1. GENERAL

1.1 Controls Sub-Contractor

.1 Read Mechanical General Requirements Section 15010 as part of this Section.

1.2 Work of Controls Sub-Contractor (hereinafter in this Section referred to as “Contractor” or “Controls Contractor”).

- Provision of Building Automation System (BAS) modules, nodes, wiring and conduit to suit new components and equipment, programming as required, and update of existing BAS for the work in this project.
- Update existing BAS graphics design to include new equipment.
- 120/1/60 power wiring for BAS requirements.
- BAS control conduit and wiring to VFD for chilled water pump.
- BAS communications conduit and wiring to new chiller CLR-2.
- BAS conduit and wiring from chiller CLR-2 power meter to BAS.
- BAS conduit and wiring to MCC 5-1 for refrigeration ventilation fan.
- Temperature sensors.
- BAS conduit and wiring to refrigerant alarm control panel.

1.3 Work by other Divisions:

.1 Provision of automatic control valves (valves and actuators) by Div 15.

.2 Wiring from Chiller CLR-2 power meter to CARMA system by Div 15 .

.3 Installation of thermowells for temperature sensors by Div 15.

1.4 Controls Contractor for this project is:

Johnson Controls Canada LP
7400 Birchmount Road
Markham, Ontario L3R 5V4
Contact: Jatin Patel
T: 905-474-5373
C: 416-629-9731

.1 Work of this Division shall be scheduled, coordinated, and interfaced with associated work of other trades. Division 15 Mechanical Contractor to coordinate all divisions of work.

.2 Work of this Division shall be as required by Specifications, Control Sequences and Drawings.

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

1.5 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 Automation System (BAS):The complete integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BAS Contractor and to be interfaced to the associated work of other related trades.

.4 Controls Contractor: The Contractor to provide the work of this Division (Johnson Controls). This Contractor shall be the primary manufacturer representative, installer, commissioner and ongoing service provider for Controls, BAS and BAS work.

.5 Control Sequence: A BAS 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 BAS 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 BAS Network: The total digital on-line real-time interconnected configuration of BAS 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 BAS network.

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

.10 Provide: The term “Provide” and its derivatives when used in this Division shall mean to supply, 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 Supply: The term “Supply” and its derivatives when used in this Division shall mean supply at the Controls Contractor’s cost to designated third party trade contractor for installation. Controls Contractor shall connect supplied items to BAS, calibrate, test, commission, warrant and document.

.13 Wiring: The term “Wiring” and its derivatives when used in this Division shall mean provide the electrical and Control 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 BAS network nodes.

.16 Provide: The term “provide” and its derivatives when used in this Division shall mean supply and install.

.17 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 BAS industry for real-time, on-line, integrated BAS configurations.

.18 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.

.19 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.

.20 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
CPU	-	Central Processing Unit
CRT	-	Cathode Ray Tube
CZC	-	Commercial Zone Control
DAC	-	Digital to Analog Converter

DC	-	Digital Controller
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
TBA	-	To Be Advised
TCP/IP	-	Transmission Control Protocol/Internet Protocol
TTD	-	Thermistor Temperature Device
UPS	-	Uninterruptible Power Supply
VAC	-	Volts, Alternating Current
VAV	-	Variable Air Volume
VDC	-	Volts, Direct Current
WAN	-	Wide Area Network
XVGA	-	Extended Video Graphics Adapter

1.6 BAS Description

.1 Existing Building Automation System (BAS) to be extended to encompass work of this project as indicated on drawings and in specifications. Devices residing on enterprise IT network shall be fully IT compatible devices that mount and communicate directly on IT infrastructure in facility. Contractor to be responsible for coordination with Owner's staff to ensure that BAS will perform in Owner's environment without disruption to any of the other activities taking place on that LAN.

.2 All points of user interface to be on either local display, standard PCs with appropriate software, standard Web Browser or combination of these methods.

