SECTION 25 00 00 – BUILDING AUTOMATION SYSTEMS (BAS) GENERAL

PART 1 - GENERAL

Note: Reference the “University of Houston Design Guidelines, Element D3060, Controls and Instrumentation – General” document. This document describes how to employ this and other controls-related Specifications. The Engineer is instructed to consult the document for guidance on the nature of these Specifications, methods for deleting non-applicable text, and use and deletion of Editor’s Notes before proceeding with modification of this Specification to suit the Project.

Engineer shall utilize the BAS Retrofit Specifications 25 00 10, 25 11 19, 25 11 10, 25 14 10, 25 15 10, and 25 30 10 for all University of Houston area projects unless specifically directed to utilize Sections 25 00 00, 25 08 00, 25 11 09, 25 11 00, 25 14 00, 25 15 00, and 25 30 00. Engineer shall confirm with the Manager of Building Automation Services located in the departments and Environmental Health and Safety before utilizing Sections: 25 00 00, 25 08 00, 25 11 09, 25 11 00, 25 14 00, 25 15 00, and 25 30 00 for a Houston area project.

1.01 RELATED DOCUMENTS

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

B. Although Specifications throughout the Mechanical, Electrical, Communications, Electronic Safety and Security divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them; additional Divisions also may be reciprocally applicable to this Section.

1.02 SUMMARY

A. Section Includes:

1. Description of Work.
2. Quality Assurance.
4. Distributed Processing Units/Quantity and Location.
5. Demolition and Reuse of Existing Materials and Equipment.

B. Contractor shall furnish and install a direct digital control and building automation system (BAS). The new BAS shall utilize electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves (except where noted otherwise) to perform control sequences and functions specified. The BAS for this Project will generally consist of monitoring and control of systems described herein. Reference shall also be made to control Drawings, Sequence of Operation, and points lists.

C. The HVAC systems being controlled are [describe the type of mechanical systems included in the Project]. This Section defines the manner and method by which these controls function.
1.03 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.

C. The Authority Having Jurisdiction (AHJ) for building automation systems (BAS) shall be the Building Management Systems shop. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).


3. Electronics Industries Alliance:
   c. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

4. Underwriters Laboratories:
   b. UUKL 864: UL Supervised Smoke Control if the BAS is used for smoke control.

5. NEMA Compliance:
   a. NEMA 250: Enclosure for Electrical Equipment.
   b. NEMA ICS 1: General Standards for Industrial Controls.

6. NFPA Compliance:
   a. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
   b. NFPA 70 National Electrical Code (NEC).

7. Institute of Electrical and Electronics Engineers (IEEE)
   b. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN.

1.04 DEFINITIONS

A. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.

B. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).

C. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications.

D. BACnet/BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 and all current addenda and annexes.

E. BACnet Interoperability Building Blocks (BIBB): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a Specification.

F. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended or required destinations.

G. Building Automation System (BAS): The entire integrated management, monitoring, and control system.

H. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the LAN backbone and sub-LANs, and data storage for trend information, time schedules, and alarm data.

I. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135).

J. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.

K. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).

L. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.

M. Control Systems Server (CSS): This shall be a computer (or computers) that maintains the systems configuration and programming database. This may double as an operator workstation.

N. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.
O. Functional Profile: A collection of variables required to define key parameters for a standard application. For the HVAC industry, this would include applications like VAV terminal units, fan coil units, etc.

P. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-(use the most current version)

Q. Hand Held Device (HHD): Manufacturer’s microprocessor based device for direct connection to a Controller.

R. IT LAN: Reference to the facility’s Information Technology network, used for normal business-related e-mail and Internet communication.

S. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS.

T. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.

U. Local Supervisory LAN: Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs and CSSs and the LAN to which the GEMnet will be interfaced. See System Architecture herein.

V. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard (ASHRAE/ANSI 135).

W. UNIVERSITY OF HOUSTON WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser.

X. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.

Y. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.

Z. Operator Workstation (OWS): The user’s interface with the BAS system. As the BAS network devices are stand-alone, the OWS is not required for communications to occur.

AA. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.

BB. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.

CC. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135).

DD. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture herein.

