



PROJECT:

Event Center Re-Roof and HVAC Replacement
Hoover High School, Fresno, CA

Date: 03/15/2021

TETER Project No.: A 18-10805 D

CLIENT:

Fresno Unified School District
2309 Tulare Street
Fresno, CA 93721

Client Project No.: 62166-373

DSA File No.: 10-H8

DSA Appl. No.: 02-117242

The following additions, deletions and revisions to the plans, specifications and Addenda shall become a part of the plans and specifications. It is the responsibility of the General Contractor to submit the information contained in this addendum to all subcontractors and suppliers. The Bidder shall acknowledge receipt of the Addendum in the Bid Proposal. (Addendum number of pages: 1 pages + 17 attachments = 18 total pages).

PROJECT MANUAL:

3 – 01: PROJECT MANUAL, SPECIFICATION SECTION 230923 – “DIRECT DIGITAL CONTROL SYSTEMS FOR HVAC”, revise as follows:

- A. Replace this specification section in its entirety with Specification Section 230900 “Building Automation Systems (BAS)”.

DRAWINGS:

3– 02: DRAWINGS, SHEET M002 – MECHANICAL SCHEDULES, revise as follows:

- A. Revise efficiency of filters for Air Handler Schedule to indicate MERV 13 filters.
- B. Revise efficiency of filters for Package Air Conditioning Schedule to indicate MERV 13 filters.

END OF ADDENDUM NO. 3

SECTION 230900
BUILDING AUTOMATION SYSTEMS (BAS)

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The intent of this document is to describe a system that is complete in every respect without further cost to the Owner. Anything not shown on the drawings or indicated in the specifications, and required for complete operating systems, shall be included as part of this Work. This will also include all connections to new services.
- B. All parts of the plans and specifications fully apply when applicable to work of this Division. No attempt has been made to divide the work between the various trades or subcontractors.
- C. OPERATION: The entire Building Automation System (BAS) shall be comprised of a network of interoperable, stand-alone digital controls communicating on the Niagara N4 open protocol communication network to a host computer communicating via the internet to the FUSD host computer. The BAS shall communicate to third party systems such as chillers, boilers, air handling systems, energy metering systems, other energy management systems, access control systems, fire-life safety systems and other building management related devices with open, inter operable communication capabilities.
- D. Work specified by others:
 - 1. HVAC Subcontractor:
 - a. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
 - b. Access doors where required.
 - c. Installation of impression wells and pressure taps.
 - d. Installation of flow switches.
 - e. Installation of automatic control valves.
 - f. Installation of pressure taps and associated shut-off cocks. Pete's plugs shall be installed next to each temperature and pressure sensor.
 - 2. Electrical Subcontractor:
 - a. Electrical work shall, in general, comply with the following:
 - 1) Electrical work may include both line-voltage and low-voltage wiring, as required.
 - 2) All electrical work shall comply with the latest California Electrical Code and local electrical codes.
 - 3) All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.
 - 4) All magnetic starters for mechanical equipment shall be furnished with integral 120V control transformers, sized to handle the additional VA needed for the controls - pilots, EP valves, etc. All motor starters to be NEMA rated; no IEC rated starters.

- 5) The motor starter supplier shall provide auxiliary contacts as required for interlock by BAS Contractor; the supplier shall estimate an allowance of at least one auxiliary contact per starter. All interlock and control wiring shown on the electrical prints is by the electrical subcontractor.

1.2 QUALITY ASSURANCE

A. Minimum Contractor Qualifications:

1. BAS Contractor; programs software and ensures network compatibility with all hardware as specified within, and the following requirements:
 - a. Hold a Niagara N4 Framework Certification for at least two years, obtained from a Tridium certified training facility, no exceptions.
 - b. Shall have installed a minimum of three functioning networked systems.
 - c. Must provide a list of at least three projects of similar scope and cost, list to include:
 - 1) Project name / School District.
 - 2) Contact name and phone number.
2. Controls Contractor: Installs all hardware controls as specified within, and the following requirements:
 - a. A minimum of three installed and operational Building Automation Systems (BAS) with the Niagara N4 Framework within the last five years.
 - b. A minimum of five years' experience in servicing a networked BAS.
 - c. Must provide a list of at least three projects of similar scope and cost, list to include:
 - 1) Project name / School District.
 - 2) Contact name and phone number.

