SECTION 250504

BUILDING Automation System (BAS) GENERAL

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***NOTE TO SPECIFIER***

*Use this Specification Section for Mail Processing Facilities.*

***This is a Type 3 Specification with primarily required text; therefore, most of the text cannot be edited, but there is editable text which is noted within the Section with a “Note to Specifier.” Do not revise the required paragraphs without an approved Deviation from USPS Headquarters, Facilities Program Management, through the USPS Project Manager.***

*For Design/Build projects, do not delete the Notes to Specifier in this Section so that they may be available to Design/Build entity when preparing the Construction Documents.*

*For the Design/Build entity, this specification is intended as a guide for the Architect/Engineer preparing the Construction Documents.*

*The MPF specifications may also be used for Design/Bid/Build projects. In either case, it is the responsibility of the design professional to edit the Specifications Sections as appropriate for the project.*

*Text shown in brackets must be modified as needed for project specific requirements.* *See the “Using the USPS Guide Specifications” document in Folder C for more information.*

*The last date that USPS revised this standard specification section occurs in two places, at the end of this section and in the Table of Contents. If the date in this section matches the date in the Table of Contents, then you are using the latest version. Do not delete or revise the “last revised” date at the end of the section during the development of the Project Manual.*

*The footer in this section should be edited to replace the text, “USPS MPF SPECIFICATION” with the project name, and the blank date in the center should be replaced with the submission date, for interim design reviews, or the issue date of the completed Project Manual.*

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1. GENERAL
	1. Summary
		1. Section includes
			1. General Requirements
			2. Description of Work
			3. Quality Assurance
			4. System Architecture
			5. Distributed Processing Units/Quantity and Location
			6. Demolition and Reuse of Existing Materials and Equipment
			7. Sequence of Work

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***NOTE TO SPECIFIER***

*Select the following specification sections according to the project requirements*

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* + 1. Related documents
			1. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
			2. Section 260500 – Common Work Results for Electrical
			3. Section 260533 – Raceway and Boxes for Electrical Systems
			4. Section 265100 – Interior Lighting
			5. Section 265600 – Exterior Lighting
			6. Section 260623 – Lighting Control Devices
			7. Section 270500 – Common Work Results for Communications
			8. Section 230500 – Common Work Results for HVAC
			9. Section 251104 – Metering Devices
			10. Section 250804 – Building Automation System (BAS) Commissioning
	1. DESCRIPTION OF WORK
		1. Provide a Direct Digital Control (DDC) and Building Automation System (BAS) that uses electronic sensing, microprocessor-based digital control, and electronic actuation of dampers and valves to perform control sequences and functions specified.
		2. The DDC and BAS interfaces with the USPS EEMS Network, and utilizes the BACnet communication requirements as defined by ASHRAE/ANSI 135-2004 for all communication.
		3. The BAS will consist of monitoring and control of systems listed below. Reference control drawings, sequences of operation, and points lists.

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**NOTE TO SPECIFIER**

Describe scope of the project in first set of brackets [\_\_\_\_]. Describe HVAC systems being controlled in second set of brackets [\_\_\_\_].

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* + 1. The systems to be controlled under work of this section comprise of:
			1. [\_\_\_\_\_\_\_\_\_]
		2. The HVAC systems being controlled are:
			1. [\_\_\_\_\_\_\_\_\_]
	1. Application of Open PRotocols
		1. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing BACnet. System components shall communicate using native BACnet in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all building controllers, and all application specific controllers. Gateways to other communication protocols are not an acceptable solution and should only be used when communicating with a device or piece of equipment not provided by this contractor and/or only when directed by the Project Manager.
	2. QUALITY ASSURANCE
		1. All products used in this project shall be a current product under manufacture. Spare parts are to be available for a period of at least five years after project commissioning. The vendor shall have a stated policy of maintaining backward compatibility with previous versions of its product.
		2. 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 2 years since date of final completion in at least 10 installations of comparative size and complexity. Submittals shall document this requirement with references.
		3. 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 three years prior experience with that manufacturer’s products. Experience starts with awarded Final Completion of previous projects. Submittals must document this experience with references.
		4. 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 3 projects of similar size and complexity. Submittals shall document this experience with references.
		5. Installer’s Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than 5 years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than 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. The 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.
		6. Installer’s Service Qualifications: The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum 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.
		7. Installer’s Response Time and Proximity
			1. Installer must maintain a fully capable service facility within a 30 [\_\_] mile radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
			2. Emergency response time should be within an hour. Installer must demonstrate the ability to meet the response times.

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***NOTE TO SPECIFIER***

*Use the paragraph below to add any project specific qualifications needed; otherwise delete.*

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* + 1. [Other quality assurance requirements.]
	1. Codes and Standards
		1. The following codes and standard intended to apply as applicable as not all will apply to all installations
		2. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
			1. ASHRAE 135-2004 and all addenda: BACnet - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 2004 including all Addendums.
		3. Electronics Industries Alliance
			1. EIA-709.1-A-99: Control Network Protocol Specification
			2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
			3. EIA-232: Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
			4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
			5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
			6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
			7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
			8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
			9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications
		4. Underwriters Laboratories
			1. UL 916: Energy Management Systems.
		5. NEMA Compliance
			1. NEMA 250: Enclosure for Electrical Equipment
			2. NEMA ICS 1: General Standards for Industrial Controls.
		6. NFPA Compliance
			1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
			2. NFPA 70 National Electrical Code (NEC)
		7. Institute of Electrical and Electronics Engineers (IEEE)
			1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
			2. IEEE 802.3: CSMA/CD (Ethernet – Based) LAN
			3. IEEE 802.4: Token Bus Working Group (ARCNET – Based) LAN
	2. DEFINITIONS
		1. 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.
		2. 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).
		3. 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. .
		4. BACnet/BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135-2004.
		5. BACnet Interoperability Building Blocks (BIBB): A 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.
		6. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended opr required destinations.
		7. Building Automation System (BAS): The entire integrated management and control system.
		8. 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.
		9. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135-2004).
		10. 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.
		11. 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).
		12. Controller or Control Unit (CU): Intelligent stand-alone control panel. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.
		13. Control Systems Server (CSS): This shall be a computer (or computers) that maintains the system's configuration and programming database. This may double as an operator workstation.
		14. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic.
		15. Enterprise Energy Management System (EEMS): The USPS Enterprise Energy management System is an existing Ethernet/Internet-based network based system connecting multiple facilities with a central data warehouse and server and, accessible via standard web-browser and Terminal Services.
		16. Functional Profile: A collection of variables required to define the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.
		17. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them (ASHRAE/ANSI 135-2004).
		18. Hand Held Device (HHD): Manufacturer’s microprocessor based device for direct connection to a Controller.
		19. IT LAN: Reference to the facility’s Information Technology network, used for normal business-related e-mail and Internet communication.
		20. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS
		21. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.
		22. Local Supervisory LAN: Ethernet-based LAN connecting Primary Controller LANs with each other and OWSs, CSSs and EEMS if specified. See System Architecture below. CAN BE THE PRIMARY CONTROLLING LAN.
		23. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard. (ASHRAE/ANSI 135-2004).
		24. 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.
		25. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.
		26. 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.
		27. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.
		28. Portable Operators Terminal (POT): Laptop PC used both for direct connection to a controller and for remote dial up connection.
		29. 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 135-2004).
		30. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Architecture below.
		31. Router: A device that connects two or more networks at the network layer.
		32. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Primary Controlling LAN. Refer to System Architecture below.
		33. 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.
		34. SQL: Standardized Query Language, a standardized means for requesting information from a database.
		35. 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.
	3. SUBMITTALS
		1. Submit under provisions of Section 013300.
		2. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and operation and maintenance 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 2004 or later version drawing file and/or Adobe Portable Document Format file. 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
		3. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate item above.
		4. 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.
		5. Shop Drawings: Submit shop drawings 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. Each shop drawing shall contain the following information:
			1. 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, 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, 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 as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
			2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.
			3. 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.
			4. On each schematic, provide a point summary table listing building number and abbreviation, Ethernet backbone network number, network number, device ID, full point name, point description, , object ID (object type, instance number). See Section 251404 - Part III for additional requirements.
			5. Provide as a separate table a listing of each BACnet object to include Device ID, object ID description, alarm value, for each I/O, virtual and calculated point
			6. Label each control device with setting or adjustable range of control.
			7. Label each input and output with the appropriate range.
			8. 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.
			9. 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.
			10. 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, which are existing, factory-installed and portions to be field-installed.
			11. Sheets shall be consecutively numbered.
			12. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
			13. Table of Contents listing sheet titles and sheet numbers.
			14. Legend and list of abbreviations.
			15. Memory allocation projections.
			16. Submit along with shop drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.
		6. Open Protocol Information
			1. BACnet Systems:
				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.
		7. Framed Control Drawings: Laminated control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.
		8. Control Logic Documentation
			1. 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.
			2. 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.
			3. Include written description of each control sequence.
			4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.
			5. Sheets shall be consecutively numbered.
			6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
			7. Include Table of Contents listing sheet titles and sheet numbers
			8. 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 Section 017704.
		9. Operation and Maintenance Materials:
			1. Submit documents under provisions of Section 013300. One copy of the materials shall be delivered directly to the USPS facilities operation staff, in addition to the copies required by other Sections.
			2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
			3. Submit BAS User’s Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
			4. Submit BAS advanced Programming Manuals for each controller type and for all workstation software.
			5. 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 1.
			6. Submit listing required preventative and predictive maintenance tasks required for all equipment furnished, network and system health monitoring and activities. For each item listed, provide specific task instructions, acceptance criteria and recommended task frequency.
			7. Submit schedule of planned maintenance tasks to be completed by the vendor during the warranty period specified below.
		10. Provide 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 5 years as part of the contract price, and will be offered to the USPS thereafter for the same price as to a dealer or branch.
		11. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance.
		12. Product Warranty Certificates: Submit manufacturers product warranty certificates covering the hardware provided.
	4. PROJECT RECORD DOCUMENTS
		1. Submit documents under provisions of Section 013300.
		2. Record copies of product data and control shop drawings updated to reflect the final installed condition.
		3. 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.
		4. Record copies of approved project specific graphic software on CDs.
		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
	5. SYSTEM ARCHITECTURE
		1. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. Provide 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.
		2. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.
		3. 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), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.
			1. EEMS LAN: Internet-based network connecting multiple facilities with a central data warehouse and then EEMS server. This is an existing infrastructure and the Contractor is not required to configure any components of this EEMS. Contractor is however required to provide BACnet Objects and services at the Local Supervisory LAN via BACnet over IP. Refer to Section 251404 for requirements.
			2. Local Supervisory LAN: The Local Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWSs. The LAN serves as the inter-BC communications path and OWS-to-BC gateway and communications path. Refer to section 251404 coordination requirements with USPS. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps throughput. Power-line carrier communication shall not be acceptable for communications. The higher level layers of this network shall be BACnet as described below:
				1. BACnet Supervisory LAN: BACnet/IP as defined in Addendum A (Annex J) of the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in BACnet. Point/Object naming conventions are specified in 251404 - Part III.
			3. Primary Controller LAN (‘Primary LAN’): High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and Building Controllers (BCs) and communicate exclusively control information. Acceptable technologies include:
				1. Ethernet (IEEE802.3)
				2. ARCNET (IEEE802.4)
			4. Secondary Controller LAN (‘Secondary LAN’): Network used to connect AACs or ASCs to BC. These can be Master Slave/ Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.
		4. 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.

