Part 1 General

1.1 RELATED DOCUMENTS

.1 All Work of this Division shall be coordinated and provided by the single Building Management System (BMS) Contractor.

.2 The Work of this Division shall be scheduled, coordinated, and interfaced with the associated Work of other trades. Reference the Division 21 Sections for details.

.3 The Work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

.4 If the BMS Contractor believes there are conflicts or missing information in the project documents, the Contractor shall promptly request clarification and instruction from the design team.

1.2 DEFINITIONS

.1 Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.

.2 Binary: A two-state system where an "ON" condition is represented by one discrete signal level and an "OFF" condition is represented by a second discrete signal level.

.3 Building Management System (BMS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BMS Contractor and to be interfaced to the associated Work of other related trades.

.4 BMS Contractor: The single Contractor to provide the Work of this Division. This Contractor shall be the primary manufacturer, installer, commissioner and ongoing service provider for the BMS Work.

.5 Control Sequence: An BMS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

.6 Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BMS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.

.7 BMS Network: The total digital on-line real-time interconnected configuration of BMS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.

.8 Node: A digitally programmable entity existing on the BMS network.

.9 BMS Integration: The complete functional and operational interconnection and interfacing of all BMS Work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BMS as required by this Division.

.10 Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.

.11 PC: IBM-compatible Personal Computer from a recognized major manufacturer

.12 Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the BMS Contractor's cost to the designated third party trade contractor for installation. BMS Contractor shall connect furnished items to the BMS, calibrate, test, commission, warrant and document.

.13 Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the BMS wiring and terminations.

.14 Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.

.15 Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BMS network nodes.

.16 Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BMS industry for real-time, on-line, integrated BMS configurations.

.17 The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.

.18 Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.

.19 The following abbreviations and acronyms may be used in describing the Work of this Division:

ADC	-	Analog to Digital Converter
AI	-	Analog Input
AN	-	Application Node
ANSI	-	American National Standards Institute
AO	-	Analog Output
ASCII	-	American Standard Code for Information Interchange
ASHRAE		American Society of Heating, Refrigeration and Air Conditioning Engineers
AWG	-	American Wire Gauge
CCMS	-	Central Control & Monitoring System
CPU	-	Central Processing Unit

CRT	-	Cathode Ray Tube
DAC	-	Digital to Analog Converter
DDC	-	Direct Digital Control
DI	-	Digital Input
DO	-	Digital Output
EEPROM	-	Electronically Erasable Programmable Read Only Memory
EMI	-	Electromagnetic Interference
FAS	-	Fire Alarm Detection and Annunciation System
GUI	-	Graphical User Interface
HOA	-	Hand-Off-Auto
ID	-	Identification
IEEE	-	Institute of Electrical and Electronics Engineers
I/O	-	Input/Output
LAN	-	Local Area Network
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
MCC	-	Motor Control Center
NC	-	Normally Closed
NIC	-	Not In Contract
NO	-	Normally Open
OWS	-	Operator Workstation
OAT	-	Outdoor Air Temperature
PC	-	Personal Computer
RAM	-	Random Access Memory
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
RH	-	Relative Humidity
ROM	-	Read Only Memory
RTD	-	Resistance Temperature Device
SPDT	-	Single Pole Double Throw
SPST	-	Single Pole Single Throw
XVGA	-	Extended Video Graphics Adapter
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network

1.3 BMS DESCRIPTION

.1 The City of Winnipeg has an existing central monitoring system in place. Where DDC points are identified as centrally monitored points, the controls contractor shall provide and install required hardware and software to interface to the The City's Johnson Controls Metasys EA servers and workstations. These are located at the Central Control Offices, 510 Main Street, Winnipeg, Manitoba (ie City Hall).

.2 Controls contractor to supply all drawings/graphics/sequence of operations in both a hard and soft copy. Drawings and graphics to be able to be read and modified by City of

Winnipeg Staff. User interface graphics to be completed using Graphic Generation Tool software. Graphics must use City of Winnipeg graphic templates. Contractor to supply As-Built drawings in an editable format, able to be easily edited by City of Winnipeg Staff. Contractor shall use metric units; imperial units will not be accepted.

.3 The use of either N2Open or BACnet to be determined based on type of building where the Work is being performed. The new Work is to be tied into the existing controls. The contractor should contact City of Winnipeg technical staff to determine the best protocol to use based on existing equipment.

.4 The existing facility consists of multiple NAE's. At a minimum, one new NAE shall be provided for the new system.

.5 No LON protocols are to be accepted.

.6 The Building Management System (BMS) shall be a complete system designed for use with the enterprise IT systems. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the The City's IT staff to ensure that the FMS will perform in the The City's environment without disruption to any of the other activities taking place on that LAN.

.7 All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BMS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.

.8 Where necessary and as dictated elsewhere in these Specifications, Servers shall be used for the purpose of providing a location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data stored will be through the use of a standard data base platform: Microsoft Data Engine (MSDE) or Microsoft SQL Server as dictated elsewhere in this specification.

.9 The Work of the single BMS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing Work as referenced in the related documents.

.10 The BMS Work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BMS.

.11 Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.

.12 Manage and coordinate the BMS Work in a timely manner in consideration of the Project schedules. Coordinate with the associated Work of other trades so as to not impede or delay the Work of associated trades.

.13 The BMS as provided shall incorporate, at minimum, the following integrated features, functions and services:

.1 Operator information, alarm management and control functions.

.2 Enterprise-level information and control access.

.3 Information management including monitoring, transmission, archiving, retrieval, and reporting functions.

.4 Diagnostic monitoring and reporting of BMS functions.

.5 Offsite monitoring and management access.

.6 Energy management

.7 Standard applications for terminal HVAC systems.

.8 Indoor Air Quality monitoring and control

1.4 QUALITY ASSURANCE

.1 General

.1 The Building Management System Contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management Systems.

.2 The BMS Contractor shall be a recognized national manufacturer, installer and service provider of BMS.

.3 If a franchised dealer is to be considered via addendum, the dealer must provide a letter written by a minimum Vice President of Operations for the specific automatic temperature control manufacturer with the following verbiage; “should the Franchise Dealer fail to provide a complete and operational system (as judged by the The City/Contract Administrator), the Manufacturer will complete the project to the Contract Administrators satisfaction at no additional cost to the City”. This letter must be provided to the Contract Administrator along with the other supporting documentation at the time of request for equal in accordance with B7.

