1 General

1.01 Abbreviations and Definitions

.1 Abbreviations used in this Specification are as follows:

.1 BAS building automation system;

.2 DDC direct digital controls;

.3 LAN local area network;

.4 PC personal computer.

1.02 Submittals

.1 Submit shop drawings/product data sheets for BAS components. As a minimum, submit the following:

.1 BAS network architecture, including modes and interconnections;

.2 systems schematics, sequences, and flow diagrams;

.3 points schedule for each point in BAS, 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 Materials for each system or application, identifying quantities, part numbers, descriptions, and optional features;

.6 control damper schedule including a separate line for each damper and a column for each of 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 and a column for valves as for control dampers;

.8 room schedule including a separate line for each HVAC terminal unit indicating type, location and address;

.9 details of BAS interfaces and connections to other systems;

.10 product data sheets or marked catalogue pages including part number, photograph and description for BAS hardware and software.

1.03 Closeout Submittals

.1 Submit a site inspection and start-up report from manufacturer’s representative as specified in Part 3 of this Section.

.2 Record "as-built" drawings are to include:

.1 schematic outline of BAS for quick reference of overall system scope;

.2 adequate record of work as installed, including locations and routing of system wiring.

.3 O&M Manual is to include:

.1 hardware specification manual which gives a functional description of hardware components;

.2 operator's manual which outlines concise instructions for operation of system and an explanation and recovery route for system alarms;

.3 engineering manual which outlines and defines system set-up, definition and application;

.4 data manual which indicates applications data programmed into system;

.5 system software documentation.

1.04 Description of the Building Automation System

.1 Contractor to coordinate with the Region and the park project for coordination of control systems of both projects and dashboard accessibility. Contractor also to coordinate with AGO's requirements.

.2 Building automation system is to consist of a modular, BACnet protocol, open architecture system incorporating direct digital control and monitoring of equipment and systems and consisting of all hardware and software required for complete, functional DDC control system. BAS is to be accessible through standard personal computers within building through a wireless application protocol device, or remotely through Internet by means of a standard web browser.

.3 BAS is to be field expandable, with a distributed architectural design to eliminate dependence upon any single device for alarm reporting and control execution. Failure of any single component or network connection is not to interrupt execution of control strategies at other operational devices. BAS is to maintain all settings and overrides through a system re-boot, and is to incorporate, as a minimum, following integrated features, functions, and services:

.1 graphic user interface for accessing and viewing BAS information, commanding points, changing setpoints, responding to alarms, programming time-of-day schedules;

.2 operator information, alarm management, and control features;

.3 enterprise-level information and control access;

.4 information management including monitoring, transmission, archiving, retrieval, and reporting functions;

.5 diagnostic monitoring and reporting of BAS functions;

.6 off-site monitoring and management access;

.7 energy management;

.8 standard applications for terminal HVAC systems.

.4 BAS is to include, but not be limited to, following:

.1 personal computer based server for networking and integrating all hardware components into a single BAS;

.2 personal computer based operator work station with colour monitor for colour graphic displays, and a colour printer;

.3 portable operator's terminal;

.4 network of standalone network automation engine(s);

.5 network of field equipment controllers;

.6 input/output modules;

.7 local display devices;

.8 distributed user interfaces;

.9 network processing, data storage and communication equipment;

.10 all other components required for a complete and operating BAS.

1.05 Quality Assurance

.1 BAS hardware and software is to be installed by experienced personnel employed and trained by manufacturer/supplier of field equipment controllers. System wiring is to be installed by journeyman electricians or under direct on-site supervision of journeyman electricians.

2 Products

2.01 General Re: Building Automation System

.1 Control system components (field devices) other than those specified in this Section are generally specified in Section 25 05 01 – Automatic Control Systems. Components factory installed with equipment or supplied with equipment are specified in mechanical work Sections with equipment.

.2 BAS specified in this Section is an expandable DDC building automation system in accordance with drawing control diagrams and sequences, and points lists.

.3 Manufacturers:

.1 Johnson Controls Inc.;

.2 Siemens Building Technologies Inc.;

.3 Automated Logic.

