Section 23 05 13.01 – Variable Frequency Drive requirements. Supplied and installed by this Section

2.20 STATIC PRESSURE SENSORS DUCT-MOUNTED

.1 Duct mounted static pressure sensors shall meet the following as a minimum.

.2 Input range shall be appropriate for application. Range shall be selected from a minimum of 0% to a maximum of 150% of maximum duct static pressure.

.3 Output shall be 4-20 mA or 0-10 VDC proportional to duct static pressure.

.4 1% full-scale accuracy.

.5 Operating temperature range: 0°C to 60°C.

.6 Easy accessible, integral non-interacting zero adjustment.

.7 Minimum over-pressure input protection of 2 times rated input, or 7 kPa, whichever is greater.

PART 3 - EXECUTION

3.1 ELECTRICAL - GENERAL

.1 Do complete installation to the Canadian Electrical Code.

.2 Determine manufacturer's recommendations regarding storage and installation of equipment and adhere to these recommendations.

.3 Check all factory joints and tighten where necessary to ensure continuity.

.4 Install electrical equipment between heights of 900 mm and 1800 mm whenever possible, and adjacent to related equipment.

.5 Protect exposed live equipment such as panel mains and outlet wiring during construction.

.6 Shield and mark all live parts "LIVE 120 VOLTS" or with appropriate voltage.

.7 Holes through exterior walls and roof to be flashed and made weatherproof.

.8 Make all necessary arrangements for cutting chases, drilling holes and other structural work required to install electrical conduit, cables, pull boxes and outlet boxes.

.9 Install all cables, conduits, and fittings, which are to be embedded or plastered over, neatly and closely to building structure so that necessary furring can be kept to minimum.

.10 Where cables or conduits pass through floors and fire rated walls, pack space between wiring and sleeve with alumina silica ceramic fibre and seal top of holes in floors with concrete mix.

3.2 WIRING

.1 All wiring shall be done in accordance with the Canadian Electrical Code.

3.3 INSTALLATION

.1 Provide all remote sensing points and instrumentation as indicated and/or required for the complete operational capability of the Building Automatic Control System.

.2 All equipment shall be installed according to manufacturer's published instructions.

.3 Temperature and Humidity Sensors.

.1 All sensors shall be stabilized to such a level as to permit on-the-job installations that will require minimum field adjustments or calibration.

.2 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.

.3 Outdoor installation shall be weatherproof construction in Nema 12 enclosures. These installations shall be protected from solar radiation and wind effects by stainless steel shields.

.4 Sensor located in finished spaces shall be with brushed aluminium covers and guards.

.5 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only, and shall not be located in dead air spaces. The location shall be within the vibration and velocity limits of the sensor. Where an extended surface element is required to properly sense the average temperature, it shall be securely mounted within the duct to measure the best average temperatures. Elements shall be thermally isolated from brackets and supports to respond to air temperature only. Sensor element to be supported separately and not connected to coils or filter racks.

.4 Temperature Transmitters, Humidity Transmitters, Controllers and Relays to be installed in NEMA I enclosures.

.1 Panels to be either free standing for wall mounted enamelled steel cabinets with hinged and key locked front door. Arrange for conduit and tubing entry from top, bottom or either side.

.2 Panels shall be modular multiple panels being used if required for capacity in any particular location. They shall handle all requirements with space to accommodate an additional 20% without adding further cabinets.

.3 All panels shall be lockable with same key.

.4 All wiring and tubing within panels to be located in trays or individually clipped to back of panel, and clearly identified.

.5 Field mounted transmitters and sensors to be properly supported on pipe stands or channel brackets, all wall mounted devices to be mounted on plywood panel properly attached to the wall.

.6 Testing:
.1 All field devices shall be properly calibrated and tested for performance and accuracy.

.7 Status of a single speed motor shall be monitored with current sensing relays. Differential pressure switches shall not be used for this purpose. Contractor shall install current sensing relays at the MCC starters of at the local starters where MCC are not installed.

.8 Controls Contractor shall include in the tender to provide two (2) eight-hour days for training school personnel following the Interim Inspection and one (1) eight hour day, six months after contract completion. Exact timing and number of people to attend training shall be provided by the departmental representative.