- ### B. Response Requirements:
- The BAS Contractor shall provide a 24-hour emergency response service with a dedicated telephone number. The BAS contractor shall guarantee a 2-hour maximum response time by a Niagra N4 certified service technician. Fresno Unified reserves the right to obtain services and repairs from any BAS company when the 2-hour response time has been exceeded. The BAS contractor agrees by submittal of his/her bid to pay a late penalty to the District at a rate of \$75 per every half-hour interval exceeding the 2-hour response limit. The District reserves the right to implement a late penalty on a call-by-call basis, depending on the nature of the emergency service call, at the District's discretion.

- ### C. Accountability:
- The District intends to document all service calls to ensure service provided has met the District's expectations as specified. Substandard service or conduct may result in the District certifying the Contractor as non-responsive and potentially eliminate the Contractor from bidding on future projects. During the warranty period, if the BAS is not fully functional and requires a service call, the District shall not be limited by any exclusivity arrangement between the BAS or Controls Contractor at any time.

1.3 CODES, STANDARDS, ORDINANCES AND REGULATIONS

- A. All work and materials shall be in full accordance with the latest rules and regulations of applicable codes as amended and adopted by any governmental agency which has jurisdiction over this work. Nothing in these Plans or Specifications is to be construed to permit work not conforming to these codes. Should the Plans or Specifications call for material, methods, or construction of a higher quality or standard than required by the above rules, the higher quality shall govern.
1. When not contradicting the above, the manufacturers' recommendations along with applicable parts of the following documents shall be the basis for quality and technique of installation.
 - a. Title 24, California Administrative Code, all parts.
 - b. Applicable publications of the National Fire Protection Association (NFPA), and the National Electrical Code (NEC).
 - c. Applicable publications of the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).

1.4 SITE CONDITIONS AND LOCATIONS

- A. The general location and arrangement of system hardware is shown on the drawings. Information on the drawings relative to existing services is approximate only. Minor adjustments required to conform to actual locations shall be made without additional cost to Owner. The Controls Contractor shall, as work progresses, verify the dimensions of the spaces available for the installation of the work and he shall assume full responsibility for the proper locations of each portion thereof.
- B. The construction documents are generally diagrammatic and the locations indicated may be approximate only. They do not show every offset, bend, or elbow required for installation in the space provided. The Controls Contractor, therefore, shall install all equipment, conduit runs and the like as follows:
1. Adhere to the location indicated as near as possible.
 2. Maintain ample head room and access in all passageways, clearance around all equipment and under conduit runs for unrestricted passage and for easy servicing of all apparatus, equipment, devices and the like.
 3. Provide access for maintenance of all equipment.

1.5 SUBMITTALS

- A. Control Submittal: Within 30 calendar days after award of the contract, and before any materials of this Section are delivered to the job site, submit:
1. The BAS Contractor shall submit .caf files for each device, and a description of operation and schematic drawings of the System to the Architect/Engineer/Owner for approval before starting work on-site. At least two sets of submittals shall be sent through channels.
 2. Product data submittals must be complete and in a single bound document for all items supplied in this Division. Each document shall be bound with an index and marked with the equipment identification as specified in the Plans and Specifications.
 3. Provide complete control shop drawing including equipment, control devices, point to point connections with terminal numbers, and any details necessary for a complete control drawing.