2.02 BAS Architecture

.1 BAS is to be based industry standard Ethernet TCP/IP communications protocol. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. BAS is to be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. BAS is to be compatible with other enterprise-wide networks, and where indicated, BAS is to be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

.2 Network automation engines are to provide supervisory control over control network and are to support BACnet Standard MS/TP bus communication protocol (ASHRAE SSPC-135, Clause 9). Control networks are to provide either a "peer-to-peer", master-slave, or supervised token passing communications and are to operate at a minimum communication speed of 9600 baud. DDC controllers are to reside on control network.

.3 BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between BAS and building equipment/system control panels. BAS is to receive, react to, and return information from connected equipment and systems. Data required by application is to be mapped into automation engine’s data base and is to be transparent to operator. Point inputs and outputs from building equipment/system control panels is to have real-time interoperability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization, and local area network communications.

2.03 Dedicated Web Based User Interface

.1 User interface is to be web based and is to operate on a personal computer for command entry, information management, network alarm management, and database management functions. Real-time control functions including scheduling, history collection, and alarming are to be resident in appropriate components of BAS network to facilitate greater fault tolerance, availability, and reliability.

.2 Architecture of personal computer is to be implemented to conform to industry standards such that it can accommodate applications provided with BAS and mechanical systems and equipment, including but not limited to Microsoft Office Applications. Specifically, it must conform to following interface standards:

.1 Microsoft Edge (or other standard browser) for user interface functions;

.2 Microsoft Office Professional for creations, modification and maintenance of reports, and sequencing other necessary building management functions;

.3 Microsoft Outlook or other email program for supplemental alarm functionality and communication of system events, and reports;

.4 required network operating system for exchange of data and network functions such as printing of reports, trends, and specific system summaries.

.3 Personal computer server or operator workstation is to be configured at minimum as follows:

.1 memory: 20 GB;

.2 processor: Intel 7 series or AMD equal;

.3 hard drive: 500 GB free hard drive;

.4 graphics card: 1 GB DDR3;

.5 ports: 1 HMDI, 2 serial, one parallel, and 2 USB-C ports;

.6 keyboard: 101 keyboard and 2-button mouse;

.7 monitors: 584 mm (23 in) LCD monitor with 1920 x 1080 resolution;

.8 LAN communications: 10/100/1000 network card.

.4 Operating System Software: Windows Professional 64-bit Microsoft (latest version) SQL 2008 Server and SQL 2008 Server Express are automatically installed by EBI. Where user interface is not provided via browser, PC is to be equipped with a complete workstation software package including any software or hardware keys, and package is to include original installation discs and licenses for all software, device drivers, peripherals, and software registration cards which are to be handed to Owner.

.5 Printer is to be at minimum equal to Hewlet Packard "DeskJet" colour printer with a speed of 600 DPI black and 300 DPI colour, and 64 kB input print buffer.

2.04 Distributed Web Based User Interface

.1 Features and functions of dedicated web-based user interface described above are to be available on any computer connected directly or via a wide area or virtual private network to BAS network, which conforms to the following specifications:

.1 software is to run on Microsoft Edge (or other standard browser);

.2 minimum hardware requirements are:

.1 2 GB RAM;

.2 2.0 GHz clock speed Pentium 4 microprocessor;

.3 120 GB hard drive;

.4 keyboard with 83 keys minimum;

.5 SVGA 1024 x 768 resolution display with 64 k colours and 16 bit colour depth;

.6 mouse or other pointing feature.

2.05 Remote Access Via Smart Phone and/or Tablet Devices

.1 Available with an operator interface designed for use on various modern smart phone devices with network connectivity with the follow features:

.1 Mobile user interface operating over standard TCP network connection, performing well down to standard mobile 3G speeds, and optimized to ensure very high performance across different network topologies.

.2 Solution written with HTML5 web standards and browser agnostic, not deploying or using ActiveX controls, nor requiring installation of Java Runtime engine.

.3 Mobile solution incorporating full scope of responsibilities of BAS operators for remote mobile users, allowing them to view or control points within their assigned facility locations.

.4 Without alternation, mobile user interface operable within any standard internet browser from a normal personal computer.

.2 Along with optimized smart phone user interface, a dedicated tablet access user interface, optionally providing full operator workstation functionality, on a tablet style device. Tablet interface is to support standard operator workstation features including full operator scope of responsibility, and operable using commercial off-the-shelf technology.