.4 The BMS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.

.5 As evidence and assurance of the contractor’s ability to support the City's system with service and parts, the contractor must have been in the BMS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.

.6 The Building Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Management Systems, and shall be the manufacturer’s latest standard of design at the time of bid.

.2 Workplace Safety And Hazardous Materials

.1 Provide a safety program in compliance with the Contract Documents.

.2 The FMS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.

.3 The Contractor and its employees and subtrades comply with federal, state and local safety regulations.

.4 The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of Work, and that their employees receive the training required by the OSHA have jurisdiction for at least each topic listed in the Safety Certification Manual.

.5 Hazards created by the Contractor or its subcontractors shall be eliminated before any further Work proceeds.

.6 Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the Contractor or the City within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.

.7 The Contractor shall sign and date a safety certification form prior to any Work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.

.8 The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the Work in compliance with the requirements of the AHJ at the Project site.

.9 The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

.3 Quality Management Program

.1 Designate a competent and experienced employee to provide BMS Project Management. The designated Project Manger shall be empowered to make technical, scheduling and related decisions on behalf of the BMS Contractor. At minimum, the Project Manager shall:

.1 Manage the scheduling of the Work to ensure that adequate materials, labor and other resources are available as needed.

.2 Manage the financial aspects of the BMS Contract.

.3 Coordinate as necessary with other trades.

.4 Be responsible for the Work and actions of the BMS workforce on site.

1.5 REFERENCES

.1 All Work shall conform to the following Codes and Standards, as applicable:

.1 National Fire Protection Association (NFPA) Standards.

.2 National Electric Code (NEC) and applicable local Electric Code.

.3 Underwriters Laboratories (UL) listing and labels.

.4 UL 916 Energy Management

.5 NFPA 70 - National Electrical Code.

.6 NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.

.7 Factory Mutual (FM).

.8 American National Standards Institute (ANSI).

.9 National Electric Manufacturer's Association (NEMA).

.10 American Society of Mechanical Engineers (ASME).

.11 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

.12 Air Movement and Control Association (AMCA).

.13 Institute of Electrical and Electronic Engineers (IEEE).

.14 American Standard Code for Information Interchange (ASCII).

.15 Electronics Industries Association (EIA).

.16 Occupational Safety and Health Administration (OSHA).

.17 American Society for Testing and Materials (ASTM).

.18 Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.

.19 Americans Disability Act (ADA)

.20 ANSI/ASHRAE Standard 195-2004 (BACnet)

.2 In the case of conflicts or discrepancies, the more stringent regulation shall apply.

.3 All Work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.6 WORK BY OTHERS

.1 Section 22 40 10 and Section 23 60 10 to distribute and mount all pipe connected equipment including valves, , flow switches etc. in their respective locations, as supervised by Section 25 10 10.

.2 Section 23 80 10 to distribute and mount all motorized dampers, etc. in their respective locations, as supervised by Section 25 10 10.

.3 Section 23 80 10 shall provide additional galv. iron baffles as required at all mixed air plenums to ensure good air mix so controllers can function properly. Section 25 10 10 shall assist Section 23 80 10 in establishing locations of such baffles.

.4 Division 26 - Electrical to supply and install all conduit, wire and connections from the distribution panels to line side of magnetic starters and thermal overload switches, and from load side of starters and switches to motors.

.5 Division 26 - Electrical to supply and install conduit, wire and connection for line voltage control devices on single phase equipment such as:

.1 Mechanical wiring required but not specified in this section of the specifications.

.2 All safety controls must be wired in series with both "HAND" and "AUTO" starter switch positions to ensure against damage to equipment and/or system.

.3 Power source wiring to Section 25 10 10 systems panels and other devices or groups of devices requiring 120 volt power source.

.4 All control wiring for boilers in accordance with wiring diagrams supplied by boiler manufacturer.

.5 All control wiring for remote supervisory panels supplied with gas-fired units.

1.7 ELECTRICAL WIRING PERFORMED BY SECTION 25 10 10

.1 Supply and installation of all conduit, wire, electric relays, connections and other devices required for control circuit wiring for systems as specified in Section 25 10 10, whether line or low voltage, shall be responsibility of Section 25 10 10, except as noted above.

.2 Section 25 10 10 shall either use own electricians, retain and pay for services of successful Division 26, or use an electrical Subcontractor acceptable to Contract Administrator to supply and install all conduit and wiring for systems as specified in this Section.

.3 Factory trained servicemen in employ of manufacturer, shall make final wiring connections on all components, mount and electrically connect all controls.

.4 Electrical wiring shall be installed in conformance with CSA, ULC, Manitoba Building Code, National Building Code of Canada and standards set in Division 26 of this specification.

.5 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.

.6 Wire all safety controls in series with both 'Hand' and 'Auto' starter positions to ensure that systems are properly protected.

.7 Section 25 10 10 shall provide all other conduit and wiring required for Section 25 10 10 systems operation, including tie-ins from Section 25 10 10 supplied relays to motor starting circuits.

.8 As a minimum, provide separate, dedicated conduit system for each of following. Conduit to be minimum 19mm EMT.

.1 C.C.M.S. transmission wiring.

.2 All other wiring connected to an electronic control system including sensor and control wiring associated with DDC panels, DGP's, Card Access Panels, etc., which are connected to the C.C.M.S. system or are capable of being connected at some future date.

.3 Sensor and control wiring for stand-alone electric control systems. Conduit identification labels shall state "CCMS" for 1., and 2., 3. above, and "CONTROL WIRING" for above.

.9 If approved by system manufacturer, cable up to 30 Volts may be installed in extra-low voltage communication cable tray.

.10 Refer to Division 26 for conduit and cable identification requirements.

.11 Section 25 10 10 shall provide detailed wiring diagrams for remote supervisory panels supplied with rooftop equipment, connections between Section 25 10 10 supplied equipment.

.12 Supply and installation of all equipment interlocks required to meet the sequence of operations.

1.8 SUBMITTALS

.1 Shop Drawings, Product Data, and Samples

.1 The BMS contractor shall submit a list of all shop drawings with submittals dates within 30 days of contract award.

.2 Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Contract Administrator for Contract compliance.