4. List of name plates to be engraved, showing each name plate wording and location.

1.6 REMOVAL AND SALVAGE

- A. Pre-Demolition conference: Contractor shall schedule a walk-through meeting with Energy Management Department to conduct an inventory on items to be removed and salvaged from the existing building under construction.
- B. Inventory List: The Contractor shall complete and submit an inventory list of items that have been removed and salvaged to the Energy Management Department and store items in a cool dry and protected area.
- C. Delivery: Delivery of the salvaged items shall be determined by the Energy Management Department and the Contractor.
- D. Remove and Reinstall: Detach items from existing location and store them for re-installation in a strategic area of operation to be determined.
 1. Identify areas of occupancy to remain in-use and functional.
 2. If existing BAS is required to be removed, relocated, or abandoned, before proceeding with the demolition provide temporary power and communication that bypasses the area of demolition and that maintains the continuity of the BAS to other occupied parts of the site or building construction.
- E. Schedule of Demolition Activities: Indicate the following:
 1. Detailed sequence of demolition and removal work, with starting and ending dates for each activity. Ensure on-site operations of the occupied areas of the BAS are not interrupted.
 2. If there is to be an interruption in the operation of the existing BAS, Contractor shall notify Architect & District Project Manager and indicate how long the services will be interrupted in writing.

1.7 CLOSE-OUT DOCUMENTS

- A. Record Documents:
 1. At completion of project, BAS Contractor shall provide to the Architect/Engineer all As-Built drawings, communications and controller map, wiring diagrams, equipment specifications, Operations and Maintenance Manuals and other documentation as required to describe the system. At least two sets of operations and maintenance manuals with "as-built" drawings, parts lists, etc. shall be provided at job completion.
 - a. Hard copies shall be stamped with "Record Drawings".
 - b. Provide all Record Documents on a cloud based drive or physical drive; including pdf files and CAD files using AutoCAD 2008 or latest version.
 2. During progress of the work, maintain an accurate record of all changes made in the systems from those shown on the drawings, specifications and submittals.
 3. Revise Shop Drawings and provide on reproducible media and in DWG format compatible Windows operating systems and Autocad 2008 or latest version.

- B. Communications and Controller Map: To include the following;
 - 1. A detailed communication routing map showing entering and exiting locations
 - 2. A detailed list of controller locations by room number and location.
 - 3. Permanently attach the communication routing map and controller locations inside the NAC control panel.

- C. Operations and Maintenance Manuals: Upon completion of the work, a complete bound book containing the following information shall be submitted to the Architect/ Engineer:
 - 1. Complete catalog and performance data on all control devices, including all documents included in submittals.
 - 2. Complete manufacturers' operating and maintenance instructions on all control devices.
 - 3. Complete wiring and control diagrams for all equipment and systems, including list of materials, description of operation and system flow diagrams.
 - 4. Manufacturers' warranty certificates on all equipment.
 - 5. Contractor's warranty letter.

1.8 GUARANTEE

- A. The Contractor shall warrantee in writing all work performed under this contract for a period of two years from the date of notice of completion.

- B. When notified of a system failure relating to the work performed under this contract, the Contractor will be responsible for all investigation, diagnoses, repair, revision or replacement necessary to correct the condition.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT DESCRIPTION

- A. The Building Automation System (BAS) shall be capable of integrating multiple building functions, including equipment supervision and control, alarm management, energy management, and trend data collection. System shall be Johnson Controls FX-80 Web based front end with Johnson Controls devices and controllers. BACnet, N4 must reside in controller and Open licensing shall be included in each FX-80 device. Programming of the FX-80 and creating all required dynamic graphics shall be included in this section.

- B. The BAS shall consist of the following:
 - 1. Network processing, data storage and communications equipment.
 - 2. DC Controllers (HVAC etc).
 - 3. Other components required for a complete and working BAS.

- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASCs, and operator devices. Controllers shall be provided a 10% spare point capacity for all necessary applications.
- D. System architectural design shall eliminate dependence upon any single device for alarm generation and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- E. Acceptable Systems:
 - 1. Facility Explorer by Johnson Controls is the District Standard using the BACnet MSTP protocol to integrate into the District's existing server (JCI).
 - 2. No substitutions allowed.