2.06 User Interface Application Components

.1 Integrated browser based client application is to be used as user operator interface program. System is to employ an event-driven rather than a device polling methodology to dynamically capture and present new data to user. Additional features are as follows:

.1 inputs, outputs, set-points, and other parameters as defined in Part 3 of this Section, shown on drawings, or required as part of system software are to be displayed for operator viewing and modification from operator interface software;

.2 user interface software is to provide help menus and instructions for each operation and/or application;

.3 system is to support customization of user interface configuration and a home page for each operator;

.4 system is to support user preferences in alarm, trend, display, and applications screen presentations;

.5 controller software operating parameters are to be displayed for operator to view/modify from user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.;

.6 operator interface is to incorporate comprehensive support for functions including but not limited to 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 BAS internal performance supervision and diagnostics;

.7 on-line access to help menus;

.8 on-line access to current BAS as-built records and documentation;

.9 means for controlling, re-programming, and re-configuration of the BAS operation and for the manipulation of the BAS database information in compliance with applicable Codes and Regulations for individual BAS applications.

.7 system is to support a list of application programs configured by users that are called up by the Tools Menu, hyperlinks within graphic displays, and key sequences;

.8 operation of control system is to be independent of user interface, which is to be used for operator communication only.

.2 System is to have a minimum of 5 levels of nesting, and the capability of displaying multiple navigation trees to aid operator in navigating throughout all systems and points connected, adding custom trees, defining any logical grouping of points, and arranging them on a tree in any order, and nesting groups within other groups. Navigation trees are to be "dockable" to other displays such as graphics, meaning trees will appear as part of display but can be detached and then minimized to Windows task bar or closed altogether, however, a simple keystroke will reattach navigation to primary display of user interface.

.3 Alarms are to be routed directly from network automation engines to PC’s and servers, and it is to be possible for specific alarms from specific points to be routed to specific PC’s and servers. BAS is to annunciate diagnostic alarms indicating system failures and non-normal operating conditions, annunciate application alarms as required by points lists and sequences, and as a minimum, permit 4 categories of alarm sounds customizable through user defined wav files. Alarm management segment of user interface is to provide, as a minimum, following alarm functions:

.1 log, date, and time of alarm occurrence;

.2 generate a "pop-up" window or populate a dedicate section of screen with audible alarm to inform a user that an alarm has been received;

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

.4 provide an audit trail on PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, name of the user, alarm, action taken, and time/date of alarm;

.5 facilitate ability to direct alarms to an email address or alphanumeric pager, in addition to pop-up window described above;

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

.4 Reports and summaries are to be generated and directed to user interface displays with subsequent assignment to printers or discs. Summaries and reports are to be accessible via standard user interface functions, and selection of a single menu item, tool bar item, or tool bar button is to print any displayed report or summary. System is to permit creation of custom reports and queries via a standard web

services XML (Extensible Mark-up Language) interface and commercial of-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum, BAS is to provide following reports and summaries:

.1 all points in BAS;

.2 all points in each BAS 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 BAS schedules;

.8 all user defined and adjustable variables, schedules, interlocks, etc.

.5 Graphical display for time-of-day scheduling and override scheduling of building operations is to be provided, with weekly schedules for each group of equipment with a specific time use schedule, and it is to be possible to define one or more exception schedules for each schedule including reference to calendars, with monthly calendars provided to permit simplified scheduling of holidays and special days for a minimum of 5 years in advance, user selected with the pointing device or keyboard. Changes to schedules made from user interface are to directly modify network automation engine schedule database. Selection of a single menu item or tool bar button is to print any displayed schedule. As a minimum, following functions are to be provided:

.1 weekly schedules;

.2 exception schedules;

.3 monthly calendars;

.4 global schedules.

.6 BAS Is to be complete with multiple-level password access protection to permit user/manager to user interface control and display, database manipulation capabilities deemed appropriate for each user, based on an assigned password. Password access protection features are to include:

.1 each user is to have a user name (24 characters minimum), a password (12 characters minimum), and access levels;

.2 each user may change his or her password at any time;

.3 when editing or entering passwords, system is not to echo actual characters for display on monitor;

.4 minimum of 500 unique password is to be supported;

.5 operators are to be able to perform only those commands available for their respective passwords, and display of menu selections is to be limited to only those items defined for access level assigned to password of each user;

.6 BAS is to automatically generate a report of log-on/log-off and system activity for each user, and any action that results in a change in operation or configuration of control system is to be recorded, including acknowledgement and deletion of alarms;

.7 minimum of 5 levels of access is to be supported individually or in any combination of following:

.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.