.3 Allow 15 working days for the review of each package by the Contract Administrator in the scheduling of the total BMS Work.

.4 Equipment and systems requiring approval of local authorities must comply with such regulations and be approved. Filing shall be at the expense of the BMS Contractor where filing is necessary. Provide a copy of all related correspondence and permits to the City.

.5 Prepare an index of all submittals and shop drawings for the installation. Index shall include a shop drawing identification number, Contract Documents reference and item description.

.6 The BMS Contractor shall correct any errors or omissions noted in the first review.

.7 Prior to commissioning, submit as-built information and drawings for each of the above items, for use by The City during commissioning.

.8 At a minimum, submit the following:

.1 BMS network architecture diagrams including all nodes and interconnections.

.2 Systems schematics, sequences and flow diagrams.

.3 Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.

.4 Samples of Graphic Display screen types and associated menus.

.5 Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features.

.6 Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.

.7 Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.

.8 Details of all BMS interfaces and connections to the Work of other trades.

.9 Product data sheets or marked catalog pages including part number, photo and description for all products including software.

1.9 RECORD DOCUMENTATION

.1 Operation and Maintenance Manuals

.1 Three (3) copies of the Operation and Maintenance Manuals shall be provided to the City's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:

.1 Table of contents.

.2 As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

.3 Manufacturers product data sheets or catalog pages for all products including software.

.4 System Operator's manuals.

.5 Archive copy of all site-specific databases and sequences.

.6 BMS network diagrams.

.7 Interfaces to all third-party products and Work by other trades.

.2 The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

.2 On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

1.10 WARRANTY

.1 Standard Material and Labor Warranty:

.1 Provide a one-year labor and material warranty on the BMS.

.2 If within twelve (12) months from the date of acceptance of product, upon written notice from the City, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.

.3 Maintain an adequate supply of materials within Winnipeg such that replacement of key parts and labor support, including programming. Warranty Work shall be done during BMS Contractor's normal business hours.

Part 2 Products

2.1 GENERAL DESCRIPTION

.1 The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other City provided networks.

.2 The Building Management System shall consist of the following:

.1 Standalone Network Automation Engine(s)

.2 Field Equipment Controller(s)

.3 Input/Output Module(s)

.4 Local Display Device(s)

.5 Portable Operator's Terminal(s)

.6 Distributed User Interface(s)

.7 Network processing, data storage and communications equipment

.8 Other components required for a complete and working BMS

.3 The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

.4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

.5 Acceptable Manufacturers

.1 **Basis of Design**: Johnson Controls Metasys

2.2 IDENTIFICATION OF EQUIPMENT - GENERAL

.1 Use engraved black and white laminated plastic, 25mm x 62mm (1") x (2-1/2"), at all thermostats, thermometers, panels, etc., supplied so as to clearly indicate service of particular device. Manual switches, unless they come with standard nameplates, and thermostats, thermometers, switches, etc., installed on local panels to be similarly labelled. All controllers, relays, etc. mounted inside local panels may have tape labels.

.2 Excluding damper assemblies, provide lamacoid identification plates fastened with rivets or self-tapping screws at all equipment supplied by Section 25 10 10 so as to clearly indicate service of particular device. All manual switches, unless they come with standard nameplates, shall be similarly labelled.

.3 Equipment installed on surfaces of local panels shall be similarly labelled. Equipment mounted inside local panels, must have permanent plate labels with self-tapping screws. Tape labels are not acceptable.

.4 Identification plates, by Section 25 10 10, to be white background with minimum 5mm high black letters, unless specified otherwise. Electrical systems identification to be as per Division 26.

.5 Information on lamacoid identification plates to be consistent with 'as-built' control Drawings.

.6 Prior to lamacoid fabrication, submit copies of control Drawings and complete list of proposed wording for each lamacoid, for approval by Contract Administrator and City. Include copy of approved lamacoid list in each Maintenance/Operating Manual.

2.3 INSTRUMENT CABINETS

.1 Provide at each system or groups of systems, cabinet type metal control panel with all instruments mounted inside locking cover. All panels shall have same key. Temperature indication and control point adjustments and gauges labelled as to function with lamacoid nametags fixed to panel face with self-tapping screws. All electrical equipment mounted in cabinet to be pre-wired to labelled terminal strips.

2.4 IDENTIFICATION OF EQUIPMENT CONTROLLED BY C.C.M.S.

.1 Provide adhesive back tags for all pieces of equipment controlled by the C.C.M.S.

.2 Tags shall be white background with red letters, 100mm wide x 70mm high, with rounded corners, and shall read as follows:

"WARNING

- THIS EQUIPMENT IS UNDER CENTRAL CONTROL AND MAY START OR STOP WITHOUT WARNING
- Leave starters in 'AUTO' position.
- Phone CCMS Office to inform monitoring room if equipment is being shutdown.
- Ensure disconnect is locked off prior to working on equipment."

.3 Tags shall be of 3M Material, similar to that used for renewal tags on automobile licence plates, as available from Aristo-Print Limited, Winnipeg.

.4 Submit one sample tag for approval prior to installation.

.5 An example label is included at end of this section for information purposes.

2.5 BMS ARCHITECTURE

.1 Automation Network

.1 The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

.2 The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

.3 The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

.4 Network Automation Engines (NAE) shall reside on the automation network.

.5 The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.2 Control Network

.1 Network Automation Engines shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

.1 BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.

.2 The Johnson Controls N2 Field Bus.

.2 Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

.3 DDC Controllers shall reside on the control network.

.4 Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

.5 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.6 The Conformance Statements shall be submitted 10 day prior to bidding.

.3 Integration

.1 Hardwired

.1 Analog and digital signal values shall be passed from one system to another via hardwired connections.

.2 There will be one separate physical point on each system for each point to be integrated between the systems.

.2 Direct Protocol (Integrator Panel)

.1 The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and 3rd party manufacturers' control panels. The BMS shall receive, react to, and return information from multiple building systems, including but not limited to the boilers and variable frequency drives.

.2 All data required by the application shall be mapped into the Automation Engine's database, and shall be transparent to the operator.

.3 Point inputs and outputs from the third-party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

.3 BACnet Protocol Integration - BACnet

.1 The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.