2.2 CONDUIT AND WIRING

- A. Control Contractor shall provide and install all low voltage conduit and wiring for DDC system as required for a complete and operating system. Conduit and wiring shall conform to Division 16 requirements.
- B. Wiring:
 - 1. BACnet communications cable shall be Connect Air: W223C-2144FCBJC 22-3C (Blue Jacketed). Install per manufacturer's recommendations. No splices, Tee's, or cuts of any kind will be allowed. Identify both ends at terminal blocks, field devices, and sensors. All wiring that is routed below grade shall be W221P-1003PE (Outdoor Polyethylene BACnet-Black).
 - a. Communication Loop and sensors must be run in separate conduits and junction boxes.
 - b. The outside air sensor must be brought into the NAC I/O at all times. An outside air sensor brought into a controller is not acceptable.
 - 2. Sensor wire shall be: Connectair Part # W181P-2040PRB 18-2 (Purple).
 - 3. Analog Output shall be: W184C2059PINK 18-4 (Pink).
 - 4. Thermostat wire shall be Connect Air: W224C-2020WHT 22-4C (White Jacketed).
 - 5. Cable routed in accessible ceiling spaces shall comply with EIA/TIA standards for communications cabling. Communication bus wire shall be W223C-2144FCBJC 22 3C (Blue Jacketed) Connect Air, blue jacketed shielded cable.
- C. Conduit: Conduit shall be minimum 1 inch diameter except that minimum conduit size for 120 volt power shall be 3/4-inch. For underground conduit, provide 100% spare capacity by installing a second conduit (empty) along all conduit routes. All conduits shall be sized as follows: Size per the CEC (NEC with California Amendments) and then oversize by one size. All conduits shall be RGSC (Rigid galvanized steel conduit) only. All fittings shall be steel/not malleable or aluminum.

2.3 BAS ARCHITECTURE

- A. Automation Network
 - 1. The automation network shall be configured as a Client/Server network with a web server operating on the Clients LAN/WAN. The web browser interface is extended over the LAN/WAN. Monitoring and control of the BAS is available using the web browser interface.

2. The automation network shall include the option of a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.
3. The BAS shall network multiple user interface clients, system controllers and systems supervisors(s) as required for systems operation.
4. The automation network option shall be capable of operating at a communication speed of at least 100 Mbps or more.
5. The automation network option will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network:

1. Control networks shall provide either “Peer-to-Peer,” Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 to 76,800baud.
2. Digital Controllers shall reside on the control network via BACnet MSTP.

C. Integration:

1. Hardwired
 - a. Analog and digital signal values shall be passed from one system to another via hardwired connections.
 - b. There will be one separate physical point on each system for each point to be integrated between the systems.
2. Direct Protocol (Integrator Panel)
 - a. The BAS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BAS system and 3rd party manufacturers’ control panels. The BAS shall receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, and power monitoring system.
 - b. All data required by the application shall be mapped into the BAS system, and shall be transparent to the operator.
 - c. Point inputs and outputs from the controllers shall have real-time interoperability with BAS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and Local Area Network Communications.

2.4 USER INTERFACE

A. Browser Based Interface

1. The system shall be capable of supporting an unlimited number of clients using standard Web browser such as Internet Explorer™, Google Chrome and Mozilla Firefox. 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.

2. 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 Building Automation System (BAS), shall not be acceptable.
3. The Web browser client shall support at a minimum, the following functions:
 - a. User log-on identification and password shall be required. If an unauthorized user attempts access, notice of access failure shall be displayed. Security using authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - b. 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.
 - c. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - d. Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
 - e. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - 1) Modify common application objects, such as schedules and setpoints in a graphical manner.
 - 2) Commands binary objects to start and stop.
 - 3) View logs and charts.
 - 4) View alarms.
 - f. 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.
4. Alarms
 - a. Alarm feature shall allow user configuration of criteria to create, route, and manage alarms and events. It shall be possible for specific alarms from specific points to be routed to specific alarm recipients. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - 1) Allow configuration to generate alarms on any numeric, binary, or data point in the system.
 - 2) Generate alarm records that contain a minimum of a timestamp, original state, acknowledged state, alarm class and priority.
 - 3) Allow the establishment of alarm classes that provide the routing of alarms with similar characteristics to common recipients.
 - 4) Allow a user, with the appropriate security level, to manage alarms - including sorting, acknowledging, and tagging alarms.
5. Reports and Summaries
 - a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - 1) All points in the BAS
 - 2) All points in each BAS application
 - 3) All points in a specific controller
 - 4) All points in a user-defined group of points