.7 User interface is to be equipped with screen management capabilities that allows user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network of user defined navigation trees.

.8 Graphics application program is to be an integral part of user interface and is to include a create/edit function and a runtime function, and system architecture is to support a number of graphic documents (graphic definition files) limited only by memory and computing resources to be generated and executed. Graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include following:

.1 maximum of 16 graphic applications are to be able to be executed at any one time on a user interface or workstation with 4 visible to user, and each graphic application is to capable of following functions:

.1 all graphics are to be fully scalable;

.2 graphics are to support a maintained aspect ratio;

.3 multiple fonts are to be supported;

.4 unique background is to be assigned on a per graphic basis;

.5 colour of animations and values on displays is to indicate status of object attribute.

.2 it is to be possible to change values (set-points) and states in system controlled equipment by using drop-down windows accessible via pointing device;

.3 graphic editing tool is to be provided to permit creation and editing of graphic files, and graphic editor is to be capable of performing/defining animations, defining runtime binding, and:

.1 in general, facilitate creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required;

.2 be capable of adding additional content to any graphic by importing backgrounds in the SVG, BMP, or JPG file formats.

.4 many graphic displays representing part of building and various building components are exact duplicates, with exception that various variables are bound to different field values, consequently, it is to be possible to bind value of a graphic display to aliases, as opposed to physical field tags.

.9 Trend and change of value data is to be stored within the automation engines or server and uploaded to a dedicated trend database or exported in a selectable data format via a data export utility. Uploads to a dedicated database are to occur based on one of user-defined interval, manual command, or when trend buffers are full. Exports are to be as requested by user or on a time scheduled basis. System is to be equipped with a configurable data storage sub-system for collection of historical data which can be stored in either Microsoft Access or SQL database format. Each automation engine is to store, trend, and point history data for analog and digital inputs and outputs as follows:

.1 any point, physical or calculated, may be designated for trending, and methods of collection are to be defined time interval or a change of value;

.2 each automation engine or server is to capable of storing multiple samples for each physical point and software variable based on available memory, including an individual sample time/date stamp, and points may be assigned to multiple history trends with different collection parameters.

.10 Trend viewing utility with access to data points and capability of defining trend study displays to include multiple trends is to be provided, and is to include:

.1 capability of retrieving any historical database point for use in displays and reports by specifying point name and associated trend name;

.2 displays which are able to be single or stacked graphs with on-line selectable display characteristics such as ranging, colour, and plot style;

.3 display magnitude (zoom capability) and units selectable by operator at any time without reconfiguration of processing or collection of data;

.4 display magnitude is to be automatically scaled to show full graphic resolution of data being displayed;

.5 trend studies are to be capable of calculating and displaying calculated variables including highest value, lowest value, and time based;

.6 display is to support user’s ability to change colours, sample sizes, and types of markers.

.11 BAS is to be equipped with a database manager that separates database monitoring and management functions by supporting 2 separate windows. Database secure access is to be accomplished using standard SQL authentication including ability to access data for use outside of BAS application. Additional features are as follows:

.1 database management function is to include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions;

.2 database manager is to support 4 tabs as follows:

.1 statistics, which is to display database server information and trend, alarm (event), and audit information on BAS database;

.2 maintenance, which is to be an easy method of purging records from BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting database, and allowing for retention of a selected number of day’s data;

.3 backup, which is to provide means to create a database backup file and select a storage location;

.4 restore, which is to provide a restricted means of restoring a database by requiring user to log into an Expert Mode in order to view Restore screen.

.3 status bar is to appear at bottom of BAS database manager tabs and is to indicate information on current display activity with icons as follows:

.1 Ready;

.2 Purging Record From Database;

.3 Action Failed;

.4 Refreshing Statistics;

.5 Restoring Database;

.6 Shrinking A Database;

.7 Backing-Up A Database;

.8 Resetting Internet Information Services;

.9 Shutting Down BAS Deice Manager;

.10 Action Successful.