.3 Existing server to be used for the purpose of providing location for extensive archiving of system configuration data, and historical data such as trend data and operator transactions. All data will be stored in database.

.4 Work of single Controls Contractor to be as defined individually and collectively in all Sections of this Division specification together with the associated Control Sequences and Drawings and associated interfacing work as referenced in related documents.

.5 BAS work to 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 BAS.

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

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

.8 The BAS as provided shall incorporate, as required the following integrated features, functions and services:

.1 Operator information, alarm management and control functions.

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

.3 Diagnostic monitoring and reporting of BAS functions

.4 Offsite monitoring and management access

.5 Energy management

1.7 Quality Assurance

.1 Workplace Safety and Hazardous Materials

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

.2 The Controls 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 sub-trades comply with federal, provincial, 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 having jurisdiction for at least each topic listed in the Safety Certification Manual.

.5 Hazards created by the Contractor or its subcontractors to 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 Prime Contractor or the Owner within same day. Contractor to be required to avoid the hazard area until hazard has been eliminated.

.7 Contractor to 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 Contractor's safety program to include written policy and arrangements for handling, storage and management of all hazardous materials to be used in work in compliance with requirements of authority having jurisdiction at Project site.

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

.2 Quality Management Program

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

.1 Manage scheduling of work to ensure that adequate materials, labor and other resources are available as needed.
.2 Manage financial aspects of BAS contract.
.3 Coordinate as necessary with other trades.
.4 Be responsible for the work and actions of BAS workforce on site.

1.8 References

.1 All work to conform to following Codes and Standards, as applicable:
.1 National Fire Protection Association (NFPA) Standards.
.2 Ontario Electrical Code (OEC). Ontario Electrical Code (OEC).
.3 Ontario Building Code (OBC).
.4 Underwriters Laboratories (UL) listing and labels.
.5 UL 916 Energy Management
.6 NFPA 70 - National Electrical Code.
.7 NFPA 90A - Standard For The Installation Of Air Conditioning And Ventilating Systems.
.8 Factory Mutual (FM).
.9 American National Standards Institute (ANSI).
.10 National Electric Manufacturer's Association (NEMA).
.11 American Society of Mechanical Engineers (ASME).
.12 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
.13 Air Movement and Control Association (AMCA).
.14 Institute of Electrical and Electronic Engineers (IEEE).
.15 American Standard Code for Information Interchange (ASCII).
.16 Electronics Industries Association (EIA).
.17 Ontario Occupational Safety and Health Act (OHSA).
.18 American Society for Testing and Materials (ASTM).
.19 Federal Communications Commission (FCC) including Part 15, Radio Frequency Devices.
.20 ANSI/EIA 909.1-A-1999 (LonWorks)
.21 ANSI/ASHRAE Standard 135-2004 (BACnet)
.22 IEEE 802.15.4 ZigBee
.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.

1.9 Work by Others

.1 The demarcation of work and responsibilities between the Controls Contractor and other related trades shall be as outlined in the CONTROLS RESPONSIBILITY MATRIX .

CONTROLS RESPONSIBILITY MATRIX				
WORK	**SUPPLY**	**INSTALL**	**LOW VOLTAGE WIRING/CONDUIT**	**LINE POWER**
CONTROLS low voltage and communication wiring	CONTROLS	CONTROLS	CONTROLS	CONTROLS
CONTROLS conduits and raceway	CONTROLS	CONTROLS	CONTROLS	CONTROLS
Manual valves	15	15	N/A	N/A
Automatic valves	15	15	CONTROLS	CONTROLS
Automatic valve control panels	CONTROLS	CONTROLS	CONTROLS	CONTROLS
Pipe insertion devices and taps including thermowells, flow and pressure stations.	CONTROLS	15	CONTROLS	CONTROLS