- 5) All points currently in alarm
- 6) All BAS schedules
- 7) All user defined and adjustable variables, schedules, interlocks and the like.
- b. Reports shall be exportable to .pdf, .txt, or .csv formats.
- c. The system shall allow for the creation of custom reports and queries.
6. Schedules
 - a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - 1) Regular schedules
 - 2) Repeating schedules
 - 3) Exception schedules
 - b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
 - c. It shall be possible to define one or more exception schedules for each schedule including references to calendars.
 - d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days. Holidays and special days shall be user-selected with the pointing device or keyboard.
7. Password
 - a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, Based on an assigned password.
 - b. Each user shall have the following: a user name, a password, and access levels.
 - c. The system shall provide the capability to require a password of minimum length and require a combination of characters and numerical or special characters.
 - d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
 - e. The system shall provide unlimited flexibility with access rights. A minimum of four levels of access shall be provided along with the ability to customize the system to provide additional levels.
 - f. A minimum of 100 unique passwords shall be supported.
 - g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
 - h. The system shall automatically generate a report of log-on/log-off and system activity for each user.
 - i. All log data shall be available in .pdf, .txt, and .csv formats.
8. Historical Data Collection
 - a. All numeric, binary or data points in the system database shall allow their values to be logged over time (trend log). Each historical record shall include the point's name, a time stamp including time zone, and the point's value.
 - b. The Network Area Controller (NAC) shall have the ability to store its historical data records locally and periodically to a remote server on the network (archiving).
 - c. The configuration of the historical data collection shall allow for recording data based on change of value or on a user-defined time interval.
 - d. The configuration of the historical data collection shall allow for the collection process to stop or rollover when capacity has been reached.

- e. A historical data viewing utility shall be provided with access to all history records. This utility shall allow historical data to be viewed in a table or chart format.
 - f. The history data table view shall allow the user to hide/show columns and to filter data based on time and date. The history data table shall allow exporting to .txt, .csv, or .pdf file formats.
 - g. The historical data chart view shall allow different point histories to be displayed simultaneously, and also provide panning and zooming capabilities.
9. Audit Log
- a. 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.
10. Database Backup and Storage
- a. The user shall have the ability to backup the System Controller databases.

2.5 AUTOMATION NETWORK

A. Network Server (NIC)

1. F.U.S.D. District N4 server is existing, BAS Contractor shall have the responsibility of bringing the firmware to current revisions. Any structures on the site with existing BAS that require this to match shall also be included in this project.
2. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from a standard Web browser (WBI) by connecting to the server.
 - a. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.
 - b. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
 - c. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.