.4 database manager monitoring functions are to be accessed through Monitoring Settings window and are to continuously read database information once user has logged in;

.5 system is to advise user via task bar icons and email messages when a database value has exceeded a warning or alarm limit;

.6 Monitoring Settings window is to have following sections:

.1 General: allow user to set and review scan intervals and start times;

.2 Email: allow user to create and review email and telephone text messages to be delivered when a warning or alarm is generated;

.3 Warning: allow user to define warning limit parameters, set reminder frequency, and link email message;

.4 Alarm: allow user to define alarm limit parameters, set reminder frequency, and link email message;

.5 Database Login: protect system from unauthorized database manipulation by creating a read access and write access for each trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.

.7 Monitoring Settings taskbars to display following informational icons:

.1 Normal: indicates by colour and size that databases are within their limits;

.2 Warning: indicates by colour and size that one or more databases have exceeded their warning limit;

.3 Alarm: which indicates by colour and size that one or more databases have exceeded their alarm limit.

.8 BAS is to indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit;

.12 BAS is to be equipped with a demand limiting and load rolling program for purpose of limiting peak energy usage and reducing overall energy consumption. Program is to support both Sliding Window and Fixed Window methods of predicting demand. Additional features are as follows:

.1 system is to support 3 levels of sensitivity in Sliding Window demand calculations for fine tuning the system, as follows:

.1 Low Setting: sheds loads later and over shortest period of time and maximizes period of time equipment is on;

.2 Medium Setting: sheds loads earlier over a period of time greater than Low Setting, and increases time equipment is on and decreases probability of exceeding "Tariff Target";

.3 High Setting: sheds loads earlier and over a longer period of time than Medium Setting to minimize probability of exceeding "Tariff Target".

.2 system is to have both a Shed Mode and a Monitor Only Mode of operation, as follows:

.1 when Shed Mode is engaged, system is to actively control demand;

.2 when Monitor Mode is engaged, system is to simulate shedding action but will not take any action.

.3 Demand Limiting Program is to monitor energy consumption rate and compare it to a user defined "Tariff Target", and maintain consumption below target by selectively shedding loads based on a user defined strategy;

.4 Demand Limiting Program is to be capable of supporting a minimum of 10 separate load priorities, with each load user assigned, and a minimum of 12 separate "Tariff Targets" defining maximum allowed average power usage during current interval;

.5 system is to support a maximum shed time for each load as determined by user, and system is to restore load before maximum shed time has expired;

.6 system is to support a minimum shed time for each load as determined by user, and system is not to restore load before minimum shed time has expired;

.7 system is to support a minimum release time for each load as determined by user, and system is not to shed load until it has been off for minimum release time;

.8 system is to support three user defined options if meter does not function properly, as follows:

.1 shedding – currently shed loads will be released as their maximum shed time expires;

.2 maintain current shed rate – system will use demand limiting shed rate that was present when meter began to function improperly;

.3 use unreliable meter shed rate – system is to control to a user defined unreliable shed rate target.

.9 Load Rolling Program is to sum the loads currently shed and compare sum to a user defined load rolling target, and system is to maintain consumption below target by selectively shedding loads based on a user defined load priority;

.10 Load Rolling Program is to be capable of supporting a minimum of 10 separate load priorities with each load user defined to a load priority;

.11 Load Rolling Program is to be capable of supporting a minimum of 12 separate "Tariff Targets" defining amount of energy by which demand must be reduced;

.12 system is to equip user with a Load Tab that displays all demand limiting and load rolling parameters for any selected load;

.13 system is to be complete with a Load Summary that displays all loads associated with demand limiting and load rolling program, and status icons for each load are to indicate:

.1 Load Is Offline;

.2 Load Is Disabled;

.3 Load Is Shed;

.4 Load Is Locked;

.5 Load Is In Comfort Override.

.14 Load Summary is to include a load summary runtime view listing following load conditions:

.1 Load Priority;

.2 Shed Strategy;

.3 Load Rating;

.4 Present Value;

.5 Ineligible Status;

.6 Active Timer;

.7 Time Remaining;

.8 Last Shed time.