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***NOTE TO SPECIFIER***

*Remote data access specified below is controlled due to network security. Before specifying remote access confer with USPS Project Manager.*

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* + 1. [Remote Data Access: The system shall support the following methods of remote access to the building data.
			1. Dial-in via minimum of a 56k modem. Dial-in connection shall allow access to all control system facilities and graphics with appropriate password. The USPS shall provide and pay for the digital grade voice line to support this remote connection.
			2. DSL/Broadband/Fiber. All workstations shall be equipped with standard 100 megabit Ethernet cards; the USPS at its option may elect to use DSL or other broadband service to access the system.
			3. Browser-based access: A remote user using a standard browser shall be able access all control system facilities and graphics with proper password. USPS shall secure and be responsible for the continuous Internet connection. The following paradigms are acceptable for browser-based access:
				1. Native Internet-based user interfaces (HTML, Java, XML, etc.) that do not require a plug-in.
				2. 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.]
		2. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. 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. Reconfigure LAN as necessary to accomplish these performance requirements. Generally, requirements do not apply when a remote connection must be established via modem:
			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 and 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 10 points.
		3. Control Systems Server (CSS): This shall be a computer (or computers) that maintain the systems configuration and programming database. This will double as an operator workstation. 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 251404 - BAS Field Panels for its requirements.
		4. The Operator Work Station (OWS) interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 251404 – BAS Field Panels.
		5. The BCs, AACs, ASCs, 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 251404 - BAS Field Panels.
		6. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on a server or workstation on the Local Supervisory LAN. User tools provided to the USPS shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device. Database Schema shall be published and provided to the USPS to facilitate easy access to the data.
		7. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.
		8. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.
		9. 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. WARRANTY MAINTENANCE
		1. Warrant all products and labor for a period of one yearafter Substantial Completion.
		2. The USPS reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. Warrant parts and installation work regardless of any such changes made by the USPS.
		3. At no cost to the USPS, during the warranty period, Provide maintenance services for software and hardware components as specified below:
			1. Maintenance services shall be provided for all devices and hardware specified in Sections 233004 through 251404. Service all equipment per the manufacturer’s recommendations and maintenance schedule submitted. All devices shall be calibrated within the last month of the warranty period.
			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 notification by the USPS.
				1. Response by telephone to any request for service shall be provided within 2 hours of the USPS's initial telephone request for service.
				2. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one hardware and software technician, trained in the system to be serviced, shall be dispatched to the USPS's site within 8 hours of the USPS'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 USPS to the Contractor.
				1. Response by telephone to any request for service shall be provided within 8 working hours (40 hours per week normal working period) of the USPS's initial telephone request for service.
				2. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one hardware and software technician, trained in the system to be serviced, shall be dispatched to the USPS's site within 3 working days of the USPS's initial telephone request for such services, as specified.
			4. Telephonic Request for Service: Provide a maximum of three telephone numbers for the USPS 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. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.
			5. Technical Support: Provide technical support by telephone throughout the warranty period.
			6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements and submitted maintenance plan.
	2. DELIVERY, STORAGE, AND HANDLING
		1. Provide factory-shipping cartons for each piece of equipment and control device. 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.
	3. LISTING AND LABELING
		1. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.
1. PRODUCTS
	1. MATERIALS AND EQUIPMENT

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***NOTE TO SPECIFIER***

*Edit the below paragraph to suit the project. The cost effectiveness of pneumatically driven actuators shall be assessed by the* *Architect/Engineer. The USPS prefers all electronic where practical and cost effective. Note that extensions of an existing pneumatically driven system with large actuators should be evaluated for cost effectiveness. The USPS would prefer at a minimum an alternate electronic device upgrade option on all renovation projects. The condition of the control air source and distribution equipment must also be taken into consideration.*

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* + 1. General: Provide electronic [pneumatic] [or] [electric] control products in sizes and capacities indicated, consisting of valves, dampers, thermostats, clocks, controllers, sensors, and other components as required for a complete installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information; designed and constructed as recommended by manufacturer, and as required for application indicated.

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**NOTE TO SPECIFIER**

Edit the following to suit the project. The Contractor may reuse existing control air in buildings where pneumatic controls will be replaced.