.2 A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

.3 The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.6 USER INTERFACE

.1 Dedicated Web Based User Interface

.1 The control system shall be compatible with the existing central monitoring system; refer to BMS description.

.2 No outside PC's can reside on the City of Winnipeg network.

.2 User Interface Application Components

.1 Operator Interface

.1 An integrated browser based client application shall be used as the user operator interface program.

.2 All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system

software, shall be displayed for operator viewing and modification from the operator interface software.

.3 The user interface software shall provide help menus and instructions for each operation and/or application.

.4 All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

.5 The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

.1 User access for selective information retrieval and control command execution

.2 Monitoring and reporting

.3 Alarm, non-normal, and return to normal condition annunciation

.4 Selective operator override and other control actions

.5 Information archiving, manipulation, formatting, display and reporting

.6 FMS internal performance supervision and diagnostics

.7 On-line access to user HELP menus

.8 On-line access to current FMS as-built records and documentation

.9 Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.

.6 The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

.2 Navigation Trees

.1 The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

.2 Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

.3 The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

.3 Alarms

.1 Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management

portion of the user interface shall, at the minimum, provide the following functions:

.1 Log date and time of alarm occurrence.

.2 Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.

.3 Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.

.4 Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.

.5 Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.

.6 Any attribute of any object in the system may be designated to report an alarm.

.2 The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions

.3 The FMS shall annunciate application alarms at minimum, as required by Part 3.

.4 Reports and Summaries

.1 Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

.1 All points in the BMS

.2 All points in each BMS application

.3 All points in a specific controller

.4 All points in a user-defined group of points

.5 All points currently in alarm

.6 All points locked out

.7 All BMS schedules

.8 All user defined and adjustable variables, schedules, interlocks and the like.

.2 Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.

.3 Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.

.4 The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

.5 Schedules

.1 A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

.1 Weekly schedules

.2 Exception Schedules

.3 Monthly calendars.

.2 Weekly schedules shall be provided for each group of equipment with a specific time use schedule.

.3 It shall be possible to define one or more exception schedules for each schedule including references to calendars

.4 Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.

.5 Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.

.6 Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.

.7 Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

.6 Password

.1 Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.

.2 Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.

.3 The system shall allow each user to change his or her password at will.

.4 When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

.5 A minimum of five levels of access shall be supported individually or in any combination as follows:

.1 Level 1 = View Data

.2 Level 2 = Command

.3 Level 3 = Operator Overrides

.4 Level 4 = Database Modification

.5 Level 5 = Database Configuration

.6 Level 6 = All privileges, including Password Add/Modify

.6 A minimum of 100 unique passwords shall be supported.

.7 Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

.8 The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection

parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

.7 Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

.8 Dynamic Color Graphics

.1 The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

.2 The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.

The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.

.3 Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:

.1 All graphics shall be fully scalable

.2 The graphics shall support a maintained aspect ratio.

.3 Multiple fonts shall be supported.

.4 Unique background shall be assignable on a per graphic basis.

.5 The color of all animations and values on displays shall indicate if the status of the object attribute.

.4 Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device

.5 Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

.1 The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.

.2 In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

.6 Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

.9 Historical trending and data collection

.1 Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

.1 Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

.1 Defined time interval

.2 Upon a change of value

.2 Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

.2 Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

.3 The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.

.10 Trend data viewing and analysis

.1 Provide a trend viewing utility that shall have access to all database points.

.2 It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.

.3 The trend viewing utility shall have the capability to define trend study displays to include multiple trends

.4 Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.

.5 Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.

.6 Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.

.7 Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

.3 Portable Operator Terminal

.1 The control system shall provide full access to systems configuration and definition via the Browser Based user interface. Providing a portable operator terminal for programming purposes is not acceptable.

2.7 NETWORK AUTOMATION ENGINES (NAE)

.1 Network Automation Engine (**NAE**)

.1 The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed

application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

.2 Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.

.3 User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

.1 The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.

.2 The NAE shall support up four (4) concurrent users.

.3 The web based user shall have the capability to access all system data through one NAE.

.4 Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

.5 Systems that require the user to address more than one NAE to access all system information are not acceptable.

.6 The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.

.7 Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.

.8 The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:

.1 Configuration

.2 Commissioning

.3 Data Archiving

.4 Monitoring

.5 Commanding

.6 System Diagnostics

.9 Systems that require workstation software or modified web browsers are not acceptable.

.10 The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

.4 Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.

.5 Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

.6 Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.

.7 The NAE shall include troubleshooting LED indicators to identify the following conditions:

.1 Power - On/Off

.2 Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic

.3 Ethernet Connection Speed – 10 Mbps/100 Mbps

.4 FC Bus – Normal Communications/No Field Communications

.5 Peer Communication – Data Traffic Between NAE Devices

.6 Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running

.7 Bat Fault – Battery Defective, Data Protection Battery Not Installed

.8 Fault – General Fault

.9 Modem RX – NAE Modem Receiving Data

.10 Modem TX – NAE Modem Transmitting Data

.8 Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

.1 Up to two (2) USB port

.2 Up to two (2) URS-232 serial data communication port

.3 Up to two (2) RS-485 port

.4 One (1) Ethernet port

.9 Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

.10 Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

.1 During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

.2 Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

.11 Certification – The NAE shall be listed by Underwriters Laboratories (UL).

.12 Controller network – The NAE shall support the following communication protocols on the controller network:

.1 The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

.1 A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

.2 The Conformance Statements shall be submitted 10 day prior to bidding.

.3 The NAE shall support a minimum of 100 control devices.

.2 The NAE shall support the Johnson Controls N2 Field Bus.

.1 The NAE shall support a minimum of 100 N2 control devices.

.2 The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.

.3 The Bus shall employ a master/slave protocol where the NAE is the master.

.4 The Bus shall employ a four (4) level priority system for polling frequency.

.5 The Bus shall be optically isolated from the NAE.

.6 The Bus shall support the Metasys Integrator System.

2.8 DDC SYSTEM CONTROLLERS

.1 Field Equipment Controller (**FEC**)

.1 The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

.2 The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

.3 Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

.4 The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.5 The FEC shall include a removable base to allow pre-wiring without the controller.

.6 The FEC shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Field Controller Bus - Normal Data Transmission

.7 Field Controller Bus - No Data Transmission

.8 Field Controller Bus - No Communication

.9 Sensor-Actuator Bus - Normal Data Transmission

.10 Sensor-Actuator Bus - No Data Transmission

.11 Sensor-Actuator Bus - No Communication

.7 The FEC shall accommodate the direct wiring of analog and binary I/O field points.