EE. Router: A device that connects two or more networks at the network layer.

FF. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture herein.
GG. Server: A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.

HH. SQL: Standardized Query Language, a standardized means for requesting information from a database.

II. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with the controller network to which it is connected. This differs from an ASC in that it typically deals only with one variable.

JJ. XML (Extensible Markup Language): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

1.05 QUALITY ASSURANCE

Use “A” to define any specific qualifications needed; otherwise leave “Reserved”.

A. [Reserved].

B. Product Line Demonstrated History: The product line being proposed for the Project must have an installed history of demonstrated satisfactory operation for a length of five (5) year since date of final completion in at least ten (10) installations of comparative size and complexity. Submittals shall document this requirement with references.

C. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years. Firms with experience in DDC installation projects with point counts equal to this Project and systems of the same character as this Project. If installer is a Value Added Reseller (VAR) of a manufacturer's product, installer must demonstrate at least five years prior experience with that manufacturer's products. Experience starts with awarded Final Completion of previous projects. Submittals must document this experience with references.

D. Installer's Experience with Proposed Product Line: Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than one year from date of final completion on at least three (3) projects of similar size and complexity. Submittals shall document this experience with references.

E. Installer's Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than five (5) years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than two (2) projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. Proposed individuals must show proof of the following training:

1. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the manufacturer on that product line for installation and configuration.

2. Programming Training: Individuals involved with programming the Site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the manufacturer.
3. Installer’s Service Qualifications: The installer must be experienced in control system
operation, maintenance and service. Installer must document a minimum five (5) year
history of servicing installations of similar size and complexity. Installer must also
document at least a one year history of servicing the proposed product line.

F. Installer’s Response Time and Proximity:

1. Installer must maintain a fully capable service facility within a 60 mile radius of the Project
Site. Service facility shall manage emergency service dispatches and maintain inventory
of spare parts.

2. Emergency response times are listed below in this Section. Installer must demonstrate
ability to meet response times.

G. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an
Energy Management System.

H. The BAS shall be listed by Underwriters Laboratories (UUKL 864) for Supervised Smoke
Control.

1.06 SUBMITTALS

A. General: Submit under provisions of Division 01. Two (2) copies of the materials shall be
delivered directly to UNIVERSITY OF HOUSTON Monitoring Services staff, in addition to the
copies required by other Sections. In addition, an electronic version of the completed
materials shall be provided per owner’s format. Data can be in searchable native file format
where necessary. Refer to Section 25 08 00 for additional Commissioning submittal
requirements.

B. Functional Intent: Throughout the Contract Documents, detailed requirements are
specified, some of which indicate a means, method or configuration acceptable to meet that
requirement. Contractor may submit products that utilize alternate means, methods, and
configurations that meet the functional intent. However these will only be allowed with prior
approval.

C. Electronic Submittals: While all requirements for hard copy submittal apply, control
submittals and operation and maintenance (O&M) information shall also be provided in
electronic format as follows:

1. Drawings and Diagrams: Shop Drawings shall be provided on electronic media as an
AutoCAD drawing per Owner’s CAD standards. All ‘x reference’ and font files must be
provided with AutoCAD files.

2. Other Submittals: All other submittals shall be provided in Adobe Portable Document
Format

D. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for
the appropriate items.

E. Product Data: Submit manufacturer’s technical product data for each control device,
panel, and accessory furnished, indicating dimensions, capacities, performance and
electrical characteristics, and material finishes. Also include installation and start-up
instructions.
1. Shop Drawings: Submit Shop Drawings electronically on AutoCAD software for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated per the University of Houston BAS Manager. Shop Drawings shall contain the following information:

a. System Architecture and System Layout:

1) One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.