2.07 Network Automation Engines

.1 Network automation engines are to be ULC listed and labelled, BACnet Testing Labs (BTL) certified and labelled, fully user programmable supervisory controllers to monitor a network of a minimum of 100 distributed application-specific controllers for a global strategy and direction and to communicate on a peer-to-peer basis with other network automation engines.

.2 Each network automation engine is to have ability to deliver a web based user interface as specified above, and computers connected physically or virtually to automation network are to have access to web-based user interface. Additional characteristics/requirements are as follows:

.1 web-based user interface software is to be imbedded in each network automation engine;

.2 each network automation engine is to support a minimum of 4 concurrent users;

.3 user is to be capable of accessing all system data through one network automation engine;

.4 remote users connected to network through an internet service provider or by telephone dial-up are also to have total system access through one network automation engine;

.5 each network automation engine is to be capable of generating web-based user interface graphics, and this capability is to be imbedded in network automation engine;

.6 user interface is to support following functions using a standard version of Microsoft Edge:

.1 configuration;

.2 commissioning;

.3 data archiving;

.4 monitoring;

.5 commanding;

.6 system diagnostics.

.7 each network automation engine is to permit temporary use of portable devices without interrupting normal operation of permanently connected modems.

.3 Each network automation engine is to be a multi-tasking, multi-user, microprocessor-based real time digital control processor sized to meet requirements of system with a minimum word size of 32 bits, and standard operating systems.

.4 Each network automation engine is to have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for control level devices.

.5 Each network automation engine is to include an integrated, hardware based real time clock.

.6 Each network automation engine is to be equipped with LED indicators to identify 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 A, Normal Communications/No Field Communications;

.5 FC Bus B, Normal Communications/No Field Communications;

.6 Peer Communication, Data Traffic Between Network Automation Engines;

.7 Run, NAE Running/NAE in Start-up/NAE Shutting Down/Software Not Running;

.8 Battery Fault, Battery Defective/Data Protection Battery Not Installed;

.9 24 VAC, 24 VAC Present/Loss of 24 VAC;

.10 Fault, General Fault;

.11 Modem RX, NAE Modem Receiving Data;

.12 Modem TX, NAE Modem Transmitting Data.

.7 Each network automation engine is to be equipped with ports for operation of operator input/output devices such as industry standard computers, modems, and portable operator’s terminals. Ports are to be as follows:

.1 2 USB ports;

.2 2 RS-232 serial data communication ports;

.3 2 RS-485 ports;

.4 one Ethernet port.

.8 Each network automation engine is to continually perform self-diagnostics, communications diagnostics, and diagnostics of all pane components, and transmit both local and remote annunciation of any detected component failure, low battery condition, and repeated failures to establish communication.

.9 In event of loss of normal power each network automation engine is to continue to operate for a user adjustable period of up to 10 minutes after which there is to be an orderly shut-down of all programs to prevent loss of database or operating system software, and:

.1 during a loss of normal power, control sequences are to go to normal system shutdown conditions, and critical configuration data is to be saved into Flash memory;

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

2.08 Field Equipment Controllers

.1 Each field equipment controller is to be a fully user programmable BACnet Testing Labs (BTL) certified and labelled digital controller that communicates via BACnet MS/TP protocol. Each controller is to be housed in a plenum rated plastic housing with removable base to permit pre-wiring of analog and binary input/output field points without controller in place.

.2 Each controller is to employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and is to be factory programmed with a continuous adaptive tuning algorithm that sense changes in physical environment and continually adjusts loop tuning parameters appropriately.

.3 Each field equipment controller is to:

.1 include troubleshooting LED’s to identify following conditions:

.1 Power On;

.2 Power Off;

.3 Download or Start-Up 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.

.2 support universal inputs, configured to monitor any of following:

.1 analog input, voltage mode;

.2 analog output, current mode;

.3 analog input, resistive mode;

.4 binary input, dry contact maintained mode;

.5 binary input, pulse counter mode.

.3 support binary inputs configured to monitor either of following:

.1 dry contact maintained mode;

.2 pulse counter mode.

.4 support analog outputs configured to output either of following:

.1 analog output, voltage mode;

.2 analog output, current mode.