.8 The FEC shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, current Mode

.4 Binary Outputs - shall output the following:

.1 24 VAC Triac

.5 Configurable Outputs - shall be capable of the following:

.1 Analog Output, Voltage Mode

.2 Binary Output Mode

.9 The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).

.1 The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The FC Bus shall support communications between the FECs and the NAE.

.3 The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.

.4 The FC Bus shall support a minimum of 100 IOMs and FEC in any combination.

.5 The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.

.10 The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).

.1 The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

.2 The SA Bus shall support a minimum of 10 devices per trunk.

.3 The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.

.11 The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.

.12 The FEC shall support, but not be limited to, the following:

.1 Hot water central plant applications

.2 Built-up air handling units for special applications

.3 Terminal units

.4 Special programs as required for systems control

2.9 FIELD DEVICES

.1 Input/Output Module **(IOM)**

.1 The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.

.2 The IOM shall communicate with the FEC over either the FC Bus or the SA Bus using BACnet Standard protocol SSPC-135, Clause 9.

.3 The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

.4 The IOM shall have a minimum of 4 points to a maximum of 17 points.

.5 The IOM shall support the following types of inputs and outputs:

.1 Universal Inputs - shall be configured to monitor any of the following:

.1 Analog Input, Voltage Mode

.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode

.4 Binary Input, Dry Contact Maintained Mode

.5 Binary Input, Pulse Counter Mode

.2 Binary Inputs - shall be configured to monitor either of the following:

.1 Dry Contact Maintained Mode

.2 Pulse Counter Mode

.3 Analog Outputs - shall be configured to output either of the following

.1 Analog Output, Voltage Mode

.2 Analog Output, current Mode

.4 Binary Outputs - shall output the following:

.1 24 VAC Triac

.2 Configurable Outputs - shall be capable of the following:

.3 Analog Output, Voltage Mode

.4 Binary Output Mode

.6 The IOM shall include troubleshooting LED indicators to identify the following conditions:

.1 Power On

.2 Power Off

.3 Download or Startup in progress, not ready for normal operation

.4 No Faults

.5 Device Fault

.6 Normal Data Transmission

.7 No Data Transmission

.8 No Communication

.2 Networked Thermostat **(TEC)**

.1 The Networked Thermostats shall be capable of controlling all necessary functions.

.2 The Networked Thermostat shall communicate over the Field Controller Bus using BACnet Standard protocol SSPC-135, Clause 9.

.1 The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.

.3 The Networked Thermostat shall include an intuitive User Interface providing plain text messages.

.1 Two line, 8 character backlit display

.2 LED indicators for Fan and Heat status

.3 Five (5) User Interface Keys

.1 Mode

.2 Fan

.3 Override

.4 Degrees C/F

.5 Up/Down

.4 The display shall continuously scroll through the following parameters:

.1 Room Temperature

.2 System Mode

.3 Schedule Status – Occupied/Unoccupied/Override

.4 Applicable Alarms

.4 The Networked Thermostats shall provide the flexibility to support the following inputs:

.1 Integral Indoor Air Temperature Sensor

.2 Duct Mount Air Temperature Sensor

.3 Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator.

.4 Two configurable binary inputs

.5 The Networked Thermostats shall provide the flexibility to support the following outputs:

.1 Three Speed Fan Control

.2 On/Off Control

.3 Floating Control

.4 Proportional (0 to 10V) Control

.6 The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.

.7 The Networked Thermostat shall provide the flexibility to adjust the following parameters:

.1 Adjustable Temporary Occupancy from 0 to 24 hours

.2 Adjustable heating deadband from 2º F to 5º F

.3 Adjustable heating cycles per hour from 4 to 8

.8 The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

.3 Network Sensors **(NS)**

.1 The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:

.1 Zone Temperature

.2 Zone humidity

.3 Zone setpoint

.2 The NS shall transmit the zone information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.

.3 The Network Sensors shall include the following items:

.1 A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint.

.2 An LED to indicate the status of the Override feature.

.3 A button to toggle the temperature display between Fahrenheit and Celsius.

.4 A button to initiate a timed override command

.4 The NS shall be available with either screw terminals or phone jack.

.5 The NS shall be available in either surface mount or wall mount styles.

2.10 INPUT DEVICES

.1 General Requirements

.1 Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

.2 Temperature Sensors

.1 General Requirements:

.1 Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.

.2 The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

.3 The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Room Temp	$\pm$ .5°F.
Duct Temperature	$\pm$ .5°F.
All Others	$\pm$ .75°F.

.2 Room Temperature Sensors

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have the following options when specified:

.1 Setpoint reset slide switch providing a $\pm$3 degree (adjustable) range.

.2 Individual heating setpoint slide switches.

.3 A momentary override request push button for activation of after-hours operation.

.4 Analog thermometer.

.3 Room Temperature Sensors with Integral Display

.1 Room sensors shall be constructed for either surface or wall box mounting.

.2 Room sensors shall have an integral LCD display and four button keypad with the following capabilities:

.1 Display room and outside air temperatures.

.2 Display and adjust room comfort setpoint.

.3 Display and adjust fan operation status.

.4 Timed override request push button with LED status for activation of after-hours operation.

.5 Display controller mode.

.6 Password selectable adjustment of setpoint and override modes.

.4 Thermo wells

.1 When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.

.2 Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.

.3 Thermo wells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.

.4 Thermo wells shall be constructed of 316 stainless steel.

.5 Outside Air Sensors

.1 Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

.2 Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.

.3 Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

.6 Duct Mount Sensors

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

.7 Averaging Sensors

.1 For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

.2 For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.

.3 Capillary supports at the sides of the duct shall be provided to support the sensing string.

.8 Acceptable Manufacturers: Johnson Controls, Setra.

.3 CO and NO_2 Gas Detectors

.1 BACnet controller with on board data logging & Bacnet IP output, model VA301C-DLC-BIP to supervise the zone CO detectors E3SMSCO and the zone NO2 detectors E3SMSNO2. The BACnet controller will connect to the DDC.

