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Addendum No. 1

MARION COUNTY
EXECUTIVE DRIVE HEATING PLANT IMPROVEMENTS PROJECT

March 12, 2026

This Addendum supplements and amends the original and subsequent documents making up the Owner's Project Requirements (OPR) and shall be accounted for in preparing proposals and shall become part of the OPR/Contract Documents. This Addendum is issued to qualified proposers of record. It is the proposer's responsibility to forward this Addendum information to all affected suppliers and subcontractors and/or adjust relative to the proposal/bid.

General Clarifications:

1. **Bid date is extended to Thursday, April 2nd, 2026, at 9:30 am local time.**

2. **Last day for questions will be Wednesday, March 25th, 2026, at 5:00 PM local time.** All questions should be submitted in writing to Eric Booher (ebooher@palmerC2.com) at Palmer Conservation Consulting.

3. Project estimate is $750,000.00.

4. Pre-bid Sign-in sheet attached.

5. Additional Site Visits can be arranged through Odell Daniel. His contact information is odaniel@co.marion.oh.us or 740-802-7539.

6. This project will be prevailing wage.

7. Contractor shall also provide bid bond as part of the proposal/bid. The Bond shall only pertain to the base bid scope of work budget. The alternatives do not require a bond to be provided.

8. The contractor shall provide daily cleanup of the work area.

9. The project working hours will be normal daytime working hours (7:00 AM to 4:00 PM Monday through Friday).

10. The Project is not LEED.

11. The proposer/bidder shall provide new LED strip fixtures in the boiler room. Fixtures to be installed after piping is installed to avoid conflicts.

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12. The existing boiler system has 30% glycol. The proposer shall collect and dispose of the glycol solution drained during construction. At the end of construction, the proposer/bidder shall refill the system with 30% propylene glycol solution.

OPR Specifications:

1. Add section 230900 – Open Temperature Control System. See attached.
2. Add section 230940 – Master Systems Integration Services

END OF ADDENDUM NO. 1

Marion County - Executive Drive Heating Plant Improvements

Thursday, March 5, 2026

SIGN-IN SHEET			
Name	**Company**	**Phone**	**Email**
Eric Booher	Palmer	614 588 3450	eboother@palmercl.com
Ben Stevens	Stevens Construction	740-387-1931	ben@stevensconstruction.net
Doug Stevens	Stevens Construction	740-387-1931	doug@stevensconstruction.net
Destry Ditto	mG Energy	419-236-4854	dditto@mg.energy
Mike Dishon	Owens Electric Co	740-387-1111	mike@owenselectricco.com
Bernie Davidson	DANFORTH	740 587 4033	bdavidsone JWDanforth.com.

SECTION 230900 – OPEN TEMPERATURE CONTROL SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. The Project's Owner's Project Requirements (OPR) documents provide additional graphical schematics to delineate responsibilities for Equipment/Technical Services provided by the Master Systems Integrator (MSI) and the Proposer/Contractor's Installation teams for Temperature control-related (TCS) Scopes of Work.

1. Refer to Section 230940 for Descriptions of Master Systems Integration Services being provided by this Design-Build Contractor to the Owner via the Master Systems Integration & Integrated Commissioning Provider **(Palmer Conservation)**. These services include, but are not limited to:

   a. Systems Integration equipment components: PROVIDED by the Master Systems Integrator to the Design-Build Contractor/Temperature Control Contractor (TCC) for installation. All Programming/Integration of this equipment is provided by the Master Systems Integrator (MSI) - Supervisory Computers/Software, OPEN-platform MAIN Controllers (JACE™ & Enterprise-level Controllers), Lighting Control Panels – only as noted, System/Network Computers, Workstation peripherals, etc.
   b. Integration-specific Software: OPEN System/Network-based, Lighting Control, IT Plug Load Management, Digital Signage interfaces, etc.
   c. Programming: Master level, Scheduling, Alarm Console, Energy Data & Graphing, Analytic Functions, etc.
   d. IT Systems Communication: Coordinating OPEN Control & Unitary Control interfaces with Owner's Network(s).
   e. Graphical Screens: Operational Screens & Human-Machine Interface setups, etc.
   f. Training: Specific to OPEN Integration (non-Unitary or Temperature Control Systems/TCS) portions of Building Automation System (BAS) Network.
   g. Commissioning Services: Evaluation, Assurance & Documentation that intended integrations from Unitary/TCS Controls by Proposer/Contractor are reporting and functioning as intended at Master Network/Supervisory-level.

2. Refer to Section 230994 for Scope of Work Descriptions related to SEQUENCES OF OPERATION being provided to the Owner by the Design-Build Contractor/OPEN Temperature Control Systems provider. These services include, but are not limited to:
   a. Components and programming required for complete implementation of documented Sequences (refer to published Owner's Project Requirements (OPR) documents).
3. Refer to individually published HVAC Equipment Sections and supplemental materials/product data for Temperature Control System installation/wiring and local

(non-Unitary) Control System programming required by the TCC for a complete working system/Sequence of Operation.

1.2 SUMMARY

A. Furnish all labor, materials, equipment, specialized tools (for Installation, Maintenance and/or Calibration) and service necessary for a complete and operating Temperature Control System (TCS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.

1. **The programming tool for ALL BAS control products provided as a part of this Section must use Tridium's Niagara™ software as the host programming environment**. Owner shall be provided with a minimum of six copies of the programming tool for the BAS controllers provided, and tool shall have a permanent license that never expires.

2. All devices (BACnet, Niagara, etc.) and data points mapped into employed BAS controllers specified in the Section will be exposed by the Designing/Installing TCC to the BAS Graphical User Interface (Niagara™) to permit integration into the Owner's OT network by the Master Systems Integrator (MSI).

3. The Temperature Control System (TCS) Stand-Alone Design for the Upgraded Building Automation System (BAS) will provide for ALL Sequences/Programming to reside in the new/replaced DDC Controllers employed – and noted/declared as such. NO operational Sequence programming will reside in the new/Upgraded Main Network (JACE) Controllers, provided/programmed by the MSI.

   a. Niagara EDGE devices used for real time control shall deploy an embedded ACE deterministic engine; JACE hardware is not acceptable for real time control.

   b. The Master Systems Integrator (by Design-Build Contractor) will collectively use the TCC-designed and programmed Controllers to complete the OPEN-Niagara-based Integration services as shown/required for a complete working BAS (including, MSI-related Programming & routing-up to Supervisory Components, hosting appropriate Niagara-based files, Graphics, Trend Sets, Scheduling, Alarm Functions, Data Organization, etc.).

4. The resultant Temperature Control System will be a complete functioning completely OPEN BACnet™ Communication Network.

5. This Section includes the necessary labor and materials to comply with the Cx Commissioning efforts as required (communication coordination & Functional Testing). TCS supplier's commissioning activities are to be included in this specification section's activities and are non-compensable and cannot be a cause for delay claims.

6. This Section includes the necessary labor and materials to provide Pre-Construction evaluation services on each existing designated HVAC equipment currently in service and adequate reporting on operational status.

7. This Section includes the necessary labor and materials to completely install equipment provided by Master Systems Integrator (MSI) to the Design-Build

Contractor/Temperature Control Contractor as coordinated with the Master Systems Integration Services (MSI) provider.

B. All labor, material, equipment and software not specifically referred to herein or in the OPR documents that are required to meet the functional intent of the OPR Documents/this specification, shall be provided without additional cost to the Owner.