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* + 1. Control Air Supply: Install air dryers and air filters so that all controllers and existing pneumatic devices receive a clean and dry air supply.
			1. The control air filters shall remove oil and solid particles from the compressed air. Provide a prefilter and a final filter. The prefilter shall be rated for 100 percent removal of all solids 1 micron and larger, 100 percent removal of liquid water, and 70 percent removal of oil aerosols with 2000 ppm maximum inlet liquid loading. The final filter shall be rated for 100 percent removal of liquid water and solids larger than 0.03 micron; 99.999 percent removal of oil aerosols with 100 ppm maximum inlet liquid loading. Filters shall include replaceable filter element, differential pressure gauge, and automatic liquid drain trap. Filters shall be selected for a maximum pressure drop of 2 psig at compressor capacity. Filter bodies shall be rated for 225 psig or greater operating pressure. Transparent acrylic tube housings shall be protected by a perforated steel safety shield. Filters shall be Hankison, DelTech, Wilkerson, or Arrow Pneumatics. Furnish one spare filter element per filter.
			2. For existing systems where no pneumatic tubing is subject to temperatures below 40°F and without refrigerated dryers, provide an air-cooled refrigerated dryer with flow capacity at 100 °F, 100 psig saturated entering air and 40 °F leaving dewpoint equal to or exceeding air compressor capacity. Refrigerated dryer shall be a single package unit with all necessary piping, refrigerant, controls, wiring and accessories. Dryer shall include refrigeration system, on/off switch, inlet air pressure gauge, and water separator with automatic drain. Refrigerant shall be R-134a. System shall be labeled by CSA or UL. Manufacturer shall be Hankison, Wilkerson, DelTech, Ingersoll-Rand or Arrow Pneumatics.
			3. For existing systems with outdoor pneumatic components or components otherwise exposed to ambient conditions, provide a desiccant-type heatless self-regenerative air dryer for piping providing air supply to these components. Dryer capacity shall exceed connected load, plus a 30 percent allowance for expansion with inlet conditions of 100 deg f, saturated air at 100 psig, and outlet conditions of minus 40 °F dewpoint. Dryer maximum air pressure drop at rated flow shall not exceed 5 psig. Required air flow for regeneration shall not exceed 20 percent of dryer output capacity. Dryer shall include two desiccant towers, piping, changeover valves, exhaust silencers, controls and wiring. Desiccant towers shall be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, and shall be ASME stamped for 125 psig working pressure, and fitted with suitable relief valves if tower physical size places tower within the scope of the Code where stamp is required. Desiccant dryers shall be as manufactured by Hankison, Deltech, Arrow Pneumatics, Ingersoll-Rand or Zurn.
			4. Main Air Piping (between the compressors and the field control panels): Hard drawn copper tubing, ASTM B 88, Type L.
			5. Branch Air Piping (to include main air between field control panels and field devices: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; except brass compression-type fittings at connections to equipment. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder.
			6. Branch Air Piping: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.
		2. Instrument Pipe and Tube
			1. Hydronic and Instruments
				1. Connection To Main Piping: Provide 1/2-inch minimum size threadolet, 1/2 x 2 inch brass nipple, and 1/2-inch ball valve for connection to welded steel piping. Provide tee fitting for other types of piping.
				2. Remote Instruments: Adapt from ball valve to specified tubing and extend to remote instruments. Provide a union or otherwise removable fitting at ball valve so that connection to main can be cleaned with straight rod. Where manifolds with test ports are not provided for instrument, provide tees with 1/4-inch FPT branch with plug for use as test port. Adapt from tubing size to instrument connection.
				3. Line Mounted Instruments: Extend rigid piping from ball valve to instrument. Do not use close or running thread nipples. Adapt from ball valve outlet to instrument connection size. Provide a plugged tee if pipe makes 90 degree bend at outlet of valve to allow cleaning of connection to main with straight rod without removing instrument.
				4. Instrument Tubing: Seamless copper tubing, Type K or L, ASTM B 88; with cast-bronze solder joint fittings, ANSI B1.18; or wrought-copper solder-joint fittings, ANSI B16.22; or brass compression-type fittings. Solder shall be 95/5 tin antimony, or other suitable lead free composition solder. Tubing OD size shall be not less than the larger of 1/4-inch or the instrument connection size.
				5. Rigid Piping For Line Mounted Instruments: Schedule 40 threaded brass, with threaded brass fittings.
			2. Low Pressure Air Instrument Sensing Lines
				1. Connections: Use suitable bulkhead type fitting and static sensing tip for static pressure connections. Adapt tubing to instrument connection.
				2. Tubing: Virgin polyethylene non-metallic tubing type FR, ASTM D 2737, and with flame-retardant harness for multiple tubing. Use compression or push-on brass fittings.

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***NOTE TO SPECIFIER***

*Edit the following to suit the project. The USPS may elect to provide the communication of the Local Supervisory LAN as part of their existing IT network. In this case IT equipment design and equipment supply needs to be coordinated project IT designer and/or the USPS IT group. Confer with USPS*

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* + 1. Communication Wiring: All wiring shall be in accordance with National Electrical Codes and Division 26 of this specification.
			1. Provide all communication wiring between Building Controllers, Routers, Gateways, AAC’s, ASC’s and local and remote peripherals (e.g., operator workstations, printers, and modems).
			2. Local Supervisory LAN: For any portions of this network required under this section of the specification, use Fiber or Category 5e of standard TIA/EIA (100/1000BaseT). Network shall be run with no splices and separate from any wiring over thirty (30) volts.
			3. Primary and Secondary Controller LANs: Communication wiring shall be individually 100% shielded pairs per manufacturers recommendations for distances installed, with overall PVC cover, Class 2, plenum-rated run with no splices and separate from any wiring over 30 volts. Shield shall be terminated and wiring shall be grounded as recommended by BC manufacturer.
		2. Signal Wiring: Run all signal wiring in accordance with National Electric Codes and the Division 16 Specification.
			1. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire, with PVC cover. Signal wiring shall be run with no splices and separate from any wiring above 30 volts.
			2. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.
		3. Low Voltage Analog Output Wiring: Run all low voltage control wiring in accordance with National Electric Codes and the Division 16 Specification.
			1. Low voltage control wiring shall be minimum 16-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above 30 volts.
		4. Control Panels: Provide control panels with suitable brackets for wall mounting for each control system. Locate panel adjacent to systems served.
			1. Fabricate panels of 16-gage furniture-grade steel, or 6063-T5 extruded aluminum alloy, totally enclosed on four sides, with hinged door and keyed lock, with manufacturer's standard shop- painted finish and color.
			2. Provide UL-listed cabinets for use with line voltage devices.
			3. Control panel shall be completely factory wired and piped, and all electrical connections made to a terminal strip. Control panel shall have standard manufacturer's color.
			4. All gauges and control components shall be identified by means of nameplates.
			5. All control tubing and wiring shall be run neatly and orderly in open slot wiring duct with cover.
			6. All control tube and wiring shall be labeled to match the control drawing submittals.
			7. Complete wiring and tubing termination drawings shall be mounted in or adjacent to panel.
	1. Control Valves

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***NOTE TO SPECIFIER***

*Control valve sizing and selection is the initial responsibility of the A/E and NOT left to the Contractor. A/E to provide a valve schedule that lists the requirements of the valves for Cv, close off, temperature etc. This should be a result of analyzing the valves performance across the range of control.*

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* + 1. General: Provide factory fabricated control valves of type, body material and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Control valves shall be equipped with heavy-duty actuators, and with proper close-off rating for each individual application. Minimum close-off rating shall be as scheduled and adequate for each application, and shall generally be considered at dead head rating of the pump.
		2. Plug-Type Globe Pattern for Water Service:
			1. Valve Sizing: Where not specifically indicated on the control drawings, modulating valves shall be sized for maximum full flow pressure drop between 50% and 100% of the branch circuit it is controlling unless scheduled otherwise. Two-position valves shall be same size as connecting piping.