2) Provide floor plans locating all control units, workstations, servers, LAN interface devices, gateways, etc. Include all WAN and LAN communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, address, device instance, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing conditions shall be maintained accurately throughout the construction period and the Record Drawings shall be updated to accurately reflect accurate, actual installed conditions.

b. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include written description of sequence of operation.

c. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.

d. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). If this information is not available at the time of Shop Drawings submittals, furnish with O&M manual documentation for Owner review and approval. See Section 25 15 00 for additional requirements.

e. Label each control device with setting or adjustable range of control.

f. Label each input and output with the appropriate range.

g. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.

h. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.
i. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination Drawings on separate Drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that is existing, factory-installed and portions to be field-installed.

j. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.

k. Sheets shall be consecutively numbered.

l. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.

m. Table of Contents listing sheet titles and sheet numbers.

n. User Interface Graphic Screens.

o. Trends.

p. Alarms.

q. Legend and list of abbreviations.

r. Memory allocation projections.

s. Submit along with Shop Drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.

2. BACnet Protocol Information:

a. Submit the following:

1) BACnet object description, object ID, and device ID, for each I/O point.

2) Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.

3) Submit PICS indicating the BACnet functionality and configuration of each controller.

3. Compressed Air Systems:

a. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.

b. Wiring diagrams from manufacturers detailing electrical power supply wiring to equipment. Include ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory-installed and portions that are field-installed.
c. Pneumatic piping plan and riser layouts including all main air and branch air piping sizes, and calculated pressure losses for all pneumatic lines to all components, devices, and panels.

d. Certificates of shop inspection and data report as required by provisions of the ASME Boiler and Pressure Vessel Code.

4. Framed Control Drawings: Laminated control Drawings including system control schematics, Sequence of Operation and panel termination Drawings, shall be provided in panels and mounted in a suitable frame with a .125” Lexan polycarbonate cover for major pieces of equipment, such as air handling units, chillers, boilers, etc. Drawings should be of sufficient size to be easily read. Terminal unit Drawings shall be located in the central plant equipment panel or mechanical room panel.

5. Control Logic Documentation:

a. Submit control logic program listings (for graphical programming) and logic flow charts illustrating (for line type programs) to document the control software of all control units.

b. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.

c. Include written description of each control sequence.

d. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.

e. Sheets shall be consecutively numbered.

f. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.

g. Include Table of Contents listing sheet titles and sheet numbers.

h. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below and in Division 01.

F. Record Documents:

1. Record copies of product data and control Shop Drawings updated to reflect the final installed condition.

2. Record copies of approved control logic programming and database on paper and on CD’s. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of Shop Drawings and including changes to programs made during specified testing.

3. Record copies of approved Project specific graphic software on CDs.

4. Provide network architecture Record Drawings showing all nodes including a description field with specific controller identification, description and location information.
5. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.

6. Provide record riser diagram showing the location of all controllers.

7. Maintain Project record documents throughout the Warranty Period and submit final documents at the end of the Warranty Period.

G. Operation and Maintenance Data:

1. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.

2. Submit BAS User’s Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.

3. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.

4. Include all submittals (product data, Shop Drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 01.

   a. Contractor shall provide Owner with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers or branches. This service will be provided for five (5) years as part of the Contract price, and will be offered to Owner thereafter for the same price as to a dealer or branch.

   b. Manufacturer’s Certificates: For all listed and/or labeled products, provide certificate of conformance.

   c. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.

1.07 SYSTEM ARCHITECTURE

A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.

B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.

1. Coordinate all requirements of the BAS WAN / Primary LAN with the University of Houston IT Department and EH&S Building Automation Services Department.

2. All BAS utilization of the University of Houston IT network specified by Division 25 specifications or by the project construction documents shall be compliant with the owner’s current IT network standards. Reference and compliance with Division 27 Communication specifications. The owner’s IT department (UHIT) solely manages and governs the University of Houston IT infrastructure.
3. Division 25 shall not configure, provide nor install any devices or network cables within/inside the University of Houston IT network infrastructure. Routers provided by Division 25 which utilize the University of Houston WAN or Primary LAN shall be approved by UHIT prior to connection. Refer to current UHIT telecommunications standards at [http://www.uh.edu/infotech/services/computing/networks/network-infra-standards/](http://www.uh.edu/infotech/services/computing/networks/network-infra-standards/)

4. The University of Houston IT department shall grant approval to utilize the owner's IT network and provide Ethernet IP address after all their requirements are satisfied. Upon approval an Ethernet drop will be provided with a jackplate, IP address, and computer name specified by University of Houston IT for utilization by the Division 25.