1.3 SPECIFICATION NOMENCLATURE/DEFINITIONS

A. Acronyms used in this specification are as follows:

BAS	Building Automation System
TCS	Temperature Control System
JACE	Java Application Control Engine (Tridium/Vykon N4)
Cx/CxP	Commissioning/Commissioning Services Provider
IBC	Interoperable BACnet Controller
MSI	Master Systems Integrator
GUI	Graphical User Interface
WBI	Web Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network
OPR	Owner's Project Requirements
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement
TCC	Temperature Control Contractor

1.4 SYSTEM DESCRIPTION

A. The entire Temperature Control System (TCS) shall be comprised of a network of interoperable, stand-alone digital logic controllers communicating via current BacNet™ communication protocols to a Java Application Control Engine (JACE) N4 platform (JACEs provided by the Owner's designated Master Systems Integrator to Design-Build Contractor for TCS Installation) and further specified under division 230940 MASTER SYSTEMS INTEGRATION SERVICES **(Palmer Conservation is the County's MSI)**.

1. Refer to OVERALL Specifications & schematic Diagrams for additional Work-Scope and Project intent descriptions.

2. Refer to Owner's published Standards for accompanying requirements related to ancillary control systems components.

1.5 MANUFACTURERS

A. Manufacturers, General: Products must be available for purchase from at least two wholesale distributors in the state of Ohio, and Owner must have direct ability to purchase products outside the contractor relationship.

B. Manufacturers: Subject to compliance with Specified requirements, provide major-standard Controls-related products and services by one of the following, Installed & Serviced by current manufacturer-designated/documented branch/representative:

1. Distech – BACnet™ “ECB, ECY” Product Platform – OPEN DDC Controllers.

1.6 OPEN TEMPERATURE CONTROL SYSTEM PROVIDERS/INSTALLERS

A. Providers/Installers, General: A minimum of three contractors within a 50 mile radius of Marion County, Ohio must be licensed and approved to sell and install the BAS controllers and programming software. No proprietary, geography restricted, or single dealer (contractor) brands will be accepted.

B. Providers/Installers: Subject to compliance with Specified requirements, provide TCS design, TCS engineering, coordination and full-installation of OPEN TCS/Controls-related products & Unitary Temperature Controls and services by one of the following:

1. Distech – BACnet™ Product Platform - local authorized OPEN System Installer.

C. Installer Qualifications: All contractor/TCS Sub-contractor personnel that are involved in TCS design, product selection/procurement, programming, adjusting, field-modifying or participating in specified Implementations/Checkouts/Acceptance Testing activities regarding the BAS/TCS controllers MUST meet and be able to document the following Certifications:

1. Tridium Niagara™ 4
2. Manufacturer-specific Controller Product line(s) as described in paragraph 1.5 above.

1.7 SUBMITTALS

A. General: Coordinated with Project Requirements, properly-named electronic copies of shop drawings/product data of the entire OPEN Temperature Control System/Systems Architecture/components shall be submitted/transmitted and shall consist of a complete list of equipment and materials, including manufacturer’s catalog data sheets and installation/maintenance instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as an “OPEN System”. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation for each affected system shall also be included with the submittal package.

B. Temperature Control System (TCS): Submittal shall also include a complete Point List of all connected points to the DDC TC System provided in the format as indicated in the temperature control system diagrams located on the drawings. This includes, but is not limited to:

1. BACnet™ Registers – coordinated with associated equipment.
2. Applicable PICS documentation.
3. Applicable Software Licensing documentation.
4. Naming Conventions (Points, Communications, etc.) as established by the Owner and coordinated with the Master Systems Integrator, in English TABLE form.

C. Temperature Control Contractor Certification Submittals: Provide documents of current and legitimate Product/System Certifications for each member of the Design/Implementation/Turnover team involved in the Project(s) [Names, Roles, Products/Systems, License Designations/restrictions, Dates of Active Certifications]:

1. Tridium Niagara™ Framework, Current Version(s).

2. Manufacturer-specific Controller Product line(s) utilized.

D. Quality Control Submittals: In addition to above submittals, the Commissioning (Cx) submittal requirements as outlined in Execution sections/drawings shall be included as part of this specification section requirement.

1. PRIOR to requesting review for Final Acceptance of the TCS, submit/transmit a comprehensive Verification Log to Cx Services Provider showing proof that all point-to-point checkout activities have been successfully accomplished by the TCC

E. As-Built/Record Documents: Upon completion of the work, provide a complete set of 'as-built' submittals/drawings on properly-labeled current magnetic media or jump drive/storage device all licensed to the Owner/end user. Drawings shall be provided as AutoCAD™ or Visio™ compatible files, in addition to current Adobe PDF versions. Two "hard" copies of the 'as-built' drawings and block-style software programming sheets shall be provided (in addition to the documents on flash drive media or compact disc).

1. Serial Cabling Networks: Provide Specific record of locations/equipment where full connections to updated BAS Networks were roughed-in but NOT completed (i.e. Generators, Lighting Controls, HVAC Equipment, etc.).

F. Closeout Documents: Provide at Final-Acceptance/Completion of the Work:

1. Applicable Warranty Conditions, Warranty Follow-up and On-Site Assistance documentation.

2. Verification of final TCS Training/Plans for additional training.

3. Signed certificates of Completion (coordinated with MSI/Commissioning provider).

1.8 DIVISION OF WORK

A. The Section 230900 (TCC) Contractor shall be responsible for all field labor for mounting & wiring designed/specified Building Automation System (BAS)/TCS components, (including specified Enterprise-level, devices being furnished by the Master Systems Integrator as specified in Section 230940), Distributed Application Specific Controllers/coordination (as specifically noted), Coordination with HVAC/Electrical Unitary Controllers provided with Equipment/Systems, ancillary control devices, required fabricated control panels, all unitary/Distributed/Applied controller programming not factory-furnished, unitary/non-applied controller programming software, labeled controller input/output and power wiring, labeled controller network wiring and (BAS)/TCS-based BACnet™ network wiring & connections to the Java Application Control Engine (JACE) N4 Networks, (applies to ALL required wiring scopes). SPECIFIC Equipment furnished under this section includes:

1. MAIN ENTERPRISE System Applied/Network Controls: None/furnished by Master Systems Integrator via the Design-Build Contractor – conduit, panels, conductors and

field installation/wiring Scopes only by TCC – refer to MSI Schematics published in OPR.

2. Applied Distributed OPEN Temperature Controls: As-Designated for One-for-One Replacement/Enhanced Scopes – all Controllers, conduit, conductors and field installation/wiring Scopes and network/Point-information passing coordination with Master Systems Integrator – refer to TCS/MSI Schematics published in OPR. This Scope includes, but is not limited to:

   a. Main Heating & Cooling Plant Controllers, only as applicable.

   b. Main Applied Air Handling System Controllers, only as applicable.

   c. VAV Air Terminal/FCU/WSHP/Unit Ventilator Controllers.

   d. Non-Unitary Hydronic, Air Heating-only & Air Terminal Controllers.

3. HVAC/Electrical Equipment: Coordinate with applicable Unitary System Controllers and local installations/programming required as part of a factory-fabricated unit/system. This Scope includes, but is not limited to:

   a. Packaged Heating Equipment.

   b. Packaged Cooling Equipment.

   c. Packaged HVAC Terminal Equipment (Unit Ventilators, Fan Coil Units, Water Source Heat Pumps, etc.).

   d. Packaged Emergency Power Systems.