.2 Honeywell E^3Point gas detector, wall mounted, 8.1"x5.9"x2.7" size, 24Vac nominal power, BACnet communications, model E3SMSCO for CO monitoring and model E3SMSNO2 for NO2 monitoring.

.3 For units located in new wash bay (as noted on the drawings) provide Honeywell ECLAB water proof enclosure, model TK 2518, NEMA 4X, polystyrene, 10"x7.1", sidewalls with knockouts, high cover, 4.4" high, cat. No. 116-508, type PS 2518-11-t, transparent cover.

.4 Controller shall be complete with dry contacts to start and stop fans directly

.5 Controller shall be in a NEMA 4X enclosure.

.6 Transmitter will be powered by the control panels power output rated at 17-27 Vac or by an external power supply rated at 17-27 Vac or 24-38 Vdc.

.7 The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy. For local activation of fans or louvers (or other equipment) an optional DPDT relay 5A, 30 Vdc or 250 Vac (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. Transmitter will also have the capability of sending an analog 4-20mA signal to the BMS/DDC.

.8 A ten step LED display, will provide reading of concentration of gas. Normal operation will be indicated by a green LED; fault operation will be indicated by a yellow LED. Transmitter must also be capable of incorporating an audible alarm (rated at no less than 65Db at a distance of 3 feet) which will be activated at fully programmable levels through the control panel.

.9 Transmitter will be capable of operating within relative humidity ranges of 5-90% and temperature ranges of 32F to 100F (0C to 40C). Transmitter must also have optional capacity of operating at lower temperature range.

.10 Unit will be manufactured to UL 1244 label and CSA 22.2. Transmitter must be manufactured within an ISO 9002 production environment.

.11 Transmitter unit to be installed to the following parameters:

GASES	SENSOR LOCATION	RADIUS OF COVERAGE
Carbon Monoxide (CO)	3-5 ft above the floor	50 feet
Nitrogen Dioxide (NO_2)	1-3 ft below the ceiling	50 feet

.12 Acceptable manufacturers: Honeywell

.4 Status and Safety Switches

.1 General Requirements

.1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Current Sensing Switches

.1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

.2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

.3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.4 Acceptable manufacturers: Veris Industries

.3 Air Filter Status Switches

.1 Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.

.2 A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.

.3 Provide appropriate scale range and differential adjustment for intended service.

.4 Acceptable manufacturers: Johnson Controls, Cleveland Controls

.4 Air Flow Switches

.1 Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

.2 Acceptable manufacturers: Johnson Controls, Cleveland Controls

.5 Water Flow Switches

.1 Water flow switches shall be equal in accordance with B7 to the Johnson Controls P74.

.6 Low Temperature Limit Switches

.1 The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.

.2 The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

.4 The low temperature limit switch shall be equal in accordance with B7 to Johnson Controls A70.

2.11 OUTPUT DEVICES

.1 Actuators

.1 General Requirements

.1 Damper and valve actuators shall be electronic.

.2 Electronic Damper Actuators

.1 Electronic damper actuators shall be direct shaft mount.

.2 Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.

.3 Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.4 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

.5 Acceptable manufacturers: Johnson Controls, Mamac.

.3 Electronic Valve Actuators

.1 Electronic valve actuators shall be manufactured by the valve manufacturer.

.2 Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.

.3 Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.

.4 Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

.5 Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump.

.6 Acceptable manufacturers: Johnson Controls

.2 Control Dampers

.1 The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

.2 Provide all control dampers of type and sizes indicated. All outside and exhaust control dampers to be opposed blade low leakage moduflo dampers. Frames to be heavy ga. galv. steel formed for extra strength with mounting holes for flange and enclosed duct mounting. Dampers available in 50mm (2") size increments from 203mm (8") horizontal and vertical to 1219mm (48"). Requirements over 1219mm (48") to be standard modules with interconnecting hardware. 1.6mm (16 ga.) damper blades, galv. steel, roll formed for high velocity performance. Blades of 203mm (8") width maximum; blade seals and spring loaded stainless side seals. Dampers and seals suitable for temperature ranges of -40 deg.C to 100 deg.C. Leakage shall not exceed 1% with approach velocity of 7.62M/s (1500fpm) when damper is closed against 100mm (4") W.G.

.3 Control Relays

.1 Control Pilot Relays

.1 Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

.2 Mounting Bases shall be snap-mount.

.3 DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

.4 Contacts shall be rated for 10 amps at 120VAC.

.5 Relays shall have an integral indicator light and check button.

.6 Acceptable manufacturers: Finder, Omron

.4 Control Valves

.1 All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the loads, as

specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.

.2 Ball valves shall be used for hot glycol applications except those described hereinafter.

.3 Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

.4 Acceptable manufacturers: Johnson Controls

.5 Electronic Signal Isolation Transducers

.1 A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a boiler control panel), or is to receive as an input signal from a remote system.

.2 The signal isolation transducer shall provide ground plane isolation between systems.

.3 Signals shall provide optical isolation between systems.

.4 Acceptable manufacturers: Advanced Control Technologies

.6 External Manual Override Stations

.1 External manual override stations shall provide the following:

.1 An integral HAND/OFF/AUTO switch shall override the controlled device pilot relay.

.2 A status input to the Facility Management System shall indicate whenever the switch is not in the automatic position.

.3 A Status LED shall illuminate whenever the output is ON.

.4 An Override LED shall illuminate whenever the HOA switch is in either the HAND or OFF position.

.5 Contacts shall be rated for a minimum of 1 amp at 24 VAC.

2.12 MISCELLANEOUS DEVICES

.1 Local Control Panels

.1 All control panels shall be factory constructed, incorporating the BMS manufacturer’s standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch (minimum standard of acceptance is a NEMA 4 enclosure suitable for the facility environment).

.2 In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays,

transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

.3 All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

.4 Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

.5 All wiring shall be neatly installed in plastic trays or tie-wrapped.

.6 A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

.2 Power Supplies

.1 DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

.2 Input: 120 VAC +10%, 60Hz.

.3 Output: 24 VDC.

.4 Line Regulation: +0.05% for 10% line change.

.5 Load Regulation: +0.05% for 50% load change.

.6 Ripple and Noise: 1 mV rms, 5 mV peak to peak.

.7 An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

.8 A power disconnect switch shall be provided next to the power supply.