C. The system architecture shall consist of an Ethernet-based, wide area network (WAN), a single Local Area Network (LAN) or multi-leveled LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.

1. University of Houston WAN: Internet-based network connecting multiple facilities with a central data warehouse and server, accessible via standard web-browser. This is an existing infrastructure and the Division 25 Contractor shall not configure any components of this WAN. Division 25 Contractors or designers working on existing BAS equipment may request reconfiguration of the University of Houston WAN, but only UH IT approved reconfigurations requests shall be executed by UH IT. Refer to Section 25 30 10 for requirements.

2. Local Supervisory LAN/Primary Controller LAN ('Primary LAN'): The Local Supervisory/Primary Controller LAN shall be an Ethernet-based, 10/100/1000base-T Ethernet LAN connecting Local Supervisory Controllers, Primary Control LANs, BCs, and OWSs. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path and as the connection point for the University of Houston WAN. Contractor shall utilize a dedicated LAN for the control system. The Local Supervisory LAN shall be installed by others, in accordance with Division 27 Communication specifications, which is not governed by Division 25. The BAS network configuration shall be the following:
   
a. BACnet/IP as defined in the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet Standard. Point/Object naming conventions are specified in Section 25 15 00. Refer also to the current ASHRAE 135 data communication protocol;

3. Secondary Controller LAN ('Secondary LAN'): Network used to connect AACs and ASCs. Acceptable communication protocols are BACnet over Ethernet (IEEE802.3), Master Slave/ Token Passing or polling as defined in the BACnet standard. Secondary LAN shall not directly connect to the University of Houston WAN or University of Houston Primary LAN. Division 25 shall provide and install all components of the Secondary LAN as specified in Division 25. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements and other requirements of the Specifications. The BAS Secondary LAN shall not utilize Network Data cable trays without owner approval. BAS Secondary LAN utilizing Network Data cable trays shall comply with the with Division 27 Communication specifications.

D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.
E. Remote Data Access: The system shall support the following methods of remote access to the building data. All remote access shall be approved by University of Houston Information Security department prior to installation. Remote access authorization requires completion of a “Person of Interest” Form.

1. Browser-based access: A remote user using a standard browser will be able access all control system facilities and graphics with proper password. Owner will secure and pay for the continuous Internet connection. The following paradigms are acceptable for browser-based access:
   a. Native Internet-based user interfaces (HTML, XML, etc.) that do not require a plug-in.
   b. User interfaces that via a standard browser use a freely distributed and automatically downloaded and installed plug-in or ‘thick’ client that presents the user interface across the web.

F. The communication speed between the controllers, LAN interface devices, CSS, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with Shop Drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall modify their BAS control design as necessary to accomplish these performance requirements.

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
3. 20 seconds between a Level 3-5 alarm occurrence and enunciation at operator workstation.
4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least ten (10) points.

G. Control Systems Server (CSS): This computer (or computers) shall maintain the systems configuration and programming database, and shall be restricted to Owner control. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. Refer to Section 25 11 09 - BAS Operator Interfaces for CSS requirements.

H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 25 11 09 – BAS Operator Interfaces.
I. The BCs, AACs, ASCs, and SDs shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 25 14 00 - BAS Field Panels.

J. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server or workstation on the Local Supervisory LAN. BAS shall provide user tools to the Owner that allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.

   1. Database Schema shall be published (via ODBC or SQL) and provided to the Owner to facilitate easy access to the data.

   2. Database shall be ODBC compliant or a data access driver shall be provided to act as an ODBC or OLE DB data provider.

K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other BAS nodes on the network. If a LAN is severed, separated networks shall continue to operate and communications within each network shall continue uninterrupted.

L. Anytime any controller’s database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the CSS.

1.08 DELIVERY, STORAGE AND HANDLING

A. Deliver each piece of equipment and control device in original factory shipping and packaging. Vendor shall maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

1.09 WARRANTY

A. Contractor shall warrant all products and labor for the full manufacturer’s warranty period or for two years (whichever is greater) after substantial completion.

B. The Owner reserves the right to make changes to the BAS during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS. Any disagreement between Owner and Contractor on such matters shall be subject to resolution through the Contract ‘Disputes’ clause.