B. The Section 230940 (MSI) Master Systems Integration Services provider shall be responsible for setup/coordination of the system required Java Application Control Engine (JACE) N4 components & software, Master programming of the JACE controllers, graphical user interface software (GUI), development of all graphical screens, setup of schedules, logs and alarms, BacNet(tm) network management as required to interface the JACE to the BAS network/energy meters/lighting control systems, global supervisory control applications, general system integration of BACnet/Modbus devices as shown, and Commissioned Integration/coordination and connection of the JACE to the Owner's local or wide area network. The MSI contractor will provide the JACE(s) to the Design-Build /Temperature Control Contractor for complete field installation (housing panels, Mounting, labeling, wiring) in locations as coordinated by the MSI. SPECIFIC Equipment furnished by the Design-Build Contractor via the designated MSI to the TCS for Installation under section 230940 includes:

   1. Main Supervisory Computer Equipment – Existing N4 Platform.

   2. Main JACE (N4) Network Controllers.

   3. Main Operational Technology (OT) Network Software/Devices – as specifically shown on OPR documents.

1.9 RELATED WORK - ELECTRICAL INSTALL SCOPES

A. According to applicable national/local standards and generally accepted usual & customary installation practices, provide typical/necessary Division 260000 Line & Low

Voltage Electrical scopes, via Proposer/Contractor's TCC and Electrical Power/low-voltage (Systems) subcontractors:

1. Providing motor starters and disconnect switches (unless otherwise noted).
2. Power wiring and conduit (all line and low voltage unless otherwise noted).
3. Provision, installation and wiring of smoke detectors (unless otherwise noted).
4. Providing labor and material for physically mounting each JACE controller, loose sensor(s) and metering/monitoring components of the Integrated System.
5. Providing labor and material for applicable generator network, lighting controller network and power monitoring network connections to the JACE (unless noted in other equipment sections).
6. Providing labor and material for complete System intranet, internet, BACnet, Modbus, etc. networking to the JACE from other systems or facility or global wide area networks.

1.10 AGENCY AND CODE APPROVALS

A. All products of the BAS shall be provided with the following and applicable-related agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916: Energy Management Systems.
2. UL-854: Smoke Control Systems.
3. ASHRAE Standard 135: BACnet™ Communication Protocol.
4. NFPA: Applicable Life Safety and Risk-Loss Provisions.
5. ULC; UL - Canadian Standards Association
6. FCC: Part 15, Subpart J, Class A Computing Devices

1.11 SOFTWARE LICENSE AGREEMENT

A. The Owner shall sign a copy of any TCS manufacturer's standard Unitary-Control-based software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. Software license shall not expire or utilize any sort of protection hardware device for its use.

C. A software license information form describing the manufacturer's policies and implementation shall be provided to the Owner before the job is complete.

1.12 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.13 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this

Contractor's responsibility to check the OPR/Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.14 EXTRA MATERIALS/ATTIC STOCK

A. Furnish total sets of materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Coordinate Transmission, Delivery & Storage with Primary Contractor, Commissioning Services Provider and Owner:

1. Temperature Control Components:
   a Plant Controllers – typical for each type as used in TCS, pre-configured to 'typical' Project program, quantity of One (1).
   b Pipe-mounted Insertion Sensors - typical as used in TCS, quantity of two (2).

1.15 WARRANTY

A. TCS warranty: Provider/Manufacturer's standard form in which provider/manufacturer agrees to repair or replace components of TCS wiring & equipment that fails in materials or workmanship. Submit a written warranty signed by the TCS provider and installer agreeing to furnish labor and parts for failures within a warranty period of one (1) year from the date of substantial completion/documented Start-up.

B. Extended warranty: Provider/Manufacturer's standard form in which TCS provider/manufacturer agrees to furnish parts and labor for Proposer/Contractor installed non-Integration-based TCS failures within an extended warranty period:

1. Term: Two (2) years (TOTAL) from the date of substantial completion.

2. Condition: The Second year of Parts & Labor coverage begins with final acceptance of TCS beneficial operation confirmed at 11-month TCS Walkthru with Owner's Master Systems Integrator/Commissioning Provider & Owner's representative.

PART 2 MATERIALS

2.1 GENERAL

A. The Temperature Control System (TCS) shall be comprised of an OPEN network of Enterprise-level (provided by the MSI via the Design-Build Contractor) and Distributed-level (provided by the TCC) components in an interoperable system of stand-alone digital controllers employed to achieve the specified Sequences of Operation. The TCC shall provide complete Design & installation coordinated with other control elements & devices required/specified herein to achieve a fully-operational and energy-efficient facility operations OPEN Temperature Control/Building Automation System.

1. The resultant Temperature Control System will be a complete functioning BACnet™ Communication Network. Contractors will field verify each existing network to determine extent of new cabling required for the intended installation, including the replaced serial network cabling to existing Equipment 'integrated' to the applicable

portions of existing Network(s). New cabling and connections to existing integrated Equipment can include (each to be field-verified prior to submitting Bids/Proposals):

a. Variable Frequency Drives (VFDs): New and Existing VFDs (verify - each to remain in service) may have existing BACnet Serial Interfaces (embedded or by accessory cards) that will be re-initiated/integrated to the replaced TCS Network installed.

1. Provide appropriate Integration materials/cabling for each existing VFD without the ability to be integrated to the new BACnet™ MSTP Network(s) as-is.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet technology communication protocols (MSTP-preferred/IP-for specific direct-to-JACE connections as designated on Systems Architecture Drawings.). The BAS is to be delivered by the noted combination of the furnished Enterprise-level equipment (programmed by the **Owner's** Master Systems Integrator – **Palmer Conservation**) and Proposer/Contractor/TCC provided field/unitary control components via selected Vendors/Mechanical Contractor/Electrical Contractors.

1. The Main TCS/BAS Platform furnished, installed & implemented in this project must be engineered to be fully (certifiable) "OPEN" on the Tridium Niagara™ Framework.

a. Main Distributed Controller elements: "Vykon N4 JACE™" (furnished by the designated MSI via the Design-Build Contractor specified in 230940).

b. Distributed Application Specific Controller elements: "OPEN" (Niagara N4, BACnet™) Series (furnished by the TCC under 230900 as specified).

2. The software licensing required shall have no restrictions on which brand of JACE, Supervisor or System Programming tools can interact with the system. Station Compatibility must = ALL and Tool Compatibility must = ALL.

B. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

2.3 INTEROPERABLE OPEN BACnet™ APPLICATION SPECIFIC CONTROLLERS

A. Distributed-level Controls furnished shall be microprocessor-based OPEN Interoperable BACnet (programmable) Controllers in accordance with the ANSI/ASHRAE Standard 135-1995. New Controllers shall be provided for applicable Air Handlers, Heating Plants, Cooling Plants, Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and all applications as shown on the OPR documents/drawings to meet the intentions of Distributed Systems Architectures for reliability and system functionality/Sequences of Operation. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-1995.

B. The OPEN Distributed Controllers shall communicate with the Enterprise-level controller via an Ethernet connection at a baud rate of not less than 10 Mbps or via the RS485 connection at a baud rate of not less than 38 kbps.

C. The Controller Sensor(s) shall connect directly to the Controller and shall not utilize any of the I/O points of the controller. The Controller Sensor(s) shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The Controller Sensor(s) shall provide a communications jack for connection to the BACnet communication trunk to which the Controller is connected. The Controller Sensor(s), the connected Controller, and all other devices on the BACnet bus shall be accessible by a compatible Portable Operators Terminal.

D. All Controllers shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the Controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

1. Niagara EDGE devices used for real time control shall deploy an embedded ACE deterministic engine, JACE hardware is not acceptable for real time control.

E. The TCC supplying the noted/applicable distributed application specific Controllers will coordinate with the MSI and shall provide documentation for each device, with the following information at a minimum:

1. BACnet Device; MAC address, name, type and instance number.

2. BACnet Objects; name, type and instance number.

F. The TCC will coordinate with MSI to supply a working, licensed copy of the programming software for all controllers to the Owner – refer to SUBMITTALS section for details.

G. It is the responsibility of the TCC to coordinate with the MSI to ensure that the proper BACnet objects are provided in each Controller, as required by the Sequences of Operation/Point Listings in the OPR/drawings.

2.4 ANCILLARY CONTROL SYSTEM HARDWARE/SYSTEM ELEMENTS

A. Local Control Panels: Unitized NEMA 1 cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panels of 0.06-inch thick, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.

3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, including damper-positioning switches, changeover switches, thermometers, and gages.
4. Provide ON/OFF power switch with over-current protection for control power sources to each local panel.
5. Provide/mount “lamacoid”/similar engraved label for each major subpanel/enclosure containing TCS devices coordinated with TCS Submittals and Design/Submittal documentation issued.