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***NOTE TO SPECIFIER***

*Edit/Delete the following to suit the systems applicable.*

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* + - 1. Single Seated (Two-way) Valves: Valves shall have equal-percentage characteristic for typical heat exchanger service and linear characteristic for building loop connections to campus systems unless otherwise scheduled on the drawings. Valves shall have cage-type trim, providing seating and guiding surfaces for plug on ‘top-and-bottom’ guided plugs.
			2. Double Seated (Three-way) Valves: Valves shall have linear characteristic. Valves shall be balanced-plug type, with cage-type trim providing seating and guiding surfaces on ‘top-and-bottom’ guided plugs.
			3. Temperature Rating: 25°F minimum, 250°F maximum
			4. Body: Bronze, screwed, 250 psi maximum working pressure for 1/2 to 2 inch; Cast Iron, flanged, 125 psi maximum working pressure for 2-1/2 inches and larger.
			5. Valve Trim: Bronze; Stem: Polished stainless steel.
			6. Packing: Spring Loaded Teflon or Synthetic Elastomer U-cups, self-adjusting.
			7. Plug: Brass, bronze or stainless steel, Seat: Brass
			8. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
			9. Ambient Operating Temperature Limits: -10 to 122F.
			10. Acceptable Manufacturers: Subject to compliance with the above requirements, approved manufacturers are as follows:
				1. Johnson Controls
				2. Invensys
				3. Siemens
				4. Warren
				5. Delta
				6. Belimo
		1. Plug-Type Globe Pattern for Steam Service:
			1. Valve Sizing: Where valve size is not specifically indicated on the drawings, size modulating valves for applications of 15 psig or less for 80% of inlet gage pressure unless scheduled otherwise. Modulating valves for applications of greater than 15 psig shall be sized for 42% of inlet absolute pressure unless scheduled otherwise. Two-position valves shall be same size as connecting piping.
			2. Characteristics: Modified equal-percentage characteristics. Cage-type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
				1. Working Temperature: 250°F minimum for saturated steam applications of 15 psig or less; 366°F minimum for saturated steam applications of greater than 15 psig up to 150 psig.
			3. Body: Bronze, screwed, 250 psig steam working pressure for 1/2 to 2 inches; Cast Iron, flanged, 100 psig steam working pressure for 2-1/2 inches and larger for applications of 50 psig or less.
			4. Valve Trim, Plug, Seat and Stem: Polished stainless steel.
			5. Packing: Spring Loaded Teflon.
			6. Disc: Replaceable Composition or Stainless Steel Filled PTFE.
			7. Acceptable Manufacturers: Subject to compliance with the above requirements, approved manufacturers are as follows:
				1. Johnson Controls
				2. Invensys
				3. Siemens
				4. Warren
				5. Delta
				6. Belimo
		2. Butterfly Type:
			1. Body: Extended neck epoxy coated cast or ductile iron with full lug pattern, ANSI Class 125 or 250 bolt pattern to match specified flanges.
			2. Seat: EPDM, except in loop bypass applications where seat shall be metal to metal
			3. Disc: Bronze or stainless steel, pinned or mechanically locked to shaft
			4. Bearings: Bronze or stainless steel
			5. Shaft: 416 stainless steel
			6. Cold Service Pressure: 175 psi
			7. Close Off: Bubble-tight shutoff to 150 psi
			8. Operation: Valve and actuator operation shall be smooth both seating and unseating. Should more than 2 psi deadband be required to seat/unseat the valve, valve shall be replaced at no cost to the USPS.
			9. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
				1. Jamesbury WS815
				2. Bray Series 31
				3. Keystone AR2
				4. Dezurik BGS
		3. Ball Type
			1. Body: Brass or bronze; one-, two-, or three-piece design; threaded ends.
			2. Seat: Reinforced Teflon
			3. Ball: Stainless steel.
			4. Port: Standard or ‘V’ style.
			5. Stem: Stainless steel, blow-out proof design, extended to match thickness of insulation.
			6. Cold Service Pressure: 600 psi WOG
			7. Steam working Pressure: 150 psi
			8. Acceptable Manufacturers: Subject to compliance with the above requirements, approved manufacturers are as follows:
				1. Conbraco
				2. Worcester
				3. Nibco
				4. Jamesbury
				5. PBM
				6. Delta
				7. Belimo
		4. Segmented or Characterized Ball Type
			1. Body: Carbon Steel (ASTM 216), one-piece design with wafer style ends.
			2. Seat: Reinforced Teflon (PTFE).
			3. Ball: Stainless steel ASTM A351
			4. Port: Segmented design with equal-percentage characteristic.
			5. Stem: Stainless steel.
			6. Cold Service Pressure: 200 psi WOG
			7. Cavitation Trim: Provide cavitation trim where indicated and/or required, designed to eliminate cavitation and noise while maintaining an equal percentage characteristic. Trim shall be a series of plates with orifices to break the pressure drop into multi-stages.
			8. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:
				1. Jamesbury R-Series
				2. Fisher
				3. Substitutions: As allowed in Division 1

2.3  Control Dampers

* + 1. General: Provide factory fabricated automatic control dampers of sizes, velocity and pressure classes as required for smooth, stable, and controllable air flow. Provide parallel or opposed blade dampers as recommended by manufacturers sizing techniques. For dampers located near fan outlets, provide dampers rated for fan outlet velocity and close-off pressure, and recommended by damper manufacturer for fan discharge damper service. Control dampers used for smoke dampers shall comply with UL 555S. Control Dampers used for fire dampers shall comply with UL 555.
		2. For general isolation and modulating control service in rectangular ducts at velocities not greater than 1500 fpm (7.62 m/s), differential pressure not greater than 2.5” w.c.:
			1. Performance: Test in accordance with AMCA 500.
			2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
			3. Blades: Stainless steel in lab exhausts and galvanized steel elsewhere, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2 inch shafts with set screws, 16 gauge minimum thickness.
			4. Blade Seals: Synthetic elastomer, mechanically attached, field replaceable.
			5. Jamb Seals: Stainless steel.
			6. Shaft Bearings: Oil impregnated sintered bronze, graphite impregnated nylon sleeve or other molded synthetic sleeve, with thrust washers at bearings.
			7. Linkage: Concealed in frame.
			8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
			9. Leakage: Less than one percent based on approach velocity of 1500 ft./min. and 1 inches wg..
			10. Maximum Pressure Differential: 2.5 inches wg.
			11. Temperature Limits: -10 to 150 F.
			12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with intermediate frames and jackshafts appropriate for installation.
		3. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm (20.3 m/s), differential pressure not greater than 6” w.c.:
			1. Performance: Test in accordance with AMCA 500.
			2. Frames: Galvanized steel, 16-gauge minimum thickness, welded or riveted with corner reinforcement.
			3. Blades: extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 1/2 inch shafts, 14 gauge minimum extrusion thickness.
			4. Blade Seals: Synthetic elastomeric, mechanically attached, field replaceable.
			5. Jamb Seals: Stainless steel.
			6. Shaft Bearings: Oil impregnated sintered bronze sleeve, graphite impregnated nylon sleeve, molded synthetic sleeve, or stainless steel sleeve, with thrust washers at bearings.
			7. Linkage: Concealed in frame.
			8. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
			9. Leakage: Less than 0.1 percent based on approach velocity of 4000 ft./min. and 1 inches wg.
			10. Maximum Pressure Differential: 6 inches wg.
			11. Temperature Limits: -40 to 200 F (-40 to 93 C).
			12. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.
		4. For general isolation and modulating control service in rectangular ducts at velocities not greater than 4000 fpm, differential pressure not greater than 12 inches w.c.:
			1. Performance: Test in accordance with AMCA 500.
			2. Frames: Galvanized steel, 12-gauge minimum thickness, welded or riveted with corner reinforcement.
			3. Blades: Extruded aluminum hollow airfoil shape, maximum blade size 8 inches wide by 48 inches long, attached to minimum 3/4 inch shafts with set screws
			4. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
			5. Linkage: 10-gauge minimum thickness galvanized steel clevis type crank arms, 3/16 x 3/4 inches minimum thickness tie rods.
			6. Linkage Bearings: Oil impregnated sintered bronze or graphite impregnated nylon.
			7. Leakage: Less than 0.2 percent based on approach velocity of 4000 ft./min. and 1 inches wg. differential pressure.
			8. Maximum Pressure Differential: 12 inches wg.
			9. Temperature Limits: -40 to 300 F.
			10. Where opening size is larger than 48 inches wide, or 72 inches high, provide dampers in multiple sections, with appropriately intermediate frames, and jackshafts.
		5. For general isolation and modulating control service in round ducts up to 40 inches in size at velocities not greater than 2500 fpm, differential pressure not greater than 4” w.c.:
			1. Performance: Test in accordance with AMCA 500.
			2. Frames: rolled 12 gauge steel strip for sizes 6 inch and smaller, rolled 14 gauge steel channel for larger sizes, galvanized or aluminum finish.
			3. Blades: Steel construction, 12 gauge minimum thickness for dampers less than 18 inches in size, 10 gauge minimum thickness for larger dampers.
			4. Blade Seals: Full circumference neoprene.
			5. Shaft: 1/2-inch diameter zinc or cadmium plated steel.
			6. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
			7. Leakage: Less than 0.2 percent based on approach velocity of 4000 ft./min. and 1 inches wg. differential pressure.
			8. Maximum Pressure Differential: 4 inches wg.
			9. Temperature Limits: -40 to 300 F.
		6. For general isolation and modulating control service in round ducts up to 60 inches in size at velocities not greater than 4000 fpm, differential pressure not greater than 6 inches w.c.:
			1. Performance: Test in accordance with AMCA 500.
			2. Frames: rolled 10-gauge steel channel for sizes 48 inch and smaller, rolled 3/16 inch thick steel channel for larger sizes, galvanized or aluminum finish.
			3. Blades: Steel construction, 10-gauge minimum thickness for dampers not greater than 48 inches in size, 1/4-inch minimum thickness for larger dampers.
			4. Blade stops: 1/2-inch x 1/4-inch full circumference steel bar.
			5. Blade Seals: Full circumference neoprene.
			6. Shaft: zinc or cadmium plated steel, angle reinforcing as necessary.
			7. Shaft Bearings: Oil impregnated sintered bronze or stainless steel, pressed into frame, with thrust washers at bearings.
			8. Leakage: Less than 0.4 percent based on approach velocity of 4000 ft./min. and 1 inches wg. differential pressure.
			9. Maximum Pressure Differential: 6 inches wg.
			10. Temperature Limits: -40 to 250 F.
	1. ACTUATORS
		1. General: Size actuators and linkages to operate their appropriate dampers or valves with sufficient reserve torque or force to provide smooth modulating action or 2-position action as specified. Select spring-return actuators with manual override to provide positive shut-off of devices as they are applied.
		2. Damper Actuators
			1. Ambient Operating Temperature Limits: -22 to 122F.
			2. Two Position Electric Actuators: Line voltage with spring return.