.5 support binary outputs, 24 VAC Triac;

.6 support configurable outputs capable of following:

.1 analog output, voltage mode;

.2 binary output mode.

.7 have ability to reside on a master-slave/token-passing field controller bus supporting BACnet standard protocol as follows:

.1 support communications, including input/output communications between field controllers and network automation engines;

.2 support a minimum of one hundred input/output modules and field equipment controllers in any combination;

.3 operate at a maximum distance of 4560 m (15,000 ft) between field controller and furthest connected device.

.8 have ability to monitor and control a network of sensors and actuators over a master-slave/token-passing sensor-actuator bus supporting BACnet standard protocol as follows:

.1 bus is to support a minimum of ten devices per trunk;

.2 bus is to operate at a maximum distance of 365 m (1200 ft) between field controller and furthest connected device.

.9 capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over field controller bus or sensor-actuator bus;

.10 support, but not limited to, following:

.1 hot water, chilled water/central plant applications;

.2 custom air handling units for special applications;

.3 terminal units;

.4 special programs as required for systems control.

.11 support a password protected local controller LCD back-lit display with 6 key keypad as an integral part of field controller or as a remote device communicating over sensor-actuator bus to permit user to view monitored points without logging into system, and to view and change set-points, modes of operation, and parameters.

2.09 Input/Output Modules

.1 Input/output modules to facilitate additional inputs and outputs for use in field equipment controllers are to be similar to field equipment controllers but less display and with a minimum of 4 and a maximum of 17 points.

2.10 System Configuration Tools

.1 System configuration tool is a software package supplied with BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a network automation engine and to permit programming of field equipment controllers. Configuration tool is to provide an archive database for configuration and application data and is to have same look and feel at user interface regardless of whether configuration is being done online or offline. Additional features and characteristics are as follows:

.1 tool is to include:

.1 basic system navigation tree for connected networks;

.2 integration of system enabled devices;

.3 customized user navigation tress;

.4 point naming operator parameter setting;

.5 graphic diagram configuration;

.6 alarm and event message routing;

.7 graphical logic connector tool for custom programming;

.8 downloading, uploading, and archiving databases.

.2 tool is to have capability to automatically discover field devices on connected buses and networks;

.3 tool is to be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning field equipment controllers and field devices;

.4 tool is to be complete with a Bluetooth Wireless Technology wireless access point to enable a wireless enabled portable computer to make a temporary Ethernet connection to automation network.

.2 Bluetooth Wireless Technology converter is to provide temporary wireless connection between sensor-actuator bus or field-controller bus and a wireless enabled portable computer. Converter is to be powered through a connection to either sensor-actuator bus or the field-controller bus and is to support downloading and troubleshooting field equipment controllers and field devices from portable computer over wireless connection. Converter is to be complete with LED indicators for following conditions:

.1 Power: On/Off;

.2 Fault: Fault/No Fault;

.3 SA/FC Bus: Bus Activity/No Bus Activity;

.4 Bluetooth: Bluetooth Communication Established/Bluetooth Communication Not Established.

2.11 Wiring Materials

.1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in Division 26 – Electrical.

3 Execution

3.01 General Re: Installation of the BAS

.1 Provide a complete building automation system in accordance with requirements of this Section of the Specification, Section 25 05 01 – Automatic Control Systems, drawings, and the input/output points list(s).

.2 Unless otherwise specified, perform BAS work in accordance with system manufacturer's instructions.

3.02 Installation of Direct Digital Control System Components

.1 Provide required direct digital control hardware, software, accessories, and wiring for a complete BAS. Refer to drawing control diagrams and sequences, points list(s), and Section 25 05 01 – Automatic Control Systems.

.2 Provide operator workstation, including required power and data connections, in a location as directed by the Owner.

.3 DDC work is to be performed by skilled technicians, properly trained and are qualified for this work.

.4 Materials and equipment used are to be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. Systems and components are to have been thoroughly tested and proven in actual use.

.5 System is to be modular, permitting expansion by adding hardware and software without changes in communication or processing equipment.

.6 Provide 1 supervisory controller (SC) per cabinet fan (air handler). Provide necessary field equipment controllers (FEC).