B. Sensors:

1. Electronic Temperature Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
2. Resistance Temperature Detectors: Platinum, thermistor, or balco.
    a. Accuracy: Plus or minus 0.2 percent at calibration point; thermistors shall have a maximum 5 year drift of no more than .225°F maximum error of no more than .36°F
    b. Wire: Twisted, shielded-pair cable
    c. Insertion Elements in Ducts: Single point, 6 inches long; use where not affected by temperature stratification or where ducts are smaller than 4 sq. ft.
    d. Averaging Elements in Ducts: 60 inches, long, flexible for use where prone to temperature stratification or where ducts are larger than 4 sq. ft.; 264 inches long, flexible for use where prone to temperature stratification or where ducts are larger than 16 sq. ft; length as required.
    e. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
    f. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
    g. Room Security Sensors: Stainless steel cover plate with insulated back and security screws.
3. Humidity Sensors: Bulk polymer sensor element.
    a. Accuracy: 2 percent at 10-90% RH with linear output.
    b. Room Sensors: Range of 0 to 100 percent relative humidity
    c. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.
4. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
    a. Accuracy: +/- 1 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA, 0-5 vDC, 0-10 vDC.
    c. Building Static-Pressure Range: -.1 to .1, -0.25 to 0.25, -.5 to .5, -1.0 to 1.0 IN WC., jumper selectable.
    d. Duct Static-Pressure Range: 0 to 1, 0 to 2.5, 0 to 5, 0 to 10 IN WC., jumper adjustable
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

C. Equipment operation sensors as follows:

1. Status Inputs for Fans: Differential-pressure switch with adjustable range of 0 to 5 IN WC.
2. Status Inputs for Pumps: Differential-pressure switch piped across pump with adjustable pressure-differential range of 8 to 60 psig.
3. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable trip point, split core with an integral LED for trip indication and set to 175 percent of rated motor current.

D. Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

E. Water-Flow Switches: Pressure-flow switches of bellows actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless steel or bronze paddle. For chilled water applications, provide vapor proof type.

F. Carbon-Monoxide Detectors: Single or multi-channel, dual-level detectors, using solid-state sensors with 3-year minimum life, maximum 15-minute sensor replacement, suitable over a temperature range of 23°F to 130°F, calibrated for 50 and 100 ppm, with maximum 120-second response time to 100-ppm carbon monoxide.

G. Carbon-Dioxide Sensor and Transmitter: Single detectors, using solid-state infrared sensors, suitable over a temperature range of 23°F to 130°F, calibrated for 0 to 2 percent, with continuous or averaged reading, 4 to 20 mA output; duct, space and wall mounted as required by application.

H. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

I. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
2. Dead Band: Maximum 2°F.

J. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.

6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

2.5 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action, floating-point (small reheat coil option only as appropriate) or two-position action under all environmental conditions (temperature, low power voltage fluctuations, tight seal damper design, maximum air and water flow forces) and provide BAS with accurate "feedback" positioning signals.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
3. Spring-Return Motors for Valves Larger Than NPS 2-1/2": Size for running and breakaway torque of 150 in. x lbf.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

B. Electronic Damper and Valve Actuators: Direct-coupled type non-hydraulic designed for minimum 100,000 full-stroke cycles at rated torque. The actuator shall have rating of not less than twice the thrust needed for actual operation of the damper or valve.

1. Coupling: V-bolt and V-shaped, toothed cradle.
2. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
3. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
4. Actuators shall have the ability to be tandem mounted.
5. All spring-return actuators shall have a manual override. Complete manual override shall take no more than 10 turns.
6. Power Requirements (Two-Position Spring Return): 24V ac or dc, Maximum 10VA.
7. Power Requirements (Modulating): Maximum 15 VA at 24V ac.
8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
9. Temperature Rating: -22°F to 140ºF.
10. Run Time: 200 seconds open, 40 seconds closed.
11. All actuators shall have a 5 year warranty
12. Valves: Designed & Selected for application/duty designated.

    a. Size for torque required for valve close-off at maximum pump differential pressure (regardless of water loop system pressures).
    b. Valve and Actuators shall come from the factory fully assembled.
    c. Spring Return Manual Override shall come with a 10 Degree Valve Preload to assure tight close off.

13. Dampers: Designed & Selected for application/duty designated.
    a. Size for running torque calculated as follows:
        i. Parallel-Blade Damper with Edge Seals: 7 inch-pounds/sq. ft. of damper.
        ii. Opposed-Blade Damper with Edge Seals: 5 inch-pounds/sq. ft. of damper.
        iii. Parallel-Blade Damper without Edge Seals: 4 inch-pounds/sq. ft. damper.
        iv. Opposed-Blade Damper without Edge Seals: 3 inch-pounds/sq. ft. of damper.
        v. Dampers with 2 to 3 Inches wg. of Pressure Drop or Face Velocities of 1000 to 2500 FPM Multiply the minimum full-stroke cycles above by 1.5.
        vi. Dampers with 3 to 4 Inches wg. of Pressure Drop or Face Velocities of 2500 to 3000 FPM Multiply the minimum full-stroke cycles above by 2.0.
    b. Spring Return Manual Override actuators shall a factory set 5 Degree Damper Preload.

PART 3 EXECUTION

3.01 GENERAL

A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians/electricians qualified for this work and in the regular employment of the temperature control system installer. The installing office shall have a minimum of five years of installation experience with similar Scopes of Work and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the selected component manufacturer(s). Supervision, calibration and checkout of the system shall be by the employees of the local installer contracting field office. Intent is to install & wire (power and Communications) Contractor and Furnished components/systems (coordinated with Master Systems Integrator **- Palmer Conservation**) including, but not limited to (refer to accompanying OPR documents & designated Product Data/IOMMs/Cut Sheets):
    a. Distributed OPEN JACE Controllers, Meters, Sensors, communication cabling and auxiliaries.
    b. Distributed OPEN Application Controllers, sensors, communication cabling and auxiliaries.
        i. Design for the targeted One-for-One replacement/upgrade of existing distributed controllers is to include modification/re-work of communication network(s) as required to deliver a fully-functional BAS-focused Operational Technology (OT) Network for the District, integrating in collaboration (submittal-design review) with the District’s Information Technology Team and Master Systems Integrator.
        ii. Installation of the Upgraded OT Network will employ “daisy-chain” routing of the desired BACnet™ communications as described in this specification and on the Systems Architecture Diagrams of the OPR Documents such that logically-determined End-Devices on upgraded BAS Network/(sections) will be integrated/connected to the District’s OT Network to limit the number of Internet Protocol addresses (and unmanaged IT switches) required for upgraded BAS implementation.

iii. Provide Installation of new/replaced Controller equipment and main Network Nodes/wiring in fully-accessible locations (especially above ceilings) and designate as such in As-Built/Closeout documentation.

c. NEW Serial Communication (BACnet MSTP) Network Integrations to designated/verified existing HVAC/Other Equipment-Systems; Based upon Scopes declared in OPR Documents (Specifications, Systems Architecture Diagrams, etc.) AND upon Proposing Contractor's pre-proposal field verifications of existing conditions/setups as required:

i. Variable Frequency Drives (VFDs): include this Project integration to each new and existing (verified) HVAC Fan/AHU and Pump VFD, adding Serial Interface capability as required.

ii. Existing or New/Replaced Equipment: include final connections and rough-ins (for Future use as noted):

1. Variable Air Volume Terminal Controllers.

2. Packaged Chiller Systems, as applicable.

3. Packaged Boiler Systems as applicable.

iii. Existing Systems: include rough-ins (for Future use as noted), as applicable.

iv. Digital-Integrated and/or Hand-Off-Auto Lighting Control Panels/equipment (as applicable): include rough-ins (for both Current and/or Future use) only as noted and required to meet current Design/Energy-use Standards in place and applicable to the Scope of Work designated, as applicable.