.3 Thermostats

.1 Electric space thermostats of the heavy-duty type shall be provided. All these items shall be provided with concealed adjustment. Thermostats shall be provided in enclosures to protect against the ingress of water (dripping, hosedown and splashing) and ingress of solid foreign objects (falling dirt, circulating dust/lint/fibers, settling airborne dust/lint/fibers). Finish of enclosures shall match and be manufacturer's standard finish.

Part 3 Performance / Execution

3.1 BMS SPECIFIC REQUIREMENTS

.1 Graphic Displays

.1 Provide advanced color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.

.2 User shall access the various system schematics via a graphical penetration scheme and/or menu selection. .

.2 Custom Reports:

.1 Provide custom reports as specified by the City of Winnipeg:

.3 Actuation / Control Type

.1 Primary Equipment

.1 Controls shall be provided by equipment manufacturer as specified herein.

.2 All damper and valve actuation shall be electric.

.2 Air Handling Equipment

.1 All air handers shall be controlled with a HVAC-DDC Controller

.2 All damper and valve actuation shall be electric.

3.2 INSTALLATION PRACTICES

.1 BMS Wiring

.1 All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.

.2 All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.

.3 The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.

.4 Class 2 Wiring

.1 All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.

.2 Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

.5 Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

.6 Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

.2 BMS Line Voltage Power Source

.1 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 26.

.2 Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.

.3 DDC terminal unit controllers may use AC power from motor power circuits.

.3 BMS Raceway

.1 All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".

.2 Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Contract Administrator.

.3 All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

.4 Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

.4 Penetrations

.1 Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.

.2 All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

.3 All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.

.4 Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

.5 BMS Identification Standards

.1 Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

.6 BMS Panel Installation

.1 The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

.2 The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical subcontractors.

.7 Input Devices

.1 All Input devices shall be installed per the manufacturer recommendation

.2 Locate components of the BMS in accessible local control panels wherever possible.

.8 HVAC Input Devices – General

.1 All Input devices shall be installed per the manufacturer recommendation

.2 Locate components of the BMS in accessible local control panels wherever possible.

.3 The mechanical subcontractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.

.4 Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.

.5 Outside Air Sensors

.1 Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.

.2 Sensors shall be installed with a rain proof, perforated cover.

.6 Water Differential Pressure Sensors

.1 Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.

.2 Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.

.3 The transmitters shall be installed in an accessible location wherever possible.

.7 Medium to High Differential Water Pressure Applications (Over 21" w.c.):

.1 Air bleed units, bypass valves and compression fittings shall be provided.

.8 Space Sensors:

.1 Shall be mounted per ADA requirements.

.2 Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

.9 Low Temperature Limit Switches:

.1 Install on the discharge side of the first water or steam coil in the air stream.

.2 Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.

.3 For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

.10 Air Differential Pressure Status Switches:

.1 Install with static pressure tips, tubing, fittings, and air filter.

.11 Water Differential Pressure Status Switches:

.1 Install with shut off valves for isolation.

.9 HVAC Output Devices

.1 All output devices shall be installed per the manufacturers recommendation. The mechanical subcontractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.

.2 Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke.

.3 Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

.4 Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

.5 Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a boiler control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal

isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.3 TRAINING

.1 The BMS contractor shall provide the following training services:

.1 One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.4 COMMISSIONING

.1 Fully commission all aspects of the Building Management System Work.

.2 Acceptance Check Sheet

.1 Prepare a check sheet that includes all points for all functions of the BMS as indicated on the point list included in this specification.

.2 Submit the check sheet to the Contract Administrator for approval

.3 The Contract Administrator will use the check sheet as the basis for acceptance with the BMS Contractor.

.3 Promptly rectify all listed deficiencies and submit to the Contract Administrator that this has been done.

3.5 SEQUENCES

.1 Space Pressure Differential

.1 Provide Magnahelic gauges (3 in Service Bay and 3 in B-Section) to measure space differential pressure.

.2 Provide the pressure registered from each gauge as a DDC point in the BMS.

.2 Gas Detection

.1 Gas detection system shall be configured in the following zones:

- Zone 1 (Standalone): Mechanical Room
- Zone 2: Service Bay
- Zone 3: B-Section

.2 System shall operate as follows:

.1 Zone 1 – Mechanical Room

.1 Send notification to the BMS when CO level exceeds 12 ppm.

.2 Local sounder and alarm to the BMS when CO level exceeds 25 ppm.

.3 Send fire alarm supervisory alarm signal if CO level is sustained at 200 ppm for five minutes.

.2 Zone 2 – Service Bay

.1 The highest reading in each zone shall form the basis of zone reading.

.2 Send notification to the BMS when CO level exceeds 12 ppm or NOx level exceeds 0.2 ppm. Initiate operation of MUA's, EF's and transfer fan system in Service Bay and Storage Tracks according to sequences below if not already in operation.

.3 Local sounder and alarm to the BMS when CO level exceeds 25 ppm and NOx level exceeds 2 ppm.

.4 Send fire alarm supervisory alarm signal if CO level is sustained at 200 ppm for five minutes

.3 Zone 3 – B-Section

.1 Gas detection controller shall provide the following sequences:

.1 HRU's shall operate continuously as the low level ventilation rate

.2 MUA's and associated EF's shall start as the high level ventilation rate upon *High Level Gas Detection* within the zone. If gas level continues to increase to *Alarm Level Gas Detection*, alarm shall be sent to the BMS. If gas level continues to increase to *Fire Alarm Level Gas Detection* and is sustained at this level for 5 minutes, supervisory alarm signal shall be sent to the fire alarm system. When *High Level Gas Detection* has cleared, the MUA's and EF's shall stop.

.3 The highest reading in each zone shall form the basis of zone reading

.4 The gas detection controller shall directly operate the indicated functions (ie BMS shall not perform this function).

.5 HRU-3/4, MUA-3/4 and EF-3/4 are associated with Zone 3 (B-Section)

.6 Command Set Points shall be as follows (adjustable)

Gas Detection Level	**Command Set Points (PPM)**	
	CO	**NOx**
High Level Gas Detection	12	0.2
Alarm Level Gas Detection	25	2
Fire Alarm Level Gas Detection	200 (sustained for 5 minutes)	N/A

.4 BACnet Gas Detection Network Panel will provide the DDC with all relevant information including alarms.