CONTROLS Current Switches.	CONTROLS	CONTROLS	CONTROLS	N/A
CONTROLS Control Relays	CONTROLS	CONTROLS	CONTROLS	N/A
CONTROLS interface with Chiller controls	CONTROLS	CONTROLS	CONTROLS	CONTROLS
Chiller controls interface with CONTROLS	15	15	CONTROLS	CONTROLS
Power meters	15	15/16	CONTROLS	16
All CONTROLS Nodes, equipment, housings, enclosures and panels.	CONTROLS	CONTROLS	CONTROLS	CONTROLS
Chiller Flow Switches	15	15	CONTROLS	N/A
VFDs	15	16	CONTROLS	16
Refrigerant detection and alarm	15	15	15	16
Starters, HOA switches	15	16	CONTROLS	16

Note: Division 16 is Mechanical Contractor's Electrical Sub-Contractor.

1.10 Submittals

.1 Shop Drawings, Product Data, and Samples

.1 Controls contractor to submit list of all shop drawings with submittals dates within 30 days of contract award.

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

.3 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.

.4 The Controls Contractor shall correct any errors or omissions noted in the first review.

.5 At a minimum, submit the following:

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

.2 Systems schematic, related sequences and flow diagrams.

.3 Points schedule for each point in the 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 material lists 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 Detail of all BAS 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.

1.11 Record Documentation

.1 Operation and Maintenance Manuals

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

.1 Table of contents.

.2 As built systems 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 Manufacturer's product data sheets or catalog pages for all products including software.
.4 System Operator's manual.
.5 Archive copy of all site-specific databases and sequences.
.6 BAS network diagrams
.7 Interfaces to all third-party products

.2 The Operation and Maintenance Manual CD or DVD 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.

1.9 Warranty

.3 Standard Material and Labor Warranty:
.1 Provide two-year labor and material warranty on extension of BAS for this project.
.2 If within twelve (24) months from date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it is to be replaced, repaired or adjusted at option of Controls Contractor at cost of Controls Contractor.
.3 Maintain an adequate supply of materials within 100 km of Project site such that replacement of key parts and labor support, including programming. Warranty work to be done during Controls Contractor's normal business hours.

2. PRODUCTS

2.1 General Description

.1 Existing Building Automation System to be extended for work of this project:
.1 Supervisory Controllers
.2 Programmable Controllers
.3 Input, Output Modules
.4 Local Display Devices
.5 Updated graphics
.6 Existing operator terminals to be reused
.7 Existing server to be used for network processing, data storage and communications equipment
.8 Other components required for complete and working BAS

2.2 BAS Architecture

.1 Automation Network
.1 Supervisory Controllers to reside on Automation Network
.2 Control Network
.1 Supervisory Controllers to provide management over control network(s) and support following communications protocols:
.1 BACnet® Standard (ANSI/ASHRAE Standard 135-) MS/TP and Ethernet/IP
.2 Johnson Controls® N2 Open.

.2 Supervisory Controller to be BTL (BACnet Testing Laboratories) listed as B-BC (BACnet Building Controller) and support following data link options:

.1 BACnet Internet Protocol (IP) (Annex J).
.2 BACnet IP (Annex J) Foreign.
.3 ISO 8802-3, Ehternet (Clause 7).

.3 Control networks to provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and operate at minimum communication speed of 9600 baud.

.4 Programmable Controllers to reside on control network.

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

.3 Integration

.1 Hardwired

.1 Analog and digital signal values to 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 systems.

.2 Direct Protocol (Integrator Panel)

.1 BAS to include appropriate hardware equipment and software to allow bi-directional data communications between BAS system and 3rd party manufacturers' control panels. BAS to receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, power monitoring system, lighting and security.
.2 All data required by application to be mapped into BAS, and to be transparent to operator.
.3 Point inputs and outputs from third party controllers to have real-time interoperability with BAS software features such as: Schedules, Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

.3 BACnet Protocol Integration

.1 BACnet over Ethernet and BACnet MS/TP tp comply with ASHRAE BACnet standard 135-2004.
.2 Complete Protocol Implementation Conformance Statement (PICS) to be provided for all BACnet system devices.
.3 Ability to command, share point object data, change of state (COS) data and schedules between host and BACnet systems to be provided.