B. Drawings of temperature control systems in the OPR are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Owner/Criterion Engineers shall be furnished and installed without additional cost.

1. Provide legible & Laminated Control As-Built Drawing in each installed Panel/Enclosure with notations of devices/components for that specific and related panel/components of the System.

2. Provide in-panel/enclosure (field) labeling of each component utilized in the System, matched to the required laminated As-Built Drawings inside each panel.

C. Install equipment level and plumb.

D. Install/implement software in Unitary control units and assure interface(s) to Owner's operator workstation(s), Coordinated with the Systems Integration Provider. Implement all features of programs to specified requirements and as appropriate to Sequences of Operation.

E. Connect and configure equipment and software to achieve Sequences of Operation specified.

F. Verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Locate all to ADA standards/level above the floor. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

G. Install guards or tamper proof enclosures on thermostats in the following locations:

1. Entrances.

2. Public areas – including all areas readily-accessible to students (Classrooms, etc.).
3. Where indicated.

H. Install automatic dampers according to manufacturer's listed instructions.

I. Install labels and nameplates to identify control components.

3.02 JOB SITE CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is the TCC/Proposer-Contractor's responsibility to check the Contract Documents for possible conflicts between this Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural feature.

B. The resultant Temperature Control System will be a complete functioning BACnet™ Communication Network. Contractors will verify each existing network to determine extent of new cabling required for the intended installation.

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to manufacturer's listed instructions and NEC requirements.

1. Properly 'label' each new/existing raceway Junction Box for source (panel) and service.

B. Install building wire and cable according to manufacturer's listed instructions and NEC requirements.

C. Install signal and communication cable according to manufacturer's listed instructions and NEC requirements.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Install concealed cable in raceway.
4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
6. Number-code and color-code conductors for future identification and service of control system, except local individual room control cables.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

F. Where Serial Communication/BAS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.04 CONNECTIONS

A. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.05 FIELD QUALITY CONTROL/FINAL CHECKOUT OF TCS

A. Installer's Field Service: Engage a qualified service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing. Calibration and test electric/electronic thermostats by disconnecting input sensors and stimulating operation with compatible signal generator.

1. Notify Owner/Project Construction Administration Team no less than TWO Weeks prior to scheduling the Final Checkout of EACH Major Area/Portion of the OPEN Temperature Control System and allow an Owner’s Representative(s) to observe any of the scheduled Final Checkout procedures planned by the factory/Unitary-TCC to achieve the Field Quality Control directives of this Specification; document results and transmissions.

B. Replace damaged or malfunctioning controls and equipment.

1. Start, test, and adjust control systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

C. Verify Unitary (manufacturer designed & factory/field-installed) DDC as follows:

1. Verify software including automatic restart, control sequences, alarms, scheduling, reset controls, and occupied/unoccupied cycles.
2. Verify local control units including self-diagnostics.

D. Cooperate & Coordinate with Testing & Balancing services providers to achieve Sequences of Operation specified/final-designed.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 20 hours (“banked”) dedicated instructor time on-site.
3. Review data in maintenance manuals.
4. Schedule training with Owner, through Criterion Engineer, with at least seven days' advance notice.

B. General Items: In ADVANCE of actual Training session:

1. Coordinate Functions, Schedules & Documents with Criterion Engineer/D-B Contractor.

2. Transmit any manufacturer recommended/required specialized tools used/needed for Installation, Maintenance and/or Calibration of Installed Systems.

3. Verify Punchlist & Issues Log items Resolved; Provide Project Completed Sign-off.

4. Transmit/Deliver Attic Stock materials as coordinated with Owner.

5. Transmit As-Builts/IOMMs at least one week prior to Training Session scheduled.

6. Transmit Warranty Forms, Startup Reports, Balancing Reports with Dates/Contacts.

C. Specific Items: Covered at Training session:

1. Building HVAC System Types/Overview.

2. Control Sequences of Operations overview/Operational philosophy.

3. TCS Device & Component Overview.

4. Review Attic stock Materials delivered with sourcing contacts.

5. Review Recommended Maintenance Items/Intervals; weekly checks (Graphics/field).

6. Review newly-installed/modified existing UNITARY Controls – related to BAS Control

7. Review BAS Programming Tools/Installation w/ backup process & materials.

8. Review Schedules, Equipment & Systems Startup (Start-Stop).

9. Review Alarming Features (Critical and other).

10. Review OVERRIDE Procedures.

11. Cover Troubleshooting & Reporting Procedures (Logs, Contacts, Warranty Service, etc.)

12. Schedule 11-month TCS Walkthrough date.

3.07 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide for three separate Project site visits (for EACH Building of a multi-site Scope of Work), when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

1. Two of the after-completion Project Site Visits will be noted as SEASONAL with intent of making Entering Heating and Entering Cooling System assessments.
2. The Third after-completion Project Site Visit will be at the time where Eleven months has elapsed from the date of Final Project Acceptance with intent of assessing the status of the original Warranty Period and current operating conditions.

3.08 WARRANTY EXECUTION

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance as defined in 3.10 D with additional time as determined by Extended Warranty provisions in the published OPR Documents.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Division 230900 provider at no expense to the Owner.

3.09 WARRANTY ACCESS

A. The Owner may grant qualified Mechanical Service contractors, reasonable access to the TCS during the warranty period.

3.10 ACCEPTANCE TESTING

A. The Division 230900 provider shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications. The Division 230900 contractors and 230940 services providers are to coordinate the checkout of the system such that each Division has a representative present during FINAL BAS system checkout.

B. The Division 23900 provider shall perform tests to verify proper performance of components, routines, and points PRIOR to the FINAL Coordination with the Cx Services Provider as noted above. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation; Submit documented Verification Log PRIOR to scheduling FINAL Acceptance activities with the Cx Services Provider. The Division 230940 provider shall have a representative present during system checkout by the Division 230900 provider.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: is defined as the 230900 supplier and Design-Build Contractor having completed all of the testing and demonstration activities as required by the MSI - **(Palmer Conservation)** per the published Commissioning Plan including prefunctional and functional testing and bi-seasonal testing and receiving an acceptance letter issued by the OWNER/Cx for this specification section. The Proposer/Contractor & Owner will determine the date of Functional Completion after reviewing the Commissioning Provider’s recommendation for Functional Completion. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

END OF SECTION 230900

SECTION 230940 – MASTER SYSTEMS INTEGRATION SERVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. The Owner's Project Requirement (OPR) documents provide additional Specification and graphical schematics (Drawings) to delineate responsibilities for Technical Services provided by the Master Systems Integrator (MSI) and OPEN Temperature Controls Contractor (TCC) with BOTH Services provided to the County by the Design-Build Contractor/Installation team. This includes, but is not limited to:

1. Section 230900 OPEN Temperature Control Systems intends to cover the portion of work (materials as noted & complete physical Installations) provided by the Proposing team, coordinated in-full with the Master Systems Integrator/Commissioning Provider.

2. Section 230940 HVAC Sequences of Operation intends to cover the operating routines required by the Proposer Team within the applicable/noted portions of the HVAC System(s), coordinated in-full with the Master Systems Integrator Provider.

3. There may be additional documents denoted as Supplemental or Exhibits (References) as a part of the OPR. These documents intend to provide applicable supporting information for the Proposer team to use in preparing bids/estimates and in preparing Submittals/Coordination Documents as required to execute the fully-coordinated Scopes of Work. Any supplemental information provided is declared to be as-is/as-found and require all parties to field-verify and conditions pertinent to the estimating or service-providing being done for the project.

1.2 SUMMARY

A. This section describes the Master Systems Integration Services scope of work for the project. This section also coordinates the responsibilities of the Mechanical and Electrical trades (Contractor Team) contractors pertaining to control products or systems, furnished by each trade that will be integrated by this Services Provider.