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***NOTE TO SPECIFIER***

*Control drawings should clearly show where pneumatic Positive Positioners are required. Edit to suit project specifics*

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* + - 1. Pneumatic Actuators: Provide heavy-duty actuators with stroke indication and spring return. When so indicated and where more than 2 actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable start point and operating range. Positive Positioners shall be provided on all modulating pneumatic valves larger than 1-inch and as shown on drawings.
			2. Electronic Actuators: Provide actuators with spring return for two-position (24v), 0-5 Vdc, 0-10 Vdc, 2-10Vdc, 4-20 mA, or PWM input (subject to restrictions) as required. Actuators shall travel full stroke in less than 95 seconds. Actuators shall be designed for a minimum of 60,000 full cycles at full torque and be UL 873 listed. Provide stroke indicator. Actuators shall have positive positioning circuit. Where two actuators are required in parallel or in sequence provide an auxiliary actuator driver. Actuators shall have current limiting motor protection. Actuators shall have manual override where indicated. Modulating actuators for valves shall have minimum rangeability of 40 to 1.
				1. Close-Off Pressure: Provide the minimum torque required, and spring return for fail positioning (unless otherwise specifically indicated) sized for required close-off pressure. Required close-off pressure for two-way water valve applications shall be the shutoff head of associated pump. Required close-off rating of steam valve applications shall be design inlet steam pressure plus 50 percent for low pressure steam, and 10 percent for high pressure steam. Required close-off rating of air damper applications shall be shutoff pressure of associated fan, plus 10 percent.
				2. Acceptable Manufacturers: Subject to compliance with requirements approved manufacturers are as follows:

###### 1) Belimo

###### 2) Johnson Controls

###### 3) Delta

###### 4) Invensys

* + 1. Quarter-Turn Actuators (for ball and butterfly valves):
			1. Electric
				1. Motor: Suitable for 120 or 240 Volt single-phase power supply. Insulation shall be NEMA Class F or better. Motor shall be rated for 100 percent duty cycle. Motors shall have inherent overload protection.
				2. Gear Train: Motor output shall be directed to a self-locking gear drive mechanism. Gears shall be rated for torque input exceeding motor locked rotor torque.
				3. Wiring: Power and control wiring shall be wired to a terminal strip in the actuator enclosure
				4. Failsafe Positioning: Actuators shall be spring return type for failsafe positioning.
				5. Enclosure: Actuator enclosure shall be NEMA-4 rated, and shall have a minimum of two threaded conduit entries. Provide an enclosure heater for actuators located outside of buildings.
				6. Limit Switches: Travel limit switches shall be UL and CSA approved. Switches shall limit actuator in both open and closed positions.
				7. Mechanical Travel Stops: The actuator shall include mechanical travel stops of stainless steel construction to limit actuator to specific degrees of rotation.
				8. Manual Override: Actuators shall have manual actuator override to allow operation of the valve when power is off. For valves 4 inches and smaller the override may be a removable wrench or lever or geared handwheel type. For larger valves, the override shall be a fixed geared handwheel type. An automatic power cut-off switch shall be provided to disconnect power from the motor when the handwheel is engaged for manual operation.
				9. Valve Position Indicator: A valve position indicator with arrow and open and closed position marks shall be provided to indicate valve position.
				10. Torque Limit Switches: Provide torque limit switches to interrupt motor power when torque limit is exceeded in either direction of rotation.
				11. Position Controller: For valves used for modulating control, provide an electronic positioner capable of accepting 4-20 mA, 0-10 Vdc, 2-10 Vdc, and 135 Ohm potentiometer.
				12. Ambient Conditions: Actuator shall be designed for operation from –22 to 122 °F ambient temperatures with 0 to 100 percent relative humidity.
			2. Pneumatic Single- and Double-Acting Cylinder Type:
				1. Air Cylinder: Shall consist of steel or aluminum cylinder, dual pistons, double rack and pinion gearing mechanism. Housing shall be protected both internally and externally with corrosion resistant coating. Actuator shall be equipped with piston guide rods or similar mechanism so that seals are not loaded as linear bearings. Single acting units shall have multiple symmetrically arranged springs to apply equal force to piston. Cylinder shall be configurable for direction of fail-safe mode in the field. Actuators shall be spring return type for failsafe positioning.
				2. Position Indication: Provide extended shaft position indicator that is removable for manual override of valve.
				3. Two-Position Actuators: Provide appropriate three-way or four-way solenoid valve mounted on the actuator. Solenoid valve electrical enclosure shall meet NEMA-4 requirements. Provide actuator with position switches where required.
				4. Modulating Actuators: Provide a rotary electronic positioner designed to accept 4-20 mA, 0-10 Vdc, 2-10 Vdc, or 135 Ohm potentiometer and operate integral 3-way or 4-way solenoid valve to position valve rotation angle as sensed by integral position feedback device to match signal input. Enclosure shall meet NEMA-4 requirements. Actuator linearity and resolution shall be 0.5% of span. Hysteresis and deadband shall be adjustable. Provide accessory mechanical or proximity type position switches and position transmitters where required. Actuators shall be spring return type for failsafe positioning. Provide an enclosure heater for positioners located outside of buildings.
	1. GENERAL FIELD DEVICES
		1. Provide field devices for input and output of digital (binary) and analog signals into controllers (BCs, AACs, ASCs). Provide signal conditioning for all field devices as recommended by field device manufacturers, and as required for proper operation in the system.
		2. Assure that all field devices are compatible with controller hardware and software.
		3. Field devices specified herein are generally ‘two-wire’ type transmitters, with power for the device to be supplied from the respective controller. If the controller provided is not equipped to provide this power, or is not designed to work with ‘two-wire’ type transmitters, or if field device is to serve as input to more than one controller, or where the length of wire to the controller will unacceptably affect the accuracy, provide ‘four-wire’ type equal transmitter and necessary regulated DC power supply or 120 VAC power supply, as required.
		4. For field devices specified hereinafter that require signal conditioners, signal boosters, signal repeaters, or other devices for proper interface to controllers, provide proper device, including 120V power as required. Such devices shall have accuracy equal to, or better than, the accuracy listed for respective field devices.
		5. Accuracy: As stated in this Section, accuracy shall include combined effects of nonlinearity, nonrepeatability and hysteresis.
	2. TEMPERATURE SENSORS (TS)
		1. Sensor range: When matched with A/D converter of BC, AAC/ASC, or SD, sensor range shall provide a resolution of no worse than 0.3°F (unless noted otherwise). Where thermistors are used, the stability shall be better than 0.25°F over 5 years.

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***NOTE TO SPECIFIER***

*A/E shall carefully specify other applications where matched sensors are required for the specific project.*

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* + 1. Matched Sensors: The following applications shall require matched sensors. Refer to Section 251104:
			1. Building Loop Connections: Provide matched loop and building supply sensors where control sequence requires controlling to a temperature rise (differential).
			2. Hydronic Temperature Difference Calculations: Provide matched supply and return temperature sensors where the pair is used for calculating temperature difference for use in load calculations or sequencing such as across chillers and plants.
			3. Air Handling Unit Sequencing: Provide matched pair for the cooling and heating coil leaving sensors where the sequence includes calculating an offset from the supply air setpoint to maintain a leaving heating coil temperature.