.4 Modbus Protocol Integration

.1 BAS to provide direct connection to Modbus devices without use of protocol converters.
.2 All data required by the application to be mapped into BAS and be transparent to operator.
.3 Point inputs and outputs from Modbus devices to have real-time interoperability with BAS software features such as: Schedules, Control Software, Energy Management, Custom Process programming, Alarm Management, Historical Data and Trend Analysis, Totalization and local area network communications.

2.3 User Interface

.1 Alarms

.1 Alarm feature to allow user configuration of criteria to create, route, and manage alarms and events. It is to be possible for specific alarms from specific points to be routed to specific alarm recipients. Alarm management portion of user interface to, at minimum, provide following functions:

.1 Allow configuration to generate alarms on any numeric, binary, or data point in system.
.2 Generate alarm records that contain minimum of timestamp, original state, acknowledged state, alarm class and priority.
.3 Allow establishment of alarm classes that provide routing of alarms with similar characteristics to common recipients.
.4 Allow user, with appropriate security level, to manage alarms - including sorting, acknowledging, and tagging alarms.

.2 Reports and Summaries

.1 Reports and Summaries to be generated and directed to user interface displays, with subsequent assignment to printers, or disk. As minimum, system to provide following reports:
.1 All points in BAS
.2 All points in each BAS application
.3 All points in specific controller
.4 All points in user-defined group of points
.5 All points currently in alarm
.6 All BAS schedules
.7 All user defined and adjustable variables, schedules, interlocks and like
.2 Reports shall be exportable to .pdf, .txt, or .csv formats.
.3 System to allow for creation of custom reports and queries.

2.4 Automation Network

.1 Supervisory Controller

.1 The Supervisory Controller must provide following hardware features as minimum:
.1 Communications
.1 Two 10/100/1000 Mb Ethernet Port – RJ-45 connection
.2 One RS-232 port
.3 Five RS-485 ports (up to 57,600 baud)
.4 Optional internal auto-dial/auto-answer 56K modem.
– Use for remote dial-in.
.5 Expandable communications ports including LON, RS485, Modem, Wireless Terminal Equipment Control
.6 All required protocol drivers are included.
.2 Battery Backup
.1 Battery backup provided for all on board functions including I/O
.2 Battery is monitored and trickle charged
.3 Battery maintains processor operation through power failures for pre-determined interval, and then writes all data to flash memory, shuts processor down, and maintains clock for three months.
.3 Environment
.1 Must be capable of operation over temperature range of 0 deg C to 50 deg C (32 deg F to 122 deg F).
.2 Must be capable of withstanding storage temperatures of between 0 deg C and 60 deg C (32 deg F to 140 deg F).
.3 Must be capable of operation over humidity range of 5% to 95% RH, non-condensing.

.2 Supervisory Controller to be fully user-programmable device capable of providing all of capability described in Section 2.3 Part A.

.3 Automation network –Supervisory Controller to reside on automation network. Each Supervisory Controller to support one or more sub-networks of controllers.

.4 Supervisory Controller to have capability to communicate directly with Modbus without the use of an additional gateway.

.5 Supervisory Controller to have capability to provide secure communications via SSL (Secure Socket Layer).

.6 User Interface – Each Supervisory Controller to have ability to deliver web based user interface as previously described. All computers connected physically or virtually to automation network to have access to web based UI.

.7 Power Failure – In event of loss of normal power, Supervisory Controller to continue to operate for defined period after which there is to be an orderly shutdown of all programs to prevent loss of database or operating system software. Flash memory to be incorporated for all critical controller configuration data.

.1 During loss of normal power, control sequences to go to the normal system shutdown conditions.

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

.8 Certification – All controllers to be listed by Underwriters Laboratories (UL).