1.3 MASTER SYSTEMS INTEGRATION SERVICES PROVIDER (MSI)

A. **Palmer Conservation Consulting (PCC) is the Owner's** Master Systems Integrator (MSI) for this project. All MSI-related Services, as described in the OPR Documents, including this specification, will be covered under the contract between the Design-Build Contractor and the Owner in conjunction with all other related Scopes of Work/Contractors. This section is provided for reference and coordination of the complete 'Controls' Scope of Work.

1. **Palmer Conservation Consulting (PCC)** Contractor will coordinate the following related functions:

a. Information Technology systems design & implementation, beyond that clearly noted as Installation scopes of Work by the Contractor.

b. Point List Naming conventions – TCC will provide English language Table-form data information for this coordination effort.

c. Graphic Screens & Navigation.

d. Programming Stations and Software functions.

e. End-of-Project Commissioning, Closeout & Training efforts specified/provided for in other MSI-related Sections.

f. Post-Project Warranty-period procedures as specified/provided for in other MSI-related Sections.

1.4 SYSTEM DESCRIPTION

A. The Building Automation and Control System (BAS) shall be comprised of Java Application Control Engine(s) (JACE) within each facility. The JACE (N4) shall connect to the Owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each JACE (N4) shall communicate to BACnet (Interoperable BACnet Controllers) components provided under Division (230900) Temperature Controls Installation Contractor & associated HVAC/Electrical Equipment specification sections (Integrations to Unitary Controllers).

1.5 SUBMITTAL

A. Submittal shall consist of a JACE detail drawing depicting communications network and protocols between the JACE and project-applicable HVAC Equipment, generators, lighting controllers, power monitoring modules and Owner's internal network locations with a description of the communication type, media and protocol.

B. Upon completion of the work, provide a complete set of 'as-built' JACE detail drawings and application software on flash disk media or compact disc. Drawings shall be provided as AutoCAD™ or Visio™ compatible source files with Adobe™ PDF electronic versions. Multiple copies of the 'as-built' drawings shall be provided in addition to the documents on flash disk media or compact disc. Division (230900) Temperature Controls Contractor (TCC) and effective (260000) Electrical Systems Contractor (ESC) shall provide as-builts for their portions of work, via the Installation-focused contract. Division (230940) Master Systems Integration Provider (MSI) shall be responsible for as-builts pertaining to overall BAS architecture and network diagrams.

1.6 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

BAS	Building Automation (& Control) System
TCS	Temperature Control System
JACE (N4)	Java Application Control Engine (Vykon N4)

MSI	Master Systems Integrator
IBC	Interoperable BACnet Controller
GUI	Graphical User Interface
WBI	Web Browser Interface
POT	Portable Operator's Terminal
PMI	Power Measurement Interface
DDC	Direct Digital Controls
LAN	Local Area Network
WAN	Wide Area Network
OOT	Object Oriented Technology
Cx/CxP	Commissioning/Commissioning Provider
TCC	Temperature Control Contractor
OPR	Owner's Project Requirements
PICS	Product Interoperability Compliance Statement

1.7 DIVISION OF WORK

A. The Section 230900 (TCC) contractor shall be responsible for all field labor & applicable materials for mounting & wiring designed/specified Building Automation System (BAS)/TCS components, (including specified Energy and Flow/Alarm Metering & Lighting Control System devices), Distributed Application Specific Controllers/programming (as specifically noted), ancillary control devices, required fabricated control panels, any unitary/non-applied controller programming, unitary/non-applied controller programming software, labeled controller input/output and power wiring, labeled controller network wiring and (BAS)/TCS-based BACnet™ network wiring & connections to the Java Application Control Engine (JACE) N4 Networks, (applies to ALL required wiring scopes).

B. The Section 230940 (MSI) Master Systems Integration Services provider shall be responsible for designing/coordinating the Java Application Control Engine (JACE) N4 components & software and programming of the JACE's, graphical user interface software (GUI), development of all graphical screens, setup of schedules, logs and alarms, BacNet(tm) network management as required to interface the JACE to the Contractor's TCS network/energy meters/lighting control systems, global supervisory control applications, general system integration of BACnet/Modbus devices as shown, integration and coordination and connection of the JACE to the local or wide area network. The MSI Contractor will provide the JACE(s) to the Contractor for field installation as specifically designated. SPECIFIC Equipment furnished under this section includes:

1. Main Supervisory Computer Equipment – by MSI.
2. Main JACE Network Controllers – by MSI.
3. Data Analytics "CSV" Drivers – by MSI.

1.8 RELATED WORK - ELECTRICAL INSTALL SCOPES

A. According to applicable national/local standards and generally accepted usual & customary installation practices, provide typical/necessary Division 260000 Line & Low Voltage Electrical scopes & design/field coordination, via Proposer/Contractor's TCC and Electrical Power/low-voltage (Systems) subcontractors:

1. Providing control devices and systems including but not limited to:

a. Unitary-System/Equipment-based (Applied) Control panels, devices and wiring
b. Local controller and Temperature control device sensors/networks required for coordinated interface to unitary controllers provided by the Electrical/Mechanical Contractor via the Contractor.
c. TCC BACnet network connections to the JACE (N4) Controllers, Energy-use Meters, Lighting Controllers, VAV Terminal Controllers, Packaged Air-Cooled Condensing Units, VFDs etc.

2. Providing motor starters and disconnect switches (unless otherwise noted).
3. Power wiring and conduit (unless otherwise noted).
4. Provision, installation and wiring of smoke detectors (unless otherwise noted).
5. Providing labor and material for; generator network, lighting controller network and power monitoring network connections to the JACE (unless noted in other equipment sections)
6. Providing labor and material for; intranet, internet, BACnet, LON, Modbus, etc. networking to the JACE from other systems or facility or global wide area networks.

1.9 AGENCY AND CODE APPROVALS

A. All products of the BAS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.

1. UL-916; Energy Management Systems
2. ULC; UL - Canadian Standards Association
3. FCC, Part 15, Subpart J, Class A Computing Devices

1.10 SOFTWARE LICENSE AGREEMENT

A. Software licensing for the JACE or Supervisor shall give the Owner the capability to control their system and determine which contractors can collaborate/engineer/apply within their system.

B. It shall be possible to ensure the Owner can prevent unauthorized partners from accessing the system for engineering changes.

C. Software licensing shall have the capability to individually manage authorized parties and independent parties.

D. The software licensing shall have no restrictions on which brand of JACE, Supervisor or System Programming tools can interact with the system. Station Compatibility must = ALL and Tool Compatibility must = ALL.

E. The Owner shall accept the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.11 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.12 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is the MSI Services Provider's responsibility to check the Contract Documents for possible conflicts between this Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural feature.

PART 2 MATERIALS

2.1 GENERAL

A. The Building Automation System (BAS) shall be comprised of a network of interoperable, stand-alone digital controllers specified and/or provided by the Master Systems Integrator **(Palmer Conservation)** for installation by the 230900 TCS section sub-contractor. The TCS/Proposer-Contractor will also provide & install other control elements & devices as required by the intent of the BAS/OPR as specified herein to achieve a fully-operational and energy-efficient facility operation OPEN Temperature Control/Building Automation System. The BAS will also include: a computer system, graphical user interface software, printers, network devices and other devices as specified herein. Focus of the system will be to serve the specific building/facility where installed but be OPEN connected via the Owner's network for global access & management.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall BAS.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet technology communication protocols (MSTP-default/IP-employed as noted). The BAS is to be delivered by the noted combination of the Master Systems Integrator **(Palmer Conservation)** and Contractor/TCC provided field/unitary control components & ALL installation via selected Vendors/Mechanical Contractor/Electrical Contractors.
   1. The Main TCS/BAS Platform furnished, installed & implemented in this project must be Tridium Niagara™ Vykon-OPEN System, engineered to be fully (certifiable) "OPEN" on the Tridium Niagara™ Framework.
   2. Main Distributed Controller elements (furnished by TCC under 230900): Vykon "Edge", Distech OPEN Application Specific Controllers and/or Johnson Controls Facility Explorer OPEN Controllers.
   3. The software licensing required shall have no restrictions on which brand of JACE, Supervisor or System Programming tools can interact with the system. Station Compatibility must = ALL and Tool Compatibility must = ALL.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet/Ethernet IP and/or MS/TP.