.3 Service Bay Ventilation Equipment Sequences

.1 Ventilation system shall operate in an occupied and unoccupied mode as scheduled in the BMS. Schedule shall be adjustable in the BMS as required by

The City. An override button to move the system into occupied mode shall be provided at the chief hands desk (just north of plenum along gridline X).

.2 Modes shall be as follows:

.1 Unoccupied Mode

.1 MUA-2 and EF-1a (reverse acting with CY-1) will operate continuously to provide continuous ventilation in the space.

.2 Occupied Mode

.1 New equipment [MUA-1/2, EF-1a (reverse acting with CY-1)/1b (reverse acting with CY-2)/1c] and Existing equipment in Service Bay and Storage Tracks [F-2 and EF-7/28/31/9/39/42/19/22/53/60] will operate continuously.

.2 EF-1a and CY-1 will be reverse acting (ie CY-1 is on then EF-1a is off and CY-1 is off then EF-1a is on).

.3 EF-1b and CY-2 will be reverse acting (ie CY-2 is on then EF-1b is off and CY-2 is off then EF-1b is on).

.4 EF-1d and EF-2 will be off unless one or more of EF-7/28/31/9/39/42/19/22/53/60 fails. During this occurrence, F-2 and EF-7/28/31/9/39/42/19/22/53/60 shall be off and EF-1d and EF-2 shall operate continuously until failed fan(s) are operational.

.4 Storage Tracks Existing Ventilation Equipment Sequences

.1 Track 1-12

.1 MUA-7/8/9/10/11/12 will operate continuously (this programming is already part of the BMS).

.2 MUA-7/8/9/10/11/12 and EF-3e/36 shall be interlocked.

.2 Track 13-24

.1 MUA-13/14/15/16/17/18/19 will operate continuously (this programming is already part of the BMS).

.2 MUA-13/14/15/16/17/18/19 and EF-13/46 shall be interlocked.

.3 Track 25-36

.1 MUA-20/21/22/23/24/25/26 will operate continuously (this programming is already part of the BMS).

.2 MUA-20/21/22/23/24/25/26 and EF-59/66 shall be interlocked.

.5 Heat Recovery Units, HRU-3/4

.1 HRU will come with own control components (ie actuators) wired to a terminal strip with two relays (run unit enable signal and free cooling mode to switch dampers every 3 hours).

.2 HRU will operate continuously. Heating control valve shall modulate to maintain a space temperature of 70°F (adjustable).

.3 Provide the following DDC points

.1 Supply Fan Status and Command

.2 Exhaust Fan Status and Command

.3 Supply Air Temperature

.4 Exhaust Air Temperature
.5 Pre Heat Air Temperature (ie Temperature before Heating Coil)
.6 Supply Air Low Limit Status (ie Freeze Stat)
.7 Free Cooling Command
.8 Filter differential sensor
.9 Heating Control Valve Position

.6 Make-Up Air Unit, MUA-1/2/3/4

.1 MUA will come with a BACnet protocol equipped package controller.
.2 MUA will operate as commanded by the gas detection controller or as noted above.
.3 On a call for the MUA to start, the MUA will start and the motorized dampers at the roof penetrations will open after proof of EF operation.
.4 On a call for the MUA to stop, the MUA will stop and the motorized dampers at the roof penetrations will close.
.5 Gas heating section shall modulate to maintain a supply air temperature of 70°F (adjustable).
.6 BACnet controller will provide the DDC with all relevant information including alarms (refer to MUA specification for points list).

.7 Make-up Air Unit Laminated Sequences & Interlocks

.1 Provide on each MUA a laminated 8-1/2” x 11” piece of paper on the interior of each makeup air unit door with written sequences of operation and summary of which exhaust fans it is interlocked with.
.2 Requirements are applicable to MUA-1/2/3/4 (new units) and MUA-7 to MUA-26 (existing units in storage tracks).

.8 Exhaust Fans, EF-1a/1b/1c/1d/2/3/4

.1 EF’s are hardwired, double interlocked with their associated MUA and/or Cyclone Exhaust Fans.
.2 On a call for the MUA to start, the associated exhaust fans will start and the motorized dampers at the roof penetrations will open.
.3 On a call for the MUA to stop, the associated exhaust fans will stop and the motorized dampers at the roof penetrations will close after proof of MUA stop.
.4 Provide the following DDC points
.1 Fan Status
.2 Motorized Damper Position

.9 Existing Storage Tracks Exhaust Fans

.1 EF’s shall be hardwired, double interlocked with their associated MUA as noted above.
.2 On a call for the MUA to start, the associated exhaust fans will start.
.3 On a call for the MUA to stop, the associated exhaust fans will stop.

.10 Boilers

.1 Boilers will come with BACnet protocol equipped package controllers.

.2 BAS shall enable/disable boilers when required by the system. BAS shall provide boiler packaged controls temperature setpoint.

.3 BACnet controller will provide the BAS with all relevant information including alarms.

.11 Primary Heating Pumps

.1 Primary heating pumps will come with BACnet protocol equipped package controller.

.2 The primary pumps shall operate as duty/standby in the event of a pump failure to provide 100% redundancy. Alternate lead/lag pump status based on a weekly schedule.

.3 Interlock pumps with boilers such that when boilers are enabled, pumps shall operate.

.4 The primary pumps shall be controlled by the IVS Sensorless programming (in lieu of a remote field installed pressure sensor) to meet the minimum and maximum flow required while the boilers maintain the temperature set-point.

.5 BACnet controller will provide the BAS with all relevant information including alarms.

.12 Secondary Heating Pumps

.1 Secondary heating pumps will come with BACnet protocol equipped package controller.

.2 The secondary pumps shall operate as duty/standby in the event of a pump failure to provide 100% redundancy. Alternate lead/lag pump status based on a weekly schedule.

.3 Interlock pumps with boilers such that when boilers are enabled, pumps shall operate.

.4 The secondary pumps shall be controlled by the IVS Sensorless programming (in lieu of a remote field installed pressure sensor) to maintain flow through the secondary loop.

.5 BACnet controller will provide the BAS with all relevant information including alarms.

.13 Glycol Fill Tank Package

.1 Through packaged auxiliary contacts, annunciate glycol fill tank low level on DDC.

END OF SECTION