PART 4 - SEQUENCE OF OPERATIONS

.1 AHU-1, AHU-3 and AC-7:
.1 Units shall ramp up on start-up with outdoor and relief air dampers closed, and return air damper fully open to allow the space temperature to reach its setpoint. After the setpoint has been achieved, modulate outdoor air, return air and relief air dampers as described below. There shall be two modes of operation, occupied and unoccupied.
.1 AHU-1, AHU-3 and AC-7 to start and stop on a scheduled basis. Coordinate with maintenance representatives for required schedule. Each system shall have its own schedule.
.1 The AHUs shall start 20 minutes, (or otherwise recommended by maintenance representative), prior to the scheduled time of

occupancy, and bring the room temperature up to the occupied setpoint. Only rooms and/or zones in the occupied mode, as determined by the time-of-day schedule occupancy sensors, shall maintain the occupied temperature setpoint. All others shall default to the unoccupied temperature with VAV boxes reduced to minimal air flow. (For VAV boxes being connected to occupancy sensors, this contractor to tie into lighting control system occupancy sensor dry contact relay provided by Electrical Division 26.)

.2 Should an after hour's event take place in one or more of the zones an occupancy sensor shall activate that room or zone as occupied for a period of 10 minutes after the last movement has been detected, then the system shall return to the unoccupied mode.

.2 During the unoccupied mode space temperature shall be maintained between 15°C and 18°C by energizing the perimeter heat and/or AHU as required.

.3 During the heating season and occupied mode, the AHU shall run continuously with mixed air temperature modulating the OA damper and RA damper to maintain the min setpoint, and modulate the AHU heating coil SCR to maintain the SA temperature setpoint. A temp sensor in the MA stream shall shut down the AHU should the setpoint drop below 5°C.

.4 The three (3) AHUs shall modulate to maintain its supply air setpoint linearly in accordance with the following schedule:

OAT	SAT
-20°C	18.3°C
25°C	14.0°C

.5 Inversely modulate the RA damper to the percentage of FA mixing with the RA flow to maintain a balanced system.

.6 AHU-1, AHU-3 and AC-7, complete with SA static pressure sensors, shall control the modulation of the AHU SA fan motor through the VFD to maintain the static pressure setpoint. As the static pressure increases with the closing of VAV box dampers, the VFD shall slow the supply fan motor to maintain the setpoint. conversely, as the static pressure decreases with the opening of VAV box dampers, the VFD increases the supply fan motor speed to maintain the setpoint.

.7 The RA fan shall modulate to follow the SA fan and match the flows required.

.8 Modulate humidifier output to maintain RA humidity setpoint at 30% as monitored by the return air duct humidity sensor. Supply air duct humidity to be set at a maximum of 80% as monitored by duct humidity sensors at which time, the humidifier shall be disabled. Reset humidification setpoints as follows to prevent condensation formation on exterior windows.

OAT	HUMDITY SETPOINT
-20°C	28% RH
-25°C	24% RH
-30°C	20% RH
-35°C	17% RH

The AFS shall close the humidifier control valve and prevent it from operating should the air flow stop. A second air flow switch provided by this contractor shall terminate power to the humidifier through a relay should the air flow stop.

.9 The CO2 sensor shall be located in the RA duct and in conjunction with the AFMS, shall modulate the FA dampers as required to maintain the setpoint in the RA ducts at maximum air concentrations as directed by the consultant for AHU.

.2 Space Heating:

.1 Perimeter space heating shall be performed by the opening/closing of the control valve serving ceiling mounted hydronic radiant panels, upon a call for heating from temperature sensors. Supplementary heat may be added by modulating electric reheat coils in the VAV boxes as require.

.2 Upon call for heat in interior zones, modulate electric reheat coils in the VAV boxes to maintain the setpoint.

.3 Night setback temperatures shall be a sliding setback as per the following schedule:

OAT	SPACE TEMP.
-30°C	18°C
15°C	15°C

Coordinate with building owner for required schedule.

.4 When the EMCS reaches an optimized time, each heating zone will fully return to occupied space temperature setpoints. The initial occupied space setpoint for each zone shall be 21°C.

.3 Space Cooling:

.1 A temperature sensor shall maintain the space zone temperature for AHU by increasing or decreasing the OA dampers as required. The AHU cooling coil shall modulate the modulating control valve to maintain the SA setpoint.

.2 During unoccupied periods, provide an overnight purge cycle to free cool the space with 100% OA for an adjustable time period to operate daily during the cooling season. Allow the purge cycle to operate when the outdoor enthalpy is below the indoor setpoint only.

.4 Electrical/Communications Room:
.1 Upon a call for cooling the electronic control system shall operate each unit.
.2 Existing rooftop condensing units shall each have a status point for each device and connect to existing BMS.
.3 Provide control point temperature sensor for each room served by these units and connect to BMS for room temperature monitoring.