C. At no cost to the Owner, during the Warranty Period, Contractor shall provide maintenance services for software, firmware and hardware components as specified below:

   1. Maintenance services shall be provided for all devices and hardware specified in the Contract Documents. Service all equipment per the manufacturer’s recommendations.

   Engineer shall consult with Owner prior to specifying the response times. Quicker response times may be dictated by the type of systems and facility. Edit to suit the Project.
2. **Emergency Service:** Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the Owner to the Contractor. Emergency service shall be provided 24 hours per day, 7 days per week, and 365 days per year with no exceptions and at no cost to the Owner.

   a. Response by telephone to any request for service shall be provided within two (2) hours of the Owner's initial telephone request for service.

   b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the Owner's Site within four (4) hours of the Owner's initial telephone request for such services, as specified.

3. **Normal Service:** Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the Owner to the Contractor.

   a. Response by telephone to any request for service shall be provided within eight (8) working hours (Contractor specified 40 hours per week normal working period) of the Owner's initial telephone request for service.

   b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the Owner's Site within three (3) working days of the Owner's initial telephone request for such services, as specified.

4. At any time during the Warranty Period that Contractor is on Site for maintenance, emergency, or normal service, Contractor shall notify Owner via UNIVERSITY OF HOUSTON Building Management Services and the local building operating personnel. Contractor shall notify said personnel of all work anticipated being involved for the service work. In addition, no work affecting system operation shall commence until express permission is granted via email or other written method. After the work is completed a work order ticket describing in detail all work performed (i.e. hardware replaced or serviced, software or firmware modifications made, etc.), hours worked, follow-up work required, etc., must be signed by an authorized building operators or Building Monitoring Services personnel.

5. **Owner's Telephonic Request for Service:** Contractor shall specify a maximum of three telephone numbers for Owner to call in the event of a need for service. At least one of the lines shall be attended at any given time at all times. One of the three contacted technicians shall respond to every call within 15 minutes.

6. **Technical Support:** Contractor shall provide technical support by telephone throughout the Warranty Period.

7. **Preventive maintenance:** shall be provided throughout the Warranty Period in accordance with the hardware component manufacturer's requirements.

8. In the last month of the Warranty Period, all System software and controller firmware, software, drivers, etc. will be upgraded to the latest release (version) in effect at the end of the Warranty Period.
PART 2 - PRODUCTS

2.01 GENERAL
A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 MANUFACTURERS
A. The BAS and digital control and communications components installed as work of this Contract shall be an integrated distributed processing system of the following manufacturer or communication protocol. No other products will be considered as substitutions.

B. Accepted BAS manufacturers include:
   1. Lab systems: Phoenix
   2. Building Automation Systems: Tridium, and Honeywell (Alerton)

2.03 MATERIALS AND EQUIPMENT
A. Materials shall be new, the best of their respective kinds without imperfections or blemishes, and shall not be damaged in any way. Used equipment shall not be used in any way for the permanent installation except where Drawings or Specifications specifically allow existing materials to remain in place.

2.04 UNIFORMITY
A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer

PART 3 - EXECUTION

3.01 PREPARATION
A. Examine areas and conditions under which control systems are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION
A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. All installation shall be in accordance with manufacturer's published recommendations.

C. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.

D. Refer to additional requirements in other Sections of this Specification.

Digital control stations should specifically be shown on the Drawings. Engineer should select appropriate wall/floor locations that minimize wire and tubing runs, and coordinate these locations with other disciplines. Engineer shall provide a three foot access door swing clearance at station location If the Project is a controls renovation only, locate spare breakers in a power panel where the BAS Provider can obtain 120V power and indicate on the Drawings.
3.03 DIGITAL CONTROL STATIONS, CONTROLLER QUANTITY AND LOCATION

*Engineer shall designate locations for control stations and specifically reserve wall/floor space and indicate it on the Drawings and coordinate with other disciplines. Engineer shall provide a three foot access door swing clearance at station location.*

A. Individual Digital Control Stations (DCS) are referenced to indicate allocation of points to each DCS and DCS location. Digital control stations shall consist of one or multiple controllers to meet requirements of this Specification.