2.5 DDC System Controllers

.1 General Purpose Programmable Controllers (PCG)

.1 he General Purpose Programmable Controller (PCG) to be fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

.1 PCG to support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on controller network.

.1 BACnet Protocol Implementation Conformance Statement to be provided for PCG.

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

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

.4 PCG to be assembled in plenum-rated plastic housing with flammability rated to UL94-5VB.

.5 PCG to include removable base to allow pre-wiring without controller.

.6 PCG to include troubleshooting LED indicators to identify 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 PCG to accommodate direct wiring of analog and binary I/O field points.

.8 PCG to support following types of inputs and outputs:

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

.1 Analog Input, Voltage Mode
.2 Analog Input, Current Mode

.3 Analog Input, Resistive Mode
.4 Binary Input, Dry Contact Maintained Mode

.2 Binary Inputs - to be configured to monitor either of following:
.1 Dry Contact Maintained Mode
.2 Pulse Counter Mode

.3 Analog Outputs - to be configured to output either of following
.1 Analog Output, Voltage Mode
.2 Analog Output, current Mode

.4 Binary Outputs - to output following:
.1 24 VAC Triac

.5 Configurable Outputs - to be capable of following:
.1 Analog Output, Voltage Mode
.2 Binary Output Mode

.9 PCG to have ability to reside on Field Controller Bus (FC Bus).

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

.2 FC Bus to support communications between PCGs and Supervisory Controller.

.3 FC Bus to also support Expansion I/O (PCX) communications with PCG and with Supervisory Controller.

.4 FC Bus to operate at maximum distance of 15,000 ft. between PCG and furthest connected device.

.10 PCG to have ability to monitor and control network of sensors and actuators over Sensor-Actuator Bus (SA Bus).

.1 SA Bus to be Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.

.2 SA Bus to support up to 10 devices per trunk.

.3 SA Bus to operate at maximum distance of 1,200 ft. between PCG and furthest connected device.

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

.12 PCG to support, but not be limited to following:

.1 Chilled water/central plant automation applications including but not limited to:
.1 selection and sequencing of up to 8 chillers of different sizes
.2 selection and sequencing of up to 8 (each) primary and secondary chilled water pumps of varying pump capacities
.3 selection and sequencing of up to 8 condenser water pumps
.4 selection and sequencing of cooling towers and bypass valve, including single speed, multi-speed, and Vernier control
.5 proven and documented central cooling plant optimization program that incorporates custom equipment efficiency profiles, without rewriting software code, in order to meet the building load using the least amount of energy as calculated
.6 use of advanced control algorithms that apply equipment specific parameters, including operational limits and efficiency profiles, in order to determine equipment start and runtime preferences
.7 identification of the most efficient equipment combination and automatic control of state and speed of all necessary equipment to balance runtime, optimize timing and sequencing and ensure efficiency and stability of central cooling plant
.8 control definition for chiller plant in single FX-PCG, as supported by available memory and point Input/Output (I/O), or capable of being split across multiple FX-PCGs

.2 Heating central plant applications

.3 Built-up air handling units for special applications

.4 Terminal and packaged units
.5 Special programs as required for systems control

.13 If required, PCG to support Local Controller Display (DIS), either as an integral part of PCG or as remote device communicating over SA Bus.
.1 Display to use BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
.2 Display to allow user to view monitored points without logging into system.
.3 Display to allow user to view and change set points, modes of operation, and parameters.
.4 Display to provide password protection with user adjustable password timeout.
.5 Display to be menu driven with separate paths for:
.1 Input/Output
.2 Parameter/Setpoint
.3 Overrides
.6 Display to use easy-to-read English text messages.
.7 Display to allow user to select the points to be shown and in what order.
.8 Display to support back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
.9 Display to be minimum of 4 lines and minimum of 20 characters per line
.10 Display to have keypad with no more than 6 keys.
.11 Display to be panel mountable.