- d. Each Network Area Controller 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.
 - e. The server provides central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:
 - 1) Routing of alarms to display, printer, email and email compatible pagers
 - 2) View and acknowledge of alarms
 - 3) Query alarm logs based on user-defined parameters
 - f. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs.
- B. Network Area Controller (NAC) or JACE
- 1. The NAC must provide the following hardware features as a minimum:
 - a. Communications
 - 1) One 10/100 Mb Ethernet Port – RJ-45 connection
 - 2) Digital controllers that are hardwired shall reside on the BACnet MSTP control network.
 - 3) Two RS-485 ports (up to 57,600 baud) shall be standard. Gateways or non-Johnson drivers not allowed.
 - 4) All required protocol drivers are included. BACnet, Modbus and N4 shall be resident as standard without additional costs, additional hardware External gateways shall not be acceptable.
 - b. Inputs/Outputs
 - 1) Four form C SPDT relay outputs rated for 24 VAC/DC @ 2Amps resistive each with individual LED indicators
 - 2) Six Universal Inputs for 10K NYC, 4-20 mA, 1-10 V, Dry contact
 - 3) Additional I/O modules shall be allowed if needed
 - c. Battery Backup
 - 1) Battery backup provided for all on board functions including I/O
 - 2) Battery is monitored and trickle charged
 - 3) Battery maintains processor operation through power failures for a pre-determined interval, and then writes all data to flash memory, shuts the processor down, and maintains the clock for five years.
 - d. Environment
 - 1) Must be capable of operation over a temperature range of 0°F to 122°F.
 - 2) Must be capable of withstanding storage temperatures of between 0°F and 150°F.
 - 3) Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.
 - e. Device License
 - 1) FX80 shall be licensed for 100 devices with a one year Software Maintenance Agreement (SMA).

2. The Network Area Controller (NAC) shall be a fully user-programmable device capable of providing all of the capability described in Section 2.3 Part A.
 3. Automation network – The Network Area Controller (NAC) shall reside on the automation network. Each NAC shall support one or more sub-networks of controllers.
 4. User Interface – Each Network Area Controller (NAC) shall have the ability to deliver a web based user interface as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
 5. Power Failure – In the event of the loss of normal power, The Network Area Controller (NAC) shall continue to operate for a defined period after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software. Flash memory shall be incorporated for all critical controller configuration data.
 - a. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
 - b. Certification – All controllers shall be listed by Underwriters Laboratories (UL).
- C. Application Specific Controllers (ACS's)
1. The ASC devices must provide the following hardware features as a minimum:
 - a. Communications:
 - 1) General and expansion controllers, and sensors by Johnson controls, shall be installed where specified and shown on portable classroom installations.
 - 2) BACnet/IP MS/TP Router to be used in area as needed.
 - b. Environment:
 - 1) Must be capable of operation over a temperature range of 0°F to 122°F.
 - 2) Must be capable of withstanding storage temperatures of between 0°F and 158°F.
 - 3) Must be capable of operation over a humidity range of 5% to 95% RH, non-condensing.

2.6 SOFTWARE PROGRAMMING/TOOLS

- A. Network Area Controller Toolset
1. Device embedded toolset shall provide the following capabilities in a graphical environment using a standard Web browser:
 - a. Device and point management
 - b. Scheduling, alarming and trending setup
 - c. Creation and binding of graphics
 - d. Time management
 - e. User management
 2. Toolset provides additional engineering capabilities including:
 - a. Editable table based point listings.
 - b. Automatically generated graphics for standard applications.
- B. Device Program Editor

1. Definition of application and logic and display operation shall be available in a completely graphic environment.
2. Definition of operator device characteristics, Digital Controllers (DC) panels, individual points, applications, and control sequences shall be performed in a drag and drop programming environment.
3. All temperature and equipment control strategies, energy management routines, scheduled operations and local device status indicators shall be definable by the operator. User password access and language options shall be definable by the operator.
4. Event definition, prioritization, logging and reporting options are definable by the operator.
5. Application logic shall provide for stand-alone applications as well as distributed applications that are automatically downloaded from master controllers to a network of controllers.
6. The programming environment shall provide help menus and instructions for each operation and/or application performed, for all programming library functions, and for the programming language itself.
7. Libraries of standard application modules shall be provided, such as temperature, humidity, and flow control. These modules may be used as “building blocks” in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences.