.7 Provide necessary quantity of SC to accomplish requirements of this specification, and to minimize number of mechanical systems that would be inoperative in event of a FEC failure. A maximum of 2 major mechanical systems are to be controlled by 1 FEC.

.8 Surface wall mount SC and FEC control units in Mechanical Rooms ensuring they are not mounted on vibrating surfaces, and connect to 15 A/1-pole circuit breakers dedicated for control system applications, in branch panel circuit boards in adjacent spaces. Power wiring from control units to circuit breakers is to be the responsibility of the controls contractor. Wiring is to be in conduit and conduit and wiring are to be in accordance with standards and requirements of Division 26 – Electrical. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications.

.9 Indicate via number, and systems controlled by SC and FEC. Indicate via a lamacoid label mounted inside panel the identification number of electrical panel supplying power to SC and FEC.

.10 Submit schedule(s) of input/output points to the Consultant for review. Directly connect each SC and FEC to point devices in accordance with control diagrams and schedule of miscellaneous control points as shown on drawings. Sensor wires for each analogue input are to be 18 AWG twisted-shielded cable. Other types of wire required are to be as recommended by system supplier.

.11 Provide required sensors, remote devices, etc., and required interface accessories. Mount duct and/or plenum sensors half-way across duct or plenum.

.12 Differential pressure sensor used to provide space pressurization control through regulation of return air quantities must be mounted with snubbers on indoor pressure leg to prevent sudden fluctuations caused by door openings, etc. Mount outdoor air ports in locations that minimize effects of abnormal surface flow conditions and wind gusts.

.13 Supply and turn over to the Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting Owner in defining and debugging DDC programs. These reports are to consist, as a minimum, of following:

.1 process control language (PCL) logs;

.2 control loop logs;

.3 PCL master point.

.14 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into the system.

.15 Contacts will be supplied as part of mechanical work or electrical work for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to DDC system in accordance with point schedule.

3.03 Implementation of Energy Management Programs

.1 Implement energy management programs indicated for building equipment and systems.

.2 Ensure energy management program adjustable parameters are accessible to and adjustable by building operations personnel at operator’s workstation.

.3 Configure energy management programs so they may be enabled/disabled on an individual basis for each system to which they apply.

3.04 Control Wiring

.1 Perform required control wiring work for control systems except:

.1 power wiring connections to equipment and panels, except as noted below;

.2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;

.3 starter interlock wiring.

.2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2 ft) connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.

.3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.

.4 Wiring work is to be in accordance with BAS manufacturer’s certified wiring schematics and instructions, and wiring standards specified in electrical work Division of this Specification.

3.05 Identification and Labelling of Equipment and Circuits

.1 Refer to Section 20 05 00 – Common Work Results for Mechanical.

.2 Identify BAS equipment as follows:

.1 enclosures: engraved laminated nameplates with lettering such as BAS Panel CP2, or BAS Relays, or BAS E/P Transformers, with all wording listed and approved prior to manufacture of nameplates;

.2 panel points: a weather-proof input/output layout sheet for each controller with the name of each point connected to controller, and associated wire labelling information;

.3 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings;

.4 interface components: a weather-proof layout sheet clearly illustrating/identifying purpose of each component within enclosure such that an operator or service technician can quickly identify exact use of each relay, transducer, contactor, etc., with each sheet fastened securely to back of enclosure door.

3.06 System Startup

.1 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

.2 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.07 Closeout Activities

.1 Include for demonstration and training sessions for each of 2 groups of Owner's operating and maintenance personnel as follows:

.1 3 full, 8 hour day orientation sessions at system manufacturer's office to educate personnel on BAS architecture, hardware, and software, with an overview of BAS operation and capabilities including but not limited to operational programmes, equipment functions (both individually and as part of a total integrated system), BAS commands, advisories, alarms, and appropriate operator intervention required in responding to BAS operation;

.2 2 full, 8 hour day sessions at site using BAS for a "hands-on" demonstration of BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to operator's workstation, an overview of communications network describing interplay between initiating devices, field hardware panels, systems communications, and their importance within operating BAS, and alarm indications and appropriate responses;

.3 2 full, 8 hour day seasonal (summer-winter) site sessions to perform additional instruction regarding seasonal changes and how they affect BAS.

.2 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full day to provide additional system training as required.

End of Section