.2 Programmable Controller Expansion I/O Modules (PCX)
.1 Programmable Controller Expansion I/O Module (PCX) provides additional inputs and outputs for use in PCG.
.2 PCX to communicate with PCG over FC Bus or th SA Bus.
.3 PCX to support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on controller network.
.1 BACnet Protocol Implementation Conformance Statement to be provided for PCX.
.2 Conformance Statement to be submitted 10 days prior to bidding.
.4 PCX to be assembled in plenum-rated plastic housing with flammability rated to UL94-5VB.
.5 PCX to have minimum of 4 points to maximum of 17 points.
.6 PCX to support following types of inputs and outputs:
.1 Universal Inputs - to be configured to monitor any of following:
.1 Analog Input, Voltage Mode
.2 Analog Input, Current Mode
.3 Analog Input, Resistive Mode
.4 Binary Input, Dry Contact Maintained Mode
.2 Binary Inputs - to be configured to monitor either of following:
.1 Dry Contact Maintained Mode
.2 Pulse Counter Mode
.3 Analog Outputs - to be configured to output either of following
.1 Analog Output, Voltage Mode
.2 Analog Output, current Mode
.4 Binary Outputs - to output following:
.1 24 VAC Triac
.5 Configurable Outputs - to be capable of following:
.1 Analog Output, Voltage Mode
.2 Binary Output Mode
.7 PCX to include troubleshooting LED indicators to identify 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

2.6 Input Device Characteristics

.1 General Requirements

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

.2 Temperature Sensors

.1 General Requirements:

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

.2 Temperature sensor to be of resistance type, and be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.

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

Point Type	**Accuracy**
Chilled Water, Condenser Water	± 0.5 deg F, ± 0.3 deg C

.2 Thermowells

.1 When thermowells are required, sensor and well to be supplied as complete assembly, including wellhead and Greenfield fitting.

.2 Thermowells to be pressure rated and constructed in accordance with system working pressure.

.3 Thermowells and sensors to be mounted in threadolet or ½-inch NFT-½ saddle and allow easy access to sensor for repair or replacement.

.3 Differential Pressure Transmitters

.1 General Air and Water Pressure Transmitter Requirements:

.1 Pressure transmitters to be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to momentary 40% over-range input.

.2 Pressure transmitters to transmit 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

.3 Differential pressure transmitters used for flow measurement to be sized to flow sensing device, and be supplied with Tee fittings and shut-off valves in high and low sensing pick-up lines to allow balancing Contractor and Owner permanent, easy-to-use connection.

.4 At minimum, NEMA 1 housing to be provided for transmitter. Transmitters to be located in accessible local control panels wherever possible.

.2 Low Differential Water Pressure Applications (0 – 20 in WG)

.1 Differential pressure transmitter to be of industrial quality and transmit linear, 4 to 20 mA output in response to variation of flow meter differential pressure or water pressure sensing points.

.2 Differential pressure transmitter to have non-interactive zero and span adjustments that are adjustable from outside cover and meet following performance specifications:

.1 0.1 - 20 in WG input differential pressure range.
.2 4-20 mA output.
.3 Maintain accuracy up to 20 to 1 ratio turndown.
.4 Reference Accuracy: +0.2% of full span.

.3 Acceptable Manufacturers: Greystone, Setra, Mamac.

.3 Medium to High Differential Water Pressure Applications (Over 21 in WG)

.1 Differential pressure transmitter to meet low pressure transmitter specifications with following exceptions:

.1 Differential pressure range 10 in WG to 300 psi.
.2 Reference Accuracy: ±1% of full span (includes non-linearity, hysteresis, and repeatability).

.2 Standalone pressure transmitters to be mounted in bypass valve assembly panel. Panel to be constructed to NEMA 1 standards. Transmitter to be installed in panel with high and low connections piped and valved. Air bleed units, bypass valves, and compression fittings to be provided.

.3 Acceptable Manufacturers: Greystone, Setra, Mamac.

.4 Power Monitoring Devices

.1 Current Measurement (Amps)

.1 Current measurement to be by combination current transformer and current transducer. Current transformer to be sized to reduce full amperage of monitored circuit to maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Building Automation System.