B. Where a DCS is referenced, Contractor shall provide at least one (1) controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying controllers are specified in Section 25 14 00 - BAS Field Panels. Contractor shall extend power to the DCS from an acceptable power panel. If the BAS provider wishes to further distribute panels to other locations, Contractor is responsible for extending power to that location also. Furthermore, Contractor is responsible for ensuring adequate locations for the panels that do not interfere with other requirements of the Project and maintain adequate clearance for maintenance access.

C. Contractor shall locate DCS’s as referenced in the contract documents. It is the Contractor’s responsibility to provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.

*Engineer shall consult with Owner prior to specifying the DCS and Controller requirements. Controller requirements shall be dictated by the type of systems and facility. Edit to suit the Project.*

D. Contractor shall provide a minimum of the following:

1. One DCS (including at least one controller) in each chilled water/hot water plant mechanical room
2. One DCS (including at least one controller) for each air handler located in applicable mechanical room
3. One DCS (including at least one controller) for each critical fan system
4. One DCS (including at least one controller) for each pumping system
5. One DCS (including at least one controller) for each steam pressure reducing station
6. One controller for each piece of terminal equipment unit located at the terminal equipment.

3.04 SURGE PROTECTION

A. Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10 percent above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

3.05 CONTROL POWER SOURCE AND SUPPLY

*It is preferable to have the Division 26 Contractor supply power to DCS locations and provide the appropriate level of power for all control system components as located by the Engineer.*
instance, it is good practice to supply emergency power (and sometimes uninterruptible power when available) at critical controllers, control system servers, routers, workstations etc. This Section, however, applies mainly to retrofits with no Division 26 Contractor.

A. BAS Provider shall extend all power source wiring required for operation of all equipment and devices provided under Division 25 and the Drawings.

The following item will have to be customized for each system and Project. The consideration is where to provide power for controllers. For distributed controllers that are associated with one unit, it is convenient to power them along with the system so the controller can take action based on the presence of power. However, on large centralized panels, it may be best to put these on the most reliable source of power that serves the equipment being controlled and then provide for individual monitoring of the various system power sources by the controller. The object is to make a robust system that does not interpret power failures as device failure and therefore in some instances have to take down the unit for manual acknowledged reset. This can compromise reliability.

B. General requirements for obtaining power include the following:

1. In the case where additional power is required, obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120V source fed from a common origin.

2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment’s control transformer is large enough and is the correct voltage to supply the controls, it may be used. If the equipment’s control transformer is not large enough or of the correct voltage to supply the controls, provide separate transformer.

3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

The following item will have to be customized for each system and Project. The consideration is where to provide UPS’s for controllers. Engineer shall consult with Owner prior to specifying the UPS requirements. UPS requirements shall be dictated by the type of systems and facility. Edit to suit the Project.

4. Provide an uninterruptible power supply (UPS) system battery backup for each controller or DCS, as shown on the Drawings or specified except terminal equipment controllers. UPS shall protect against blackouts, brownouts, surges and noise.

   a. UPS shall include LAN port and modem line surge protection.

   b. UPS shall be sized for a 7-minute full load runtime, 23-minute 1/2 load runtime, with a typical runtime of up to 60 minutes. Transfer time shall be 2-4 milliseconds.

   c. UPS shall provide a 480-joule suppression rating and current suppression protection for 36,000 amps and provide 90 percent recharge capability in 2-4 hours. Suppression response time shall be instantaneous. UPS low voltage switching shall occur when supply voltage is less than 94 volts.
d. Provide a Maintenance Bypass Switch that allows input voltage to bypass the UPS and directly power the connected equipment if an abnormal condition prevents the UPS from supporting the load, or if the UPS is required to be taken out of service. Provide all software, cables, peripherals etc. for a complete system.

5. Standalone Functionality: Refer to Section 25 14 00.

_The Engineer shall carefully coordinate the training requirements with the needs of Owner’s facilities staff. Expansions of existing systems obviously require less training than new systems. The following generally outlines an on-Site training session. The more advanced training may be better provided off Site on a case-by-case basis. Edit to suit Project._

3.06 BAS START-UP, COMMISSIONING AND TRAINING

A. Refer to Section 25 08 00.

END OF SECTION 25 00 00