C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 NETWORKS

A. The Local Area Network (LAN) shall be a 10/100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Java Application Control Engine (JACE) N4, user workstations and, if specified, a local server.

B. Local area network minimum physical and media access requirements, as coordinated with Owner's Informational & Operational Technology Departments:

1. Ethernet; IEEE standard 802.3
2. Cable; 10 Base-T, UTP-8 wire, category 5E
3. Minimum throughput; 10/100 Mbps

2.4 NETWORK ACCESS

A. Remote Access.

1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The Owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP.

2.5 DATA COLLECTION AND STORAGE

A. The JACE shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the JACE that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.
2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
5. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.

C. All log data shall be stored in a relational database in the JACE and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. All log data shall be available to the user in the following data formats:

1. HTML
2. XML
3. Plain Text
4. Comma or tab separated values

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The JACEs shall have the ability to archive log data either locally (to itself), or remotely to a server or other JACE on the network. Provide the ability to configure the following archiving properties, at a minimum:

1. Archive on time of day
2. Archive on user-defined number of data stores in the log (buffer size)
3. Archive when log has reached it's user-defined capacity of data stores
4. Provide ability to clear logs once archived.

2.6 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the JACE(N4). Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the JACE), to another JACE (N4) on the network, or to a server. For each log entry, provide the following data:

1. Time and date
2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

2.7 DATABASE BACKUP AND STORAGE

A. The JACE shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the JACE. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The JACE database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.8 GRAPHICAL USER INTERFACE SOFTWARE

A. Operating System**:** The GUI shall run on Microsoft Windows current applicable version for the BAS.

B. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and links to other graphic screens.
3. Graphics shall support layering and each graphic object shall be configurable for assignment to one a layer. A minimum of six layers shall be supported.
4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.

a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

D. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

a. Create, delete or modify control strategies.
b. Add/delete objects to the system.
c. Tune control loops through the adjustment of control loop parameters (If exposed in controller to LON or BacNET).
d. Enable or disable control strategies (If exposed in controller to LON or BacNET).
e. Generate hard copy records or control strategies on a printer.
f. Select points to be alarmable and define the alarm state.
g. Select points to be trended over a period of time and initiate the recording of values automatically.
h. Configure trends for all system devices as coordinated with Owner for event analysis and troubleshooting.

E. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

F. Security. Each operator shall be required to log on to that system with a username and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

G. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

H. Alarm Console

1. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.

2. When the Alarm Console is enabled, a separate alarm notification window will supercede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.9 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Google Chrome™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
4. Storage of the graphical screens shall be in the Java Application Control Engine (JACE), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

1. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
2. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
c. View logs and charts
d. View and acknowledge alarms
e. Setup and execute SQL queries on log and archive information

7. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.10 SUPERVISORY SOFTWARE AND HARDWARE

A. A central server located at the designated Owner's Facility shall be provided/upgraded/integrated to with each application. The server shall support all Java Application Control Engine(s) (JACE) connected to the Owner's network whether local or remote.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, or T1 connections.

C. It shall be possible to provide access to all Java Application Control Engine (JACE) via a single connection to the server. In this configuration, each Java Application Control Engine (JACE) can be accessed from a remote Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.

D. The server shall provide the following functions, at a minimum:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any JACE in the network, local or remote.
3. The server shall include a master clock service for its subsystems and provide time synchronization for all Java Application Control Engine (JACE)
4. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.
5. The server shall provide scheduling for all (JACE) and their underlying field control devices.
6. The server shall provide demand limiting that operates across all Java Application Control Engine (JACE). The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
7. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Java Application Control Engine (JACE).

8. Each Java Application Control Engine (JACE) supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.
9. The server shall provide central alarm management for all Java Application Control Engine (JACE) supported by the server. Alarm management shall include:
    a. Routing of alarms to displays, mobile voice devices, printers, email accounts and pagers as applicable/designated.
    b. View and acknowledge alarms.
    c. Query alarm logs based on user-defined parameters
10. The server shall provide central management of log data for all Network Area Controllers Java Application Control Engine (JACE) supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
    a. Viewing and printing log data.
    b. Exporting log data to other software applications.
    c. Query log data based on user-defined parameters

E. Server Hardware Requirements (For Reference Only, as typical Main Server components are existing/already provided) The server hardware platform shall have the following requirements:

1. The main computer(s) are employed with the following specifications/setups to meet current Tridium™ requirements;
    a. Intel Xeon E5 2640 x64 (or better) compatible with dual and qua-core processors.
    b. 400MHz side Buss.
    c. 512K L2 cache.
    d. 6/8 DDR SDRAM DIMM sockets supporting 6/8GB of main memory.
    e. 7 expansion slots 2x64-bit/133MHz PCI-X, 4x64-bit/100MHz PCI-X, 1x32-bit/33MHz PCI.
    f. LSI Logic 53C1030 Dual Integrated PCI Ultra320 LVD SCSI controller.
    g. Raid Controllers – PERC4/Di, PERCC3/DC, PERC3/QC.
    h. Drive Bays – Standard internal hard drive bays to support up to six 1” or Ultra320 SCSI hard drives.
    i. 32X Combo CD-RW/DVD-ROM Drive.
    j. Hard Drives Up to 8x1 hot plug SCSI Drives, 10,000 and 15,000 PRM (Future).
    k. Provide Internal Storage 1.168TB Internal Storage in base equipment.
    l. Internal Tape Backup PowerVault 100T DDS.
    m. Dual Universal Serial Bus (USB) Ports.
    n. Display: Video card/20” Flat Monitor 2000FP with minimum pixel resolution of 1024 x 768
2. The server operating system shall be current/best Microsoft Windows Professional and Include current/equivalent Microsoft Internet Explorer or Google Chrome.
3. Connection to the BAS network shall be via an Ethernet network interface card, 10/100 Mbps, with RJ-45 connector.

4. As noted/specified for dedicated alarm printing, provide a compatible ink jet type printer, either 80 or 132 column width. The printer shall have a USB/parallel port interface and/or Ethernet connection.

2.11 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through password access as assigned by the system administrator.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.12 SERIAL NETWORK MANAGEMENT

A. The Graphical User Interface software (GUI) shall provide a complete set of integrated BACnet network management tools for working with BACnet networks. These tools shall manage a database for all BACnet devices by type and revision and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between LonWorks devices, known as "binding". Systems requiring the use of third party LonWorks network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

D. These tools shall provide the ability to "learn" an existing BACnet network, regardless of what network management tool(s) were used to install the existing network, so that existing BACnet devices and newly added devices are part of a single network management database.

E. The network management database shall be resident in the Java Application Control Engine (JACE), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

2.13 OBJECT LIBRARIES

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACnet specification.

E. The library shall include applications or objects for the following functions, at a minimum:

1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
2. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection.

This object must be “linkable” to any or all scheduling objects for effective event control.

3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
4. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.
5. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building’s “flywheel” effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day’s performance.
6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to affect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the user’s screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.

1. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
2. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
3. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an “on” condition. The user must be able to specify either input condition as the “on” condition.

4. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
5. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
6. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
7. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
8. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
9. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
10. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
11. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.

G. The object library shall include objects to support the integration of devices connected to the Java Application Control Engine (JACE). At a minimum, provide the following as part of the standard library included with the programming software:

1. BACnet devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide BACnet manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the BACnet profile shall be supported. Information (type and function) regarding network variables not defined in the BACnet profile shall be provided by the device manufacturer.
2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.
3. For BACnet devices, provide the following objects at a minimum:

    a. BACnet AI
    b. BACnet AO
    c. BACnet BI
    d. BACnet BO
    e. BACnet Device

4. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.