.2 Current Transformer – Split core current transformer to be provided to monitor motor amps.

.1 Operating frequency – 50 - 400 Hz.
.2 Insulation – 0.6 kV class 10 kV BIL.
.3 UL recognized.
.4 Five ampere secondary.
.5 Select current ration as appropriate for application.
.6 Acceptable manufacturers: Veris Industries

.3 Current Transducer – Current to voltage or current to mA transducer to be provided. Current transducer to include:

.1 6X input over amp rating for AC inrushes of up to 120 ampere.
.2 Manufactured to UL 1244.
.3 Accuracy: +.5%, Ripple +1%.
.4 Minimum load resistance 30 kilohm.
.5 Input 0-20 A.
.6 Output 4-20 mA.
.7 Transducer to be powered by a 24 VDC regulated power supply (24 VDC +5%).
.8 Acceptable manufacturers: Veris Industries, Carlo Gavazzi, Siemens 9510/9610, Honeywell Class 500

.5 Refrigerant Leak Detectors

.1 New refrigerant leak detection system provided by Mechanical Contractor.

.6 Status and Safety Switches

.1 General Requirements

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

.2 Current Sensing Switches

.1 Current sensing switch to be self-powered with solid-state circuitry and dry contact output. It is to consist of urrent transformer, solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating

the on or off status. Load conductor to be passed through window of device. It is to accept over-current up to twice its trip point range.

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

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

.4 Acceptable manufacturers: Veris Industries, Senva.

.3 Water Flow Switches

.1 Water flow switches to be equal to Johnson Controls F61, Cleveland or equal.

2.7 Output Device Characteristics

.1 Automatic Control Valves

Provided by Division 15 Mechanical Contractor. Valve control panel provided by Controls Contractor.

.1 For butterfly valves NPS 2 1/2 and over:

.1 Automatic actuation

- 120/1/60 electric motor ON-OFF (shut-off) service.
- Declutchable manual override handwheel, for manual operation.
- CSA or UL approval.
- Direct mounting to valve body, using manufacturer's standard mounting kit.
- Internal auxiliary switches for 'OPEN' and 'CLOSED' positions, 10A at 120 VAC.
- Terminal strip.
- Die cast aluminium housing with polyester finish.
- High visibility beacon position indicator.
  Standard of Acceptance:
  - BRAY Series 70, Model 70-0301 or Model 70-0501

.2 Electronic Signal Isolation Transducers

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

.2 Signal isolation transducer to provide ground plane isolation between systems.

.3 Signals to provide optical isolation between systems.

.4 Acceptable manufacturers: Advanced Control Technologies

.3 External Manual Override Stations

.1 External manual override stations to provide following:

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

.2 Status input to BAS to indicate whenever switch is not in automatic position.

.3 Status LED to illuminate whenever output is ON.

.4 Override LED to illuminate whenever HOA switch is in either HAND or OFF position.

.5 Contacts to be rated for minimum of 1 ampere at 24 VAC.

2.8 Miscellaneous Device Characteristics

.1 Local Control Panels

.1 All control panels to be factory constructed, incorporating BAS manufacturer's standard designs and layouts. All control panels to be UL inspected and listed as an assembly and carry UL 508 label listing compliance. Control panels to be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.

.2 In general, control panels to consist of DDC controller(s), display module as specified and indicated on plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to control panel due to function. Where specified, display module to be flush mounted in panel face unless otherwise noted.

.3 All I/O connections on DDC controller to be provided via removable or fixed screw terminals.

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

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

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

.2 Power Supplies

.1 DC power supplies to be sized for connected device load. Total rated load not to exceed 75% of rated capacity of 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 to be provided and located next to power supply.

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

3. EXECUTION

3.1 BAS Specific Requirements

.1 Graphic Displays

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

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

.2 Custom Reports:

.1 Provide custom reports as required for this project:

.2 Actuation / Control Type

.3 Primary Equipment

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

.2 All valve actuation to be electric.