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***NOTE TO SPECIFIER***

*A/E must designate where various amenities to room sensors are required. The following assumes that this will be indicated on the control design drawings. Otherwise AE must add the clarification below.*

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* + 1. Room Temperature Sensor: Shall be an element contained within a ventilated cover, suitable for wall mounting. Provide insulated base. Following sensing elements are acceptable:
			1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.5°F accuracy at calibration point.
			2. Provide setpoint adjustment. The setpoint adjustment shall be a warmer/cooler indication that shall be scalable via the BAS.
			3. Provide an occupancy override button on the room sensor enclosure. This shall be a momentary contact closure
			4. Provide current temperature indication via an LCD or LED readout where indicated.
		2. Single-Point Duct Temperature Sensor: Shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.
			1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.36°F accuracy at calibration point

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***NOTE TO SPECIFIER***

*Edit the following averaging length per square foot based on how homogeneous the air temperature will be at the installed location. For instance, a preheat sensor of a mixed air plenum will require more length than the discharge off a preheat coil in a 100% OA unit.*

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* + 1. Averaging Duct Temperature Sensor: Shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide sensor lengths and quantities to result in one lineal foot of sensing element for each three square feet of cooling coil/duct face area. An averaging duct temperature sensor shall be used in ducts where stratification of the airstream may occur. i.e. mixed air temperatures, coil discharge temperatures, etc. Temperature range shall be as required for resolution indicated in paragraph A.
			1. Sensing element shall be platinum RTD, or thermistor, +/- 0.36°F accuracy at calibration point.
		2. Liquid immersion temperature sensor shall include brass thermowell, sensor and connection head for wiring connections. Temperature range shall be as required for resolution of 0.15°F.
			1. Sensing element (chilled water/glycol systems) shall be platinum RTD +/- 0.36°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.15°F.
			2. Sensing element (other systems) shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point. Temperature range shall be as required for resolution of 0.3°F.
		3. Pipe Surface-Mount Temperature Sensor: Shall include metal junction box and clamps and shall be suitable for sensing pipe surface temperature and installation under insulation. Provide thermally conductive paste at pipe contact point. Temperature range shall be as require for resolution indicated in paragraph A. Surface-Mount temperature sensors shall only be used where specifically indicated on the drawings or specifications.
			1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
		4. Outside air sensors shall consist of a sensor, sun shield, utility box, and watertight gasket to prevent water seepage. Temperature range shall be as require for resolution indicated in Paragraph A
			1. Sensing element shall be platinum RTD, thermistor, or integrated circuit, +/- 0.4°F accuracy at calibration point.
	1. Temperature Transmitters
		1. Where required by Controller, or where wiring runs are over 50 feet, sensors as specified above may be matched with transmitters outputting 4-20 mA linearly across the specified temperature range. Transmitters shall have zero and span adjustments, an accuracy of 0.1°F when applied to the sensor range.
	2. HUMIDITY TRANSMITTERS
		1. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (% RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:
			1. Input Range: 0 to 100% RH.
			2. Accuracy (% RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidity control) or +/- 3% (monitoring only) between 20-90% RH at 77°F, including hysteresis, linearity, and repeatability.
			3. Sensor Operating Range: As required by application
			4. Long Term Stability: Less than 1% drift per year.
		2. Acceptable Manufacturers: Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.
		3. General Purpose Low Pressure Air: Generally, for use in static measurement of duct pressure or constant volume air velocity pressure measurement where the range is applicable.
			1. General: Loop powered two-wire differential capacitance cell-type transmitter.
			2. Output: two wire 4-20 mA output with zero adjustment.
			3. Overall Accuracy: Plus or minus 1%.
			4. Minimum Range: 0.1 in. w.c.
			5. Maximum Range: 10 inches w.c.
			6. Housing: Polymer housing suitable for surface mounting.
			7. Acceptable Manufacturers: Modus T30. Substitutions shall be allowed per Division 1.
			8. Static Sensing Element: Provide pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing.
			9. Range: Select for specified setpoint to be between 25% and 75% full-scale.
		4. General Purpose Low Pressure/Low Differential Air: Generally, for use in static measurement of space pressure or constant volume air velocity pressure measurement where the range is applicable.
			1. General: Loop powered, two-wire differential capacitance cell type transmitter.
			2. Output: Two-wire 4-20 mA output with zero adjustment.
			3. Overall Accuracy: Plus or minus 1%.
			4. Minimum Range: 0 in. w.c.
			5. Maximum Range: 0.1, 0.25, or 0.5 inches w.c.
			6. Housing: Polymer housing suitable for surface mounting.
			7. Acceptable Manufacturers: Modus T30. Substitutions shall be allowed per Division 1.
			8. Static Sensing Element: Provide pitot-type static pressure sensing tips similar to Dwyer model A-301 and connecting tubing, where applicable.
			9. Range: Select for specified setpoint to be between 25% and 75% full-scale.
		5. VAV Velocity Pressure: Generally, for use in variable volume air velocity pressure measurement where the range is applicable.
			1. General: Loop powered two-wire differential capacitance cell type transmitter.
			2. Output: Two-wire, 4-20 mA output with zero adjustment.
			3. Overall Accuracy: Plus or minus 0.25%
			4. Minimum Range: 0 in. w.c.
			5. Maximum Range: 1 inch w.c.
			6. Housing: Polymer housing suitable for surface mounting.
			7. Acceptable Manufacturers: Setra. Substitutions shall be allowed per Division 1.
			8. Range: Select for minimum range that will accept the maximum velocity pressure expected.
	3. DIFFERENTIAL PRESSURE SWITCHES (DPS)
		1. General Service - Air: Diaphragm with adjustable setpoint and differential and snap acting form C contacts rated for the application. Provide manufacturer's recommended static pressure sensing tips and connecting tubing
		2. General Service - Water: Diaphragm with adjustable setpoint, 2 psig or adjustable differential, and snap-acting Form C contacts rated for the application. 60 psid minimum pressure differential range. 0°F to 160°F operating temperature range.
	4. PRESSURE SWITCHES (PS)
		1. Diaphragm or bourdon tube with adjustable setpoint and differential and snap-acting Form C contacts rated for the application. Pressure switches shall be capable of withstanding 150% of rated pressure.
		2. Acceptable Manufacturers: Square D, ITT Neo-Dyn, ASCO, Penn, Honeywell, and Cleveland Controls.
	5. transducers

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***NOTE TO SPECIFIER***

*Note that PWM transducer applications must be approved by the USPS. Generally, these will not be allowed on loops with a short time constant such as discharge temperature loops, economizer loops, pressure control loops and the like. They are generally acceptable for slower, standard room temperature control loops. If not to be allowed, carefully delete PWM-related language from this entire paragraph accordingly.*

*Edit below specifications to match project specifics. Delete reference to pneumatic control components if not* *applicable.*