2.7 LOCAL CONTROL PANELS

- A. All control panels shall be factory constructed, incorporating the BAS manufacturer’s standard designs and layouts. All control components shall be UL inspected and listed. Control panels shall be fully enclosed, with sub-panel, hinged door, and slotted flush latch. Control panels shall exist on all equipment specified and shall be UL listed as a complete fabricated system. UL listings shall be shown on final drawings.
- B. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
- C. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
- D. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
- E. All wiring shall be neatly installed in plastic trays or tie-wrapped.
- F. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

PART 3 - EXECUTION

3.1 PREPARATIONS

- A. Prior to Installation: Inspect the installed work executed under other Sections which affect the installation of the controls. Report unacceptable conditions to the Engineer. Do not begin work until unacceptable conditions have been corrected. Installation of the controls shall constitute acceptance of existing conditions.
- B. Coordination: Coordinate work with work specified under other Sections to ensure proper and adequate interface of work. Equipment and systems drawings are generally diagrammatic unless dimensions are indicated. Drawings and details shall be checked for interference's with structural and other conditions prior to performing work.
- C. The Contractor shall be responsible for safety and good condition of his materials and equipment until final acceptance by the Owner. He shall erect and maintain suitable barriers, protective devices, lights and warning signs where required.

3.2 INSTALLATION

- A. General:
 - 1. When applicable installation procedures are shown or specified in other sections, those procedures shall be followed.
 - 2. Provide all supports and hangers, etc., as required to install the equipment as specified or shown on the drawings. All equipment shall be supported, braced and cross-braced to comply with current CBC and CMC.
 - 3. Sealing: Wherever any part of the control system has to pierce the roofing, openings through the roof shall be flashed absolutely watertight.
 - 4. Arrange and support piping and equipment so that vibration is at a minimum and is not transmitted to or through building structure.

3.3 CONDUIT AND WIRING

- A. Control wiring and conduit shall be the responsibility of this section and be installed as follows:
 - 1. In equipment rooms/attics – Conductors shall be run in conduit. Final connection to equipment shall be flexible conduit.
 - 2. Concealed in new building construction (wall/inaccessible ceilings) - Conductors shall be run in conduit.
 - 3. Roof mounted/exterior equipment yards - Conductors shall be in conduit. All flexible conduit shall be seal-tite with weatherproof connections. Equipment on grade and detached from the building a distance greater than 36" shall have underground control conduit routed to equipment.
 - 4. Above accessible ceiling spaces - Control cable will be allowed to be installed without conduit in accessible areas above ceilings as follows:
 - a. Plenum rated cable is an approved type for the application.

- b. Cable is bundled/organized in management devices routed square with building lines (no diagonals) and kept clear of electrical devices (i.e., ballasts, transformers, etc.) that could cause interference.
- c. Conduit sleeves are provided between accessible ceiling spaces (i.e., across soffits, gypsum ceilings, etc.) as required to maintain future access to cable.

3.4 CONTROL PANELS AND DEVICE LOCATIONS

- A. All controllers, relays, switches, etc., for equipment located within equipment rooms shall be mounted in enclosed UL listed control panels with hinged locking doors. All control devices equipment located in exposed areas subject to outside weather conditions shall be mounted inside weatherproof enclosures.
- B. Location of each panel is to be convenient for adjustment and service. Submit locations of all panels to the engineer with shop drawings.

3.5 IDENTIFICATION

- A. The label wording shall match that used on the drawings and provide clearly readable printed labels for each control component inside a panel. When applicable, additional identification needed shall be documented on the Shop Drawings.
- B. Engraved nameplates shall be provided on the face of each panel and beneath each actuator and control device not in a panel describing its use.
- C. All electrical devices within the panel shall be wired to a terminal strip within the panel. An "electric terminal" numbering system shall be applied to all terminals with aforementioned numbers matching terminals shown on Shop Drawings.

3.6 CLOSING-IN OF UNINSPECTED WORK

- A. General: Do not allow or cause any of the Work of this Section to be covered up or enclosed until it has been inspected, tested, and approved by the Mechanical Engineer and by all other authorities having jurisdiction.
- B. Uncovering: Should any of the Work of this Section be covered up or enclosed before it has been completely inspected, tested, or approved, do all things necessary to uncover all such work. After the Work has been completely inspected, tested, and approved, provide all materials and labor necessary and make all repairs necessary to restore the Work to its original and proper condition at no additional cost to the Owner.

3.7 PROGRAMMING

- A. The Direct Digital Control (DDC) operational program will be provided by the BAS Contractor. The Contractor shall provide any testing program he feels necessary to fully test the operation of the various components.

3.8 SYSTEM INSTRUCTION AND RECORD DRAWINGS

- A. The BAS Contractor shall schedule a minimum of 40 hours of training to train the District's Energy Management Department in the use and care of the system. This training shall occur after all commissioning of the control system is completed.
- B. Instruction period shall be started after instruction books, service manuals and record drawings have been submitted to and approved by the Architect/Engineer and shall be at hours (regular and non-regular) arranged by the Architect/Engineer.
- C. Service manuals shall include oiling, cleaning and servicing data, compiled in clearly and easily understood form and in a durable binder. Data shall show all serial numbers of every piece of equipment and complete list of replacement parts.

3.9 TESTING AND ACCEPTANCE

- A. The commissioning period starts when the following conditions are met:
 - 1. The BAS system and all involved HVAC equipment have been installed, connected to the EMS system and ready to operate.
 - 2. A commissioning meeting has been conducted with representatives of contractors involved, Fresno Unified School District Energy Management Department Technician & HVAC Supervisor/Mechanic, General Contractor, Mechanical Contractor, and the Control System Contractor.
 - 3. Consensus is reached, by the representatives at the above referenced meeting that it is appropriate for the commissioning process to start. The operational program shall be loaded into the DDC system by the Control Systems Contractor.
- B. During the commissioning period, the Control System Contractor will maintain a commissioning file of the printed reports from the building. The District shall verify all commissioning tests.
- C. During the commissioning period all mechanical equipment with filters shall have new filters installed. The static pressure across the fan shall be accurately measured and documented if installed. System balance, if required, shall have been completed.
- D. The Contractor shall furnish a complete and operating system. The Contractor shall also verify, in the presence of the District, the system accuracy and proper function of each controlled device and sensor. The following items shall be successfully demonstrated prior to acceptance by the District:
 - 1. All system outputs, including controllers, relays and other control devices, shall be addressed and start/stop functions demonstrated.
 - 2. All inputs shall be displayed and all event-initiated functions shall be demonstrated.

3. Demonstrate program integrity and power restore sequence during and after a power failure and restoration.
4. Deliver all As-Built drawings, wiring diagrams, equipment specifications, As- Built communications routing map, Operation and Maintenance Manuals and other documentation as required to describe the system.
5. A wiring schematic shall be permanently attached to the inside door panel of each control device.
6. A detailed As-Built communications wiring loop routing map shall be permanently attached to the front end door panel and a copy shall be provided to the Maintenance Department.
7. Complete operator training in the use, programming and operation of the system.
8. The system will not be considered complete until all system graphics are operational and accurate.

3.10 COMMISSIONING THE SYSTEM

- A. The District reserves the right to employ a third party commissioner at the District's expense.
- B. During the commissioning period all mechanical equipment with filters shall have new filters installed. The static pressure across the fan shall be accurately measured and documented if installed.
- C. The commissioning process will be completed and the training process shall start when the following conditions are met:
 1. No "alarm" or "condition reports" are being generated by the DDC system for seven (7) calendar days (168 hours) due to incomplete or inaccurate installation, program, or programming.
 2. All adjustments and "fine tuning" of the system shall also be included in the training process.
 3. The system has been approved by the General Contractor, and accepted by the Mechanical Engineer and District.
- D. The Training Process: Shall consist of the following:
 1. System use, operation and field trouble shooting to be provided to the District's Energy Management Department's personnel. Training must be a total of 40 hours of hands on, as well as phone support when needed. The 40 hour training can be used in any time allotment agreed upon by the Controls Contractor and the District EMS Control Center until hours are depleted.
 2. The District reserves the right to stop the clock at any time during the training process if there has been a discovery that impedes the complete full and accurate operation of the BAS installed. This includes the software programming, hardware components, sensors, or mechanical equipment and issues therein until they have been resolved.

END OF SECTION