5. For Modbus devices, provide the ability to interface to specific “data registers” as documented and supplied by the equipment vendor. Such as;

    a. Modbus GenericBI
    b. Modbus GenericBO
    c. Modbus GenericAI
    d. Modbus GenericAO
    e. Modbus 6xRecord
    f. Modbus BitsToRegister
    g. Modbus PresetCoil
    h. Modbus PresetRegister
    i. Modbus RegisterToBits.

2.14 ENTERPRISE-LEVEL CONTROLLERS - Java Application Control Engine (JACE)

A. The Division (230940) Master Systems Integration Contractor shall design/coordinate for one or more Java Application Control Engine (JACE). Number of area controllers required is dependent on the type and quantity of devices provided under Divisions (230900) Temperature Controls. It is the responsibility of the Division (230940) Master Systems Integration Services provider to coordinate with the Owner, Division (230900) Temperature Controls Contractor and Contractors to determine the quantity, type and designated location of the Enterprise-level Controller devices.

B. The Java Application Control Engine (JACE) shall provide the interface between the LAN or WAN and the field control devices and provide global supervisory control functions over

the control devices connected to the JACE (N4). It shall be capable of executing application control programs to provide:

1. Calendar functions
2. Scheduling
3. Trending
4. Alarm monitoring and routing
5. Time synchronization
6. Integration of ModBus controller data and BACnet controller data
7. Network Management functions for all BACnet™ based devices

C. The Java Application Control Engine (JACE), Vykon N4 platform must provide the following hardware features as a minimum, or as appropriate for the application:

1. Two Ethernet Port – 10/100 Mbps
2. Two RS 485 ports (BACnet MSTP compatible)
3. One USB port
4. Four option card slots/capacity
5. NRIO port (RS485 and/or IO16 or IO34 module local IO compatibility)
6. Designed for DIN rail mounting
7. Standard drivers include BacNet™, LonWorks™.
8. One LonWorks Interface Port – 78KB FTT-10A (via option card)
9. Provide Modbus Capability
10. SRAM data / memory backup
11. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity).
12. The JACE must be capable of operation over a temperature range of -20 to 60°C.
13. The JACE must be capable of withstanding storage temperatures of between -40 and 85°C.
14. The JACE must be capable of operation over a humidity range of 5 to 95% RH, non-condensing.

D. The JACE shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the JACE shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

E. The JACE shall support standard Web browser access via the Intranet/Internet.

F. Event Alarm Notification and actions

1. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
2. The JACE shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:

a. To alarm
b. Return to normal
c. To fault

4. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
5. Provide timed (schedule) routing of alarms by class, object, group, or node.
6. Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.

G. Control equipment and network failures shall be treated as alarms and annunciated.

H. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text
2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

a. Day of week
b. Time of day
c. Recipient

3. Mobile Voice Devices via coordinated services that initiate a text-message upon receipt of call/email message.
4. Graphic with flashing alarm object(s)
5. Printed message, routed directly to a dedicated alarm printer
6. Audio messages

I. The following shall be recorded by the JACE for each alarm (at a minimum):

1. Time and date
2. Location (building, floor, zone, office number, etc.)
3. Equipment (air handler #, accessway, etc.)
4. Acknowledge time, date, and user who issued acknowledgement.
5. Number of occurrences since last acknowledgement.

J. Alarm actions may be initiated by user defined programmable objects created for that purpose.

K. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

L. A log of all alarms shall be maintained by the JACE and/or a server (if configured in the system) and shall be available for review by the user.

M. Provide a "query" feature to allow review of specific alarms by user defined parameters.

N. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

O. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

2.15 DDE DEVICE INTEGRATION

A. The Java Application Control Engine (JACE) shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Java Application Control Engine (JACE) shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of these devices into the BAS. Objects provided shall include at a minimum:

1. DDE Generic AI Object.
2. DDE Generic AO Object.
3. DDE Generic BO Object.
4. DDE Generic BI Object.

PART 3 EXECUTION

3.1 INSTALLATION

A. All work described in this section shall be performed by the Master System Integrators or qualified sub-contractors that have a successful history in the design and implementation of integrated control systems.

B. Coordinate implementation of system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

C. Drawings of BAS network are diagrammatic only and any apparatus not shown but required to make the system operative to the complete satisfaction of the Owner shall be furnished and installed without additional cost.

D. Line and low voltage electrical connections to control equipment shown specified or shown on the BAS/control diagrams shall be furnished and installed as noted by the Contractor via his pre-qualified Division 230900 Temperature Control Installer in accordance with the specifications in Divisions 230000 and 260000.

3.2 WIRING

A. All electrical control wiring and power wiring to the JACE, computers and network components shall be the responsibility of the Contractor via his pre-qualified Division 230900 Temperature Control Installer and in accordance with the specifications in Divisions 230000. Coordination of this implementation is provided by the (230940) MSI contractor **(Palmer Conservation).**

B. All wiring shall be in accordance with the Project Electrical Specifications (Division 260000), the National Electrical Code and any applicable local codes. All BAS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 260000) unless otherwise allowed by the National Electrical Code or applicable local codes. Where BAS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WARRANTY

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) reviewed/coordinated by the MSI and Owner's Representative.

3.4 WARRANTY ACCESS

A. The Owner shall grant to the Division (230940) MSI contractor **(Palmer Conservation)**, reasonable access to the BAS during the warranty period. The Owner shall allow the contractor to access the BAS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, Division 230940 (MSI) shall load all system software and start-up the system. The Division 230900 (TCC) contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications. The Division 230940 (MSI) and Proposer/ Contractor via his pre-qualified Division 230900 Temperature Control Installer are to coordinate the checkout of the system such that each Division has a representative present during system checkout.

B. The Division 23900 provider shall perform tests to verify proper performance of components, routines, and points PRIOR to the FINAL Coordination with the Cx Services Provider as noted above. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation; Submit documented Verification Log PRIOR to scheduling FINAL Acceptance activities with the Cx Services Provider. The Division 230940 provider shall have a representative present during system checkout by the Division 230900 provider.

C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

D. System Acceptance: is defined as the 230940 Master Systems Integration provider having completed all of the testing and demonstration activities as required by the Cx's (Commissioning Agent) commissioning plan including prefunctional and functional testing and bi-seasonal testing and receiving an acceptance letter issued by the Owner's Commissioning Agent (Cx) for this specification section. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR INSTRUCTION, TRAINING

A. During system commissioning and at such time acceptable performance of the BAS hardware and software has been established the Temperature Control sub-contractor shall

provide on-site operator instruction to the Owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Division 230940 (MSI) contractor shall provide 30 hours of instruction to the Owner's designated personnel on the operation of the BAS and describe its intended use with respect to the programmed functions specified. Operator orientation of the BAS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.

C. The training shall be in three sessions as follows:

1. Initial Training: One day session (2-8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the Owner's personnel can start to familiarize themselves with the system before classroom instruction begins.

2. First Follow-Up Training: One/Two days (8-16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.

3. Warranty Follow Up: One day (2-6 hours total) in no less than 2 hour increments, to be scheduled at the request of the Owner during the one year warranty period. These sessions shall cover topics as requested by the Owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

3.7 CLOSEOUT SUMMARY & INTEGRATED COMMISSIONING

A. The Division 230940 (MSI) Services Provider shall refer to & coordinate Items addressed in sections included in 230000 and with section 230900 (TCC) to determine what level of control the Java Application Control Engine (JACE) must provide, which is the responsibility of this OPEN Master Systems Integrator. It is the responsibility of the 230940 (MSI) Services Provider to coordinate control functions, such as scheduling and supervisory-level global control with the Contractor via his pre-qualified Division 230900 Temperature Control Installer(s).

END OF SECTION 230940