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* + 1. Standard Capacity Electronic-to-Pneumatic (E-P) Transducers: E-P transducers shall be Voltage-to-Pneumatic (V-P) type, Current-to-Pneumatic (I-P) type[, and Pulse Width Modulated-to-Pneumatic (PWM-P) type]:
			1. Electrical Power Supply: 24 Vac or 24 Vdc.
			2. Pneumatic Air Supply: 30 psig (2.07 bar) maximum.
			3. Air Capacity: 1100 scim @ 20 psig (300 cm3/sec @ 1.4 bar).
			4. Air Consumption: Zero at steady state.
			5. Output Span: 0-20 psig (0-1.4 bar).
			6. Input: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, or 3-15 Vdc input. [Pulse width modulated or tri-state input shall be allowed].
			7. [Pulse Width Modulated and Tri-state Input Time Base: Dip switch selectable]
			8. Enclosure: Polymer designed for surface or panel mount.
			9. Air Connections: ¼” (6.35 mm) barbed.
			10. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
			11. Acceptable Manufacturers: RE Technologies Model UCP-522. Substitutions shall be allowed per Division 1.
		2. Binary to Analog Transducers ([Pulse Width Modulating or] Tri-State-to-Voltage or -Current):
			1. Adjustable zero and span.
			2. Failure Mode on Power Loss: Shall be provided with memory feature to allow the transducer to return to last value on power failure.
			3. Accuracy: ± 1% of span
			4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10Vdc, 2-10Vdc, 0-15Vdc, 3-15Vdc
			5. Input: 4-20 mA, pulse width modulated or tri-state input.
			6. [Pulse Width Modulated] and Tri-state Input Time Base: Dip switch selectable.
			7. Enclosure: Polymer designed for surface or panel mount.
			8. Failure Mode on Power Loss: Non-failsafe transducers shall have no output air loss. Failsafe transducers shall exhaust output upon power loss.
			9. Acceptable Manufacturers: RE Technologies Model PWA Series. Substitutions shall be allowed per Division 1.
		3. Electronic-to Electronic (Voltage or Current to Current or Voltage):
			1. Adjustable zero and span.
			2. Failure Mode on Power Loss: Memory feature to allow the transducer to return to last value on power failure.
			3. Accuracy: ± 1% of span.
			4. Output Span: 4-20 mA, 0-5 Vdc, 1-5 Vdc, 0-10 Vdc, 2-10 Vdc, 0-15 Vdc, 3-15 Vdc.
			5. Input: 0-20 Vdc, 0-20 ma, 0-10 kOhm.
			6. [Pulse Width Modulated and ]Tri-state Input Time Base: Dip switch selectable
			7. Enclosure: Polymer enclosure designed for surface or panel mount.
			8. Acceptable Manufacturers: RE Technologies Model PWA Series. Substitutions shall be allowed per Division 1.
	1. Current Switches (CS)
		1. Clamp-On or Solid-Core Design Current Operated Switch (for Constant Speed Motor Status Indication)
			1. Range: 1.5 to 150 amps.
			2. Trip Point: Adjustable.
			3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
			4. Lower Frequency Limit: 6 Hz.
			5. Trip Indication: LED
			6. Approvals: UL, CSA
			7. Max. Cable Size: 350 MCM
			8. Acceptable Manufacturers: Veris Industries H-708/908; Inc., RE Technologies SCS1150A-LED. Substitutions shall be allowed per Division 1.
		2. Clamp-on or Solid-Core Wire Through Current Switch (CS/CR) (for Constant Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable Manufacturers shall be Veris Industries, Inc., Model # H938/735; or RE Technologies RCS 1150. Substitutions shall be allowed per Division 1.
			1. Where used for single-phase devices, provide the CS/CR in a self-contained unit in a housing similar with override switch to Kele RIBX. Substitutions shall be allowed per Division 1.
		3. Clamp-On Design Current Operated Switch for Variable Speed Motor Status Indication
			1. Range: 1.5 to 135 Amps.
			2. Trip Point: Self-calibrating based on VA memory associated with frequency to detect loss of belt with subsequent increase of control output to 60 Hz.
			3. Switch: Solid state, normally open, 1 to 135 Vac or Vdc, 0.3 Amps. Zero off state leakage.
			4. Frequency Range: 5-75 Hz
			5. Trip Indication: LED
			6. Approvals: UL, CSA
			7. Max. Cable Size: 350 MCM
			8. Acceptable Manufacturers: Veris Industries, Inc. H-904. Substitutions shall be allowed per Division 1.
		4. Clamp-On Wire Through Current Switch (CS/CR) (for Variable Speed Motors): Same as CS with 24v command relay rated at 5A @ 240 Vac resistive, 3A @ 240 Vac inductive, load control contact power shall be induced from monitored conductor (minimum conductor current required to energize relay 5A, max. rating of 135A). Acceptable manufacturer shall be Veris Industries, Inc., Model # H934. Substitutions shall be allowed per Division 1.
		5. Variable Speed Status: Where current switches are used to sense the status for variable speed devices, the CT shall include on-board VA/Hz memory to allow distinction between a belt break and subsequent ramp up to 60 Hz, versus operation at low speed. The belt break scenario shall be indicated as a loss of status and the operation at low speed shall indicate normal status.
	2. OUTDOOR AIR STATIC PRESSURE SENSING TIP
		1. Pressure sensor: Pressure sensing tip shall be designed to minimize the effects of wind and resulting velocity pressure up to 80 mph. Acceptable manufacturers shall be Dwyer A-306. Substitutions shall be allowed per Division 1.
		2. Low Air Pressure Surge Dampener: 30-second time constant. Acceptable manufacturer shall be Modus SD030. Substitutions shall be allowed per Division 1.
	3. AIRFLOW MEASURING STATIONS (AFMS)
		1. Pitot Tube Grids: Provide an array of velocity pressure sensing elements with averaging manifolds and air straightening vanes packaged in a sheet metal casing. Distribute sensing elements in accordance with ASHRAE for traversing ducts. Provide taps to connect tubing from instrumentation. Label AFM with drawing number designation, design flow, velocity pressure, and pressure drop. Application of pitot grids shall be allowed only where minimum expected flow is greater than 30% or maximum flow
		2. Hot Wire Grid: Provide an array of hot wire anemometer with air straightening package in a sheet metal casing. Provide averaging circuitry and transmitter to transmit a linear signal proportional to airflow.
		3. Vortex Shedding Grid: Provide an array of vortex shedding elements designed to produce stable ‘Karmen Vortices’ that are linear with air velocity. Provide the electronics to totalize the pulses and output average velocity proportional to an output signal of 4-20ma.
			1. Sensor Accuracy: ±1.5%
			2. Electronics Accuracy: ±0.5%
			3. Range: Select minimum range to accommodate the expected flow range of the project
			4. Temperature Limits: 20-140°F
			5. Acceptable Manufacturer: Tek-Air Systems Inc. ‘Vortek’ Model. Substitutions shall be allowed per Division 1.
	4. Air Velocity Pressure Sensors (Insertion Type)
		1. Single or Multi-Point Averaging (as indicated): Sensing tip shall be for insertion into duct with mounting flange and push on tube connections. Material shall be suitable to the application.

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**NOTE TO SPECIFIER**

Delete reference to CO2 sensors if Demand Control Ventilation is not included in project specifics.

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* 1. CO2 Sensors/Transmitters (CO2)
		1. CO2 sensors shall use silicon based, diffusion aspirated, infrared single beam, dual-wavelength sensor.
		2. Accuracy: ±36 ppm at 800 ppm and 68°F.
		3. Stability: 5% over 5 years.
		4. Output: 4-20 mA, 0-10 Vdc or relay.
		5. Mounting: Duct or Wall as indicated.
		6. Acceptable Manufacturer: Vaisala, Inc. GMD20 (duct) or GMW20 (wall). Substitutions shall be allowed per Division 1.

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***NOTE TO SPECIFIER***

*Delete reference to pneumatic control components if not applicable. Typically, new installations will use electric control components. Pneumatics are typically used only in existing buildings where existing pneumatic control components are going to be reused.*

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* 1. PNEUMATIC CONTROL COMPONENTS
		1. Analog Pressure Gauges: Gauges shall be pneumatic type, minimum 1-1/2" in (38 mm) diameter, with white face and black numerals. Surface-mounted gauges shall have chrome plated trim and be a minimum of 2-1/2 inches in diameter.
		2. Pneumatic Actuated Pressure Switches (PE) (for 30 psig max pressure control systems): Pressure ranges and sensitivity of PEs shall match control system sequence of operation. Switch operation shall be externally adjustable over the operating pressure range, nominal 0-20 psig, PE switches shall be SPDT type, rated for the particular application, and shall be UL listed. PE shall be as manufactured by Penn. Substitutions shall be allowed per Division 1.
		3. Pilot Positioners: Operating span adjustment range is from 3 to 13 psi. Positioner shall be furnished with a mounting bracket for attachment directly to the actuator.
	2. ELECTRIC CONTROL COMPONENTS
		1. Limit Switches (LS): Limit switches shall be UL listed, SPDT or DPDT type, with adjustable trim arm. Limit switches shall be as manufactured by Square D, Allen Bradley. Substitutions shall be allowed per Division 1.
		2. Electric Solenoid-Operated Pneumatic Valves (EP): EP valves shall be rated for a minimum of 1.5 times their maximum operating static and differential pressure. Valves shall be ported 2-way, 3-way, or 4-way and shall be normally closed or open as required by the application. EPs shall be sized for minimum pressure drop, and shall be UL and CSA listed. Furnish and install gauges on all inputs of EPs. Furnish an adjustable air pressure regulator on input side of solenoid valves serving actuators operating at greater than 30 psig.
			1. Coil Enclosure: Indoors shall be NEMA-1, Outdoors and NEMA-3, 4, 7, 9.
			2. Fluid Temperature Rating: Valves for compressed air and cold water service shall have 150 °F minimum rating. Valves for hot water or steam service shall have fluid temperature rating higher than the maximum expected fluid temperature.
			3. Acceptable Manufacturers: EP valves shall be as manufactured by ASCO or Parker. Substitutions shall be allowed per Division 1.
			4. Coil Rating: EP valves shall have appropriate voltage coil rated for the application (i.e., 24 VAC, 120 VAC, 24 VDC, etc.).
		3. Low Temperature Detector (‘Freezestat’) (FZ): Low temperature detector shall consist of a ‘cold spot’ element which responds only to the lowest temperature along any one foot of entire element, minimum bulb size of 1/8-inch x 20 feet, junction box for wiring connections and gasket to prevent air leakage or vibration noise, DPST ( 4 wire, 2 circuit) with manual reset. Temperature range 15 to 55F, factory set at 38°F.
		4. High Temperature Detectors (‘Firestat’) (FS): High temperature detector shall consist of 3-pole contacts, a single point sensor, junction box for wiring connections and gasket to prevent air leakage of vibration noise, triple-pole, with manual reset. Temperature range 25 to 215°F.
		5. Surface-Mounted Thermostat: Surface-mounted thermostat shall consist of SPDT contacts, operating temperature range of 50 to 90° F, and a minimum 10°F fixed setpoint differential.
		6. Low Voltage Wall Thermostat: Wall-mounted thermostat shall consist of SPDT sealed mercury contacts, operating temperature range of 50 to 90°F, switch rating of 24 VAC (30 VAC max.), and both manual and automatic fan operation in both the heat and cool modes.
		7. Control Relays: All control relays shall be UL listed, with contacts rated for the application, and mounted in minimum NEMA-1 enclosure for indoor locations, NEMA-4 for outdoor locations.
			1. Control relays for use on electrical systems of 120 volts or less shall have, as a minimum, the following:
				1. AC coil pull-in voltage range of +10%, -15% or nominal voltage.
				2. Coil sealed volt-amperes (VA) not greater than four (4) VA.
				3. Silver cadmium Form C (SPDT) contacts in a dustproof enclosure, with 8 or 11 pin type plug.
				4. Pilot light indication of power-to-coil and coil retainer clips.
				5. Coil rated for 50 and 60 Hz service.
				6. Acceptable Manufacturers: Relays shall be Potter Brumfield, Model KRPA. Substitutions shall be allowed per Division 1.
			2. Relays used for across-the-line control (start/stop) of 120V motors, 1/4 HP, and 1/3 HP, shall be rated to break minimum 10 Amps inductive load. Relays shall be IDEC. Substitutions shall be allowed per Division 1.
			3. Relays used for stop/start control shall have low voltage coils (30 VAC or less), and shall be provided with transient and surge suppression devices at the controller interface.
		8. General Purpose Power Contactors: NEMA ICS 2, AC general-purpose magnetic contactor. ANSI/NEMA ICS 6, NEMA type 1 enclosure. Manufacturer shall be Square 'D', Cutler-Hammer or Westinghouse. Substitutions shall be allowed per Division 1.
		9. Control Transformers: Furnish and install control transformers as required. Control transformers shall be machine tool type, and shall be US and CSA listed. Primary and secondary sides shall be fused in accordance with the NEC. Transformer shall be proper size for application, and mounted in minimum NEMA-1 enclosure.
			1. Transformers shall be manufactured by Westinghouse, Square ‘D’, or Jefferson. Substitutions shall be allowed per Division 1.
		10. Time Delay Relays (TDR): TDRs shall be capable of on or off delayed functions, with adjustable timing periods, and cycle timing light. Contacts shall be rated for the application with a minimum of two (2) sets of Form C contacts, enclosed in a dustproof enclosure.
			1. TDRs shall have silver cadmium contacts with a minimum life span rating of one million operations. TDRs shall have solid state, plug-in type coils with transient suppression devices.
			2. TDRs shall be UL and CSA listed, Crouzet type.
		11. Electric Push Button Switch: Switch shall be momentary contact, oil tight, push button, with number of N.O. and/or N.C. contacts as required. Contacts shall be snap-action type, and rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen Bradley. Substitutions shall be allowed per Division 1.
		12. Pilot Light: Panel-mounted pilot light shall be NEMA ICS 2 oil tight, transformer type, with screw terminals, push-to-test unit, LED type, rated for 120 VAC. Unit shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.
		13. Alarm Horn: Panel-mounted audible alarm horn shall be continuous tone, 120 Vac Sonalert solid-state electronic signal, as manufactured by Mallory. Substitutions shall be allowed per Division 1.
		14. Electric Selector Switch (SS): Switch shall be maintained contact, NEMA ICS 2, oil-tight selector switch with contact arrangement, as required. Contacts shall be rated for minimum 120 Vac operation. Switch shall be 800T type, as manufactured by Allen-Bradley. Substitutions shall be allowed per Division 1.

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**NOTE TO SPECIFIER**

Delete reference to Refrigerant Monitor for all but chilled water R&A projects or where the volume of refrigerant contained within internal components exceeds the requirements of the applicable edition of ASHRAE Standard 15.

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* 1. Refrigerant Monitor
		1. General: Provide a refrigerant sensitive infrared-based stationary refrigerant gas leak monitor system designed to continuously measure refrigerants. Refrigerant monitor shall be coordinated to detect [insert refrigerant types here if known or delete] refrigerants used in chiller equipment installed under Section 236416 Centrifugal Water Chillers. The alarm system shall comply with ANSI/ASHRAE 15-1994 and local code requirements.
		2. The refrigerant monitor shall be capable of monitoring multiple refrigerant gas compounds at multiple locations in concentrations of 0 PPM to a minimum of 1000 PPM. The Monitor shall have a low range resolution of 1 PPM in the range of 1 PPM through 100 PPM. Readings above 100 PPM must be accurate to within ±5% of reading. Accuracy shall be maintained within ambient environmental ranges of 32ºF through 122ºF and 5% through 90% relative humidity, non-condensing.
		3. The refrigerant monitor shall automatically and continuously monitor the areas through a sample draw type tubular pick up system with an internal pump and filter. The installation of the monitoring control and the tubing shall be in strict accordance with the manufacturer’s instructions. The location, routing, and final position of the sample tubes shall be submitted to the engineer with all necessary shop drawings and monitor specifications and installation instructions. Tubing size, tubing material, and tube length limitations shall be within the specifications of the monitor manufacture. The location and method of tube support and hangers must be identified on the shop drawings. Each of the sampling tubes shall have end of line filters.
		4. The analyzer will be based on infrared detection technology, and will be factory tested and calibrated for the specified refrigerant or refrigerants. Factory certification of the calibrations shall be provided with the O&M manuals. The analyzer shall provide a menu driven or automatic method of checking both zero, span calibration for each sensor, and allow for adjustment.
		5. The monitor shall be equipped with 4 outputs. Three relays shall energize at an adjustable user defined set point based on refrigerant concentration levels. The relay threshold adjustment shall be protected by keyed or password access controls. Adjustments and observations shall be made at the front panel operator interface. The relay threshold values can be viewed without a password. The digital display will continuously display the refrigerant concentration level and alarm status. The fourth output shall indicate a monitor malfunction alarm. The monitor shall also have an analog output that will provide a liner scaled reference to the refrigerant concentration in parts per million. The analog output signal shall be an industry standard DC voltage, or mA current signal.
		6. The monitor shall have a NEMA-4 moisture resistant enclosure with a gasketed, hinged front cover. Conduits and tube connections shall be located on the bottom of the enclosure. The enclosure shall have a rust and corrosion resistant finish.
		7. The following alarm modes will be provided by the refrigerant monitor:
			1. ALARM LEVEL ONE – Low level of refrigerant concentration at one of the sampling points has detected the presence of a possible refrigerant leak. The initial alarm threshold shall be set to 5 PPM (adj.) and increased if there are nuisance alarms. This alarm level shall be displayed on the refrigerant monitor interface panