SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. This section describes the new Building Automation System (BAS) and associated new DDC systems required for PCTI STEM HS. This new BAS located in PCTI STEM HS shall integrate to the newly installed equipment within the High School.

   2. It is a requirement of this bid to include ALL costs associated with seamlessly integrating the new BAS with the newly specified DDC systems. It is important that bidders understand that they are to include ALL costs required for integration that must include any and all integration software, field programming, operator graphics development, wiring, and field technician labor required for a complete integration of these DDC systems. It is this bidder’s responsibility to include all of these costs and not to assume the Owner is alleviating any costs associated with this integration other than network connections. The integration shall result in the Owner’s BAS operators ability to override, control, monitor, and alarm any new Trane automation point and display all of this information onto the new BAS software platform graphics and point summary.

   3. The BAS system for PCTI STEM high school consists of a Trane Tracer SC network panel, a Trane VRF system controller, newly furnished Trane Rooftop units, newly furnished Trane VAV boxes, and field controlled exhaust fans. The BAS and all systems associated with the BAS must adhere to the sequence of operations that are located on the mechanical drawings.

   4. The BAS shall be web based permitting access by multiple operators simultaneously using standard web based browser software. The Owner is to provide coordinated LAN network drops as well as static IP addresses for implementation of new BAS. This bidder is to coordinate Local Area Network access points within each school with the Owner’s IT personnel. BAS system access shall be password protected and contain software fire wall protections as to not affect the Owner’s LAN. Server shall communicate with all building DDC systems utilizing BACnet MSTP (native), BACnet/Zigbee (wireless) and BACnet/IP open communication protocols that are certified and comply with all ASHRAE standard 135 requirements.

   5. New DDC systems and associated DDC controllers shall be certified BACnet MSTP or BACnet/Zigbee communicating devices and shall not utilize any proprietary communication protocols.
1.3 PCTI NEW BUILDING MANAGEMENT SYSTEM SCOPE OF WORK

A. HIGH SCHOOL

1. Provide integration of all new equipment, controls, monitored points, and alarms to the new BAS (located in PCTI STEM HS) specified within this section. The Owner shall be able to override, control, monitor, and alarm all connected points and ALL costs associated with this integration are to be included within this bid. (Refer to system architecture drawing)
   a. New rooftop units
   b. New VAV boxes
   c. New Exhaust Fans

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product include the following:

1. Detailed product data sheets that identify construction details, material descriptions, dimensions of individual components and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
   a. BAS Centralized Server
   b. Existing DDC system communication interface and Gateways.
   c. Ethernet switches and routers where necessary
   d. Programmable and application specific DDC controllers.
   e. Instruments (i.e. room sensors, duct sensors, pressure sensors, etc.)
   f. Panel enclosures.
   g. Electrical power supplies
   h. Accessories.
   i. Control dampers and actuators.
   j. Control valves and actuators.

B. Shop Drawings:

1. General Requirements:
   a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
   b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
   c. Prepare Drawings using CAD.
   d. Drawings Size: Minimum of 11 x 17
2. Schematic drawings for each controlled HVAC system indicating the following:
   a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
   b. A graphic showing location of control I/O in proper relationship to HVAC system.
   c. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
   d. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
   e. Narrative sequence of operation.

3. Control panel layout drawings indicating the following:
   a. Dimensional information to understand size and configuration

4. DDC system network riser diagram indicating the following:
   a. Each device connected to network with unique identification for each.
   b. Interconnection of each different network in DDC system.
   c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
   d. Each network port for connection of a network panel with unique identification for each.

5. Monitoring and control signal diagrams indicating the following:
   a. Control signal cable and wiring between controllers and I/O.
   b. Point-to-point schematic wiring diagrams for each product.
   c. Control signal tubing to sensors, switches and transmitters.
   d. Pneumatic main air and control signal tubing to wireless pneumatic thermostats

6. Color graphics indicating the following:
   a. Itemized list of color graphic displays to be provided.
   b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
   c. Intended operator access between related hierarchical display screens.
   d. The timing of these graphics will be determined by the project progress and may end up occurring toward the end of the project.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.
   1. Include the following:
a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, and checklists
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Owner training materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Ingersoll-Rand/Trane Division. Call Mark Snider at 973-294-5209, no exceptions.

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.

2. System shall comply with ASHRAE 135 BACnet protocol requirements

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system shall be Web based.

1. Web-Based Access to DDC System:

a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet through Owner's LAN.
b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.

c. Web access shall be password protected and contain firewall protections.

2. Web-Compatible Access to DDC System:

a. A single centralized web server to be located in the High School

b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.

c. Web access shall be password protected.

2.4 BUILDING AUTOMATION SYSTEM ARCHITECTURE

A. System architecture shall consist of two levels of LANs.

1. **Level one** LAN shall represent the communication between network controllers that bridge communication between the centralized server and the field programmable application and application specific DDC controllers.

2. **Level two** LAN shall represent the communication network interconnecting field mounted programmable controllers, application specific controllers, and other local DDC controllers associated with specific HVAC equipment.

B. System architecture shall be modular and have inherent ability to expand to not less than three times system size indicated with no impact to performance.

C. System architecture shall perform modifications without having to remove and replace existing network equipment.

D. System design shall eliminate dependence on any single device for system control execution. Each controller shall operate independently by performing its' own control functions. Alarming and trending will occur on a capacity basis determined by the type of controller.

2.5 NETWORKS

A. Acceptable networks for connecting operator workstations and network controllers include the following:

1. IP.

2. IEEE 8802-3, Ethernet.

2.6 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout the entire BAS and associated DDC systems shall utilize open protocols and any software tools applicable shall be provided to the Owner for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:
1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.

2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.

3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.

4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
   a. ASHRAE 135.
   b. Modbus Application Protocol (Boiler Systems only)

2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.

3. DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.


5. Gateways shall be used to connect networks and network devices using different protocols.

D. ZigBee

1. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers using BACnet/Zigbee (802.15.4) as defined by the Zigbee Standard. Each communication interface shall be Zigbee Building Automation Certified product as defined by the BACnet Standard and the Zigbee Alliance. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system. Wireless equipment controllers and auxiliary control devices shall conform to:
   a. IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
   b. Communication between equipment controllers shall conform to ZigBee Building Automation (ZBA) standard as BACnet tunneling devices to ensure future integration of other ZBA certified devices.
   c. Operating range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate.
d. To maintain robust communication, mesh networking and two-way communications shall be used to optimize the wireless network health.

e. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.

f. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E

2.7 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, variable-speed drives, etc.

2.8 DDC CONTROLLERS

A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.

C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.

E. Environment Requirements:
   1. Controller hardware shall be suitable for the anticipated ambient conditions.
   2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F

F. Power and Noise Immunity:
   1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
   2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. DDC Controller Spare Processing Capacity:
   1. Memory shall support DDC controller's operating system and database and shall include the following:
      a. Monitoring and control.
      b. Energy management, operation and optimization applications.
      c. Alarm management.
      d. Operator interfaces.
H. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:
   a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
   b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
   c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
   d. Signal conditioning including transient rejection shall be provided for each AI.
   e. Capable of being individually calibrated for zero and span.
5. AOs:
   a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
   b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
   c. Capable of being individually calibrated for zero and span.
   d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
6. BIs:
   a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
   b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
   c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
   d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
   e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.
7. BOs:
   a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.

2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.

c. BOs shall be selectable for either normally open or normally closed operation.

d. Include tri-state outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.

2.9 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.10 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:
1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.11 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

C. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.
2.12 CONTROL WIRE AND CABLE

A. Single Twisted Shielded Instrumentation Cable 24 V and Less:
   1. Wire size shall be a minimum **No. 22 AWG**.
   2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
   3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
   4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
   5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.

B. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
   1. Cable shall be plenum rated.
   2. Cable shall comply with NFPA 70.
   3. Cable shall have a unique color that is different from other cables used on Project.
   4. Copper Cable for Ethernet Network:
      a. **100BASE-TX**
      b. TIA/EIA 586, **Category 5e or Category 6**
      c. Minimum **No. 22 AWG solid**.
      d. **Shielded Twisted Pair (STP)**
      e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for products to verify actual locations of connections before installation.
   1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
   2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

B. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:
   1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:
   a. Newly furnished equipment located on the new Trane Tracer SC network panel in PCTI STEM high school.

3.3 GENERAL INSTALLATION REQUIREMENTS

   A. Install products level, plumb, parallel, and perpendicular with building construction.
   B. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.
   C. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

3.4 CONTROLLER INSTALLATION

   A. Install controllers in enclosures to comply with indicated requirements.
   B. Connect controllers to field power supply
   C. Install controller with latest version of applicable software and configure to execute requirements indicated.
   D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
   E. Installation of Network Controllers:
      1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
      2. Install controllers in a protected location that is easily accessible by operators.
   F. Installation of Programmable Application Controllers:
      1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
      2. Install controllers in a protected location that is easily accessible by operators.
   G. Application-Specific Controllers:
      1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
      2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.
3.5 NETWORK INSTALLATION

A. Coordinate network connections with the Owner’s IT personnel and provide Ethernet cabling as required between the following network devices.
   1. Network controllers.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorised service representative to test and inspect components, assemblies, and installations, including connections.

3.7 COMMUNICATION Wiring

A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer’s installation recommendations for all communication cabling.

B. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer shall not be exceeded during installation.

D. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

E. When a cable enters or exits a building, a lighting arrestor must be installed between the line and ground.

F. All runs of communication wiring shall be unspliced length when the length is commercially available.

G. All communication wiring shall be labeled to indicate origin and destination.

3.8 CONTROL SYSTEM CHECKOUT AND TESTING

A. Start-up testing. All testing in this section shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the owner’s representative is notified of the system demonstration.
1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service all of the instruments, controls, and accessory equipment furnished under this specification.

2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturer’s recommendations.

4. Verify all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starter, etc.) operate properly and normal positions are correct.

5. Verify all analog output devices (I/Ps, actuators, etc) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.

6. Verify the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimal start/stop routines.

7. Alarms and Interlocks
   a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
   b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
   c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

   1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
   2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
   3. Minimum Training Requirements:

       a. Provide not less than one day of training total.
       b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
3.10 WARRANTY

A. Warrant all work as follows:

B. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).

C. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational, and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

D. Operator workstation software, project specific software, graphics, database, and firmware updates shall be provided to the Owner at no charge during the warranty period. Written authorization by the Owner must be granted prior to the installation of these updates.

E. The BAS manufacturer shall provide a web-accessible Users Network for the proposed System and give the Owner free access to question/answer forum, graphics library, user tips, upgrades, and training schedules for a one year period of time correlating with the warranty period.

3.11 SYSTEM MAINTENANCE

A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).

1. Make a minimum of 2 complete Building Automation System inspections consisting of (1) man-day each, in addition to normal warranty requirements. Inspections to include:
   a. System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.
   b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads
   c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.
   d. Database back-up
   e. Operator coaching

2. Technician shall review critical alarm log and advise owner of additional services that may be required.

3. Technician shall provide a written report to owner after each inspection.

B. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of owner.
3.12 REMOTE MONITORING

A. As part of this contract the manufacturer shall provide system components enabling remote monitoring of the control system from a remote centralized location. (Building owner shall provide TCP/IP connection to enable remote access)

B. Remote monitoring function shall occur 24 hours a day 7 days a week for a period of 1 year.

C. Remote Monitoring services shall be in addition to the regular system maintenance contract.

D. Remote Monitoring shall consist of: Active Monitoring:
   1. Timely detection and automatic notification of critical building system alarms 24 hours a day.
   2. Custom notification procedure by email, text message, and/or pager.
   3. Critical alarm history archive and reporting available by request.
   4. Automated alarm routing and notification of local Trane field office service personnel for resolution.
   5. Trane representative shall review critical alarm data and resolution with the owner quarterly.

END OF SECTION 230923