.5 Fire Alarm Signal:
.1 Upon activation of the fire alarm signal to the BMS:
.1 All air moving equipment to stop.
.2 Upon deactivation of the fire alarm signal to the BMS (Fire alarm panel cleared by local authority):
.1 All air moving equipment to be restarted in stages.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS .1 Section 25 55 00 EMCS DDC Controls

.2 Section 26 05 00 – Common Requirements - Electrical.

1.2 REFERENCES .1 Canadian Standards Association (CSA)
- .1 CAN/CSA C22.3No.1-M87, Overhead Systems

.2 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.

1.3 DESCRIPTION OF SYSTEM .1 Electrical:
- .1 Wiring to provide power from new and from existing power panels to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be tagged, locks applied to prevent inadvertent switching off.
- .2 Hard wiring between field control devices and EMCS field panels.
- .3 Wiring between EMCS field panels and main control centre.
- .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.2 Mechanical:
- .1 All wells and pipe taps required for EMCS shall be provided by EMCS contractor.
- .2 Maintenance of air flow sensors stations, dampers, and other devices requiring sheet metal trades to be mounted by mechanical. Costs to be carried by the EMCS contractor.

.3 Structural:
- .1 All special steelwork as required for installation of work.

1.4 SUPERVISORY PERSONNEL
.1 Qualified personnel to:
.1 Direct and monitor continuously all work.
.2 Attend all site meetings.

1.5 CUTTING AND PATCHING
.1 Repair all surfaces damaged during execution of work.

1.6 SPECIAL REQUIREMENTS
.1 Turn over to departmental representative all existing materials removed from work but not identified for re-use.

1.7 ACCEPTABLE MATERIALS
.1 Where materials are specified by trade name, refer to the Project Specific Instruction to Bidders for procedure to be followed in applying for approval of alternatives.

PART 2 - PRODUCTS

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

2.2 WIRING
.1 To all requirements of Division 26.

.2 Low voltage control wiring in concealed accessible spaces shall be FT-6.

2.3 CONDUIT
.1 To all requirements of Division 26.

.2 EMT, aluminum electrical metallic tubing to CSA, in Mechanical Rooms and exposed locations.

PART 3 - EXECUTION

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

3.2 SUPPORTS
.1 Install all special supports as required and as indicated.

3.3 ELECTRICAL - GENERAL
.1 Do complete installation in accordance with requirements of:
.1 Division 26, this specification.
.2 Electrical Safety Code of Province of New Brunswick.
.3 ANSI/NFPA 70.
.4 ANSI C2.

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

.3 Do underground installation to CAN/CSA C22.3 No.1, except where otherwise specified.

.4 Conform to all manufacturers' recommendations for storage, handling and installation.

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

.6 Install electrical equipment between 1000mm and 2000mm 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 all live parts "LIVE 120 VOLTS" or other appropriate voltage.

.9 Install conduits, sleeves, etc. prior to pouring of concrete.

.10 Holes through exterior wall and roofs: flash and make weatherproof.

.11 Make all necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.

.12 Install all 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 Provide conduit system in Mechanical Rooms and exposed locations to link all field panels and devices to main control centre. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Drawings do not show conduits.

.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. Total not to exceed 60% fill.

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

.5 Bend all 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, equipment, etc:

- .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
- .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
- .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from departmental representative.

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

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

.12 Pass conduits through structural members only after receipt of 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.

.16 Install terminal blocks or strips indicated in cabinets.

3.5 WIRING

.1 Install in ducts as indicated.

.2 Install multiple wiring in ducts simultaneously.

.3 Do not pull spliced wiring inside conduits or ducts.

.4 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.

.5 Tests: use only qualified personnel. Demonstrate that:
- .1 All circuits are continuous, free from shorts, unspecified grounds.
- .2 Resistance to ground of all circuits is greater than 50 Megohms.

.6 Provide departmental representative with test results showing locations, circuits, results of tests.

.7 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.

.8 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.

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

.10 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 all separate grounding conductors in conduit within building.

.3 Install ground wire in all PVC ducts and in all tunnel conduit systems.

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

3.9 TESTS

.1 General:
- .1 Give 14 days written notice of intention to test.
- .2 Conduct in presence of departmental representative and authority having jurisdiction.
- .3 Conceal work only after tests satisfactorily completed.
- .4 Report results of tests to departmental representative in writing.
- .5 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 departmental representative and authority having jurisdiction.

END OF SECTION