3.2 Installation Practices

.1 Controls Wiring

.2 All conduit, wiring, accessories and wiring connections required for installation of Building Automation System, as herein specified, to be provided by Controls Contractor. All wiring to comply with requirements of Section 15110 WIRING FOR MECHANICAL and all local and national electric codes, unless specified otherwise in this section.

.3 All BAS wiring materials and installation methods shall comply with BAS manufacturer's recommendations.

.4 Sizing, type and provision of cable, conduit, cable trays, and raceways to be design responsibility of BAS Contractor. If complications arise, however, due to incorrect selection of cable, cable trays, raceways and/or conduit by BAS Contractor, BAS Contractor is responsible for all costs incurred in replacing selected components.

.5 Class 2 Wiring

.1 All Class 2 (24 VAC or less) wiring to 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 to be supported every 5 ft. from building structure utilizing metal hangers designed for this application. Wiring to be installed parallel to building structural lines. All wiring to be installed in accordance with local code requirements.

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

.7 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 panel terminations. Avoid grounding loops.

3.3 BAS Line Voltage Power Source

.1 120-volt AC circuits used for Building Automation System to be taken from existing panel boards, circuit breakers to be provided by Controls Contractor.

.2 Circuits used for the BAS, to be dedicated to BAS and not be used for any other purposes.

3.4 BAS Raceway

.1 All wiring to be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size ½ inch (12 mm).

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

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

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

3.5 Penetrations

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

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

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

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

3.6 BAS Identification Standards

.1 Node Identification. All nodes to be identified by permanent label fastened to enclosure. Labels to be suitable for node location.

.1 Cable types specified to be color coded for easy identification and troubleshooting.

3.7 BAS Panel Installation

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

.2 Controls Contractor to be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

3.8 Input Devices

.1 All Input devices to be installed per manufacturer's recommendation

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

3.9 Input Devices – General

.1 All Input devices to be installed per manufacturer's recommendation

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

.3 Mechanical contractor to install all in-line devices such as temperature wells, pressure taps, etc.

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

.5 Water Differential Pressure Sensors

.1 Differential pressure transmitters used for flow measurement to be sized to flow-sensing device.
.2 Differential pressure transmitters to be supplied with tee fittings and shut-off valves in high and low sensing pick-up lines.
.3 The transmitters to be installed in an accessible location wherever possible.

.6 Medium to High Differential Water Pressure Applications (Over 21 in WG):
.1 Air bleed units, bypass valves and compression fittings to be provided.

.7 Water Differential Pressure Status Switches:
.1 Install with shut off valves for isolation.

3.10 Output Devices

.1 All output devices to be installed per manufacturer's recommendation. Mechanical contractor to install all in-line devices such as control valves, pressure wells, etc.

.2 Electronic Signal Isolation Transducers: Whenever an analog output signal from BAS is to be connected to an external control system as an input (such as chiller control panel), or is to receive as an input signal from remote system, provide signal isolation transducer. Signal isolation transducer to provide ground plane isolation between systems. Signals to provide optical isolation between systems.

3.11 Training Services

.1 Controls Contractor to provide following training services:
.1 Two days of on-site orientation by system technician who is fully knowledgeable with the specific installation details of project. This orientation to be at minimum, consist of review of project as-built drawings, BAS software layout and naming conventions, and walk through of facility to identify panel and device locations.

3.12 Commissioning Requirements

.1 Fully commission all aspects of Building Automation System work.

.2 Acceptance Check Sheet
.1 Prepare check sheet that includes all points for all functions of BAS as indicated on Control Sequence Drawings.
.2 Submit check sheet to Consultant for approval
.3 Consultant will use check sheet as basis for acceptance with Controls Contractor.
.4 Demonstrate to Consultant:
All modes of equipment operation.
All control sequence.
All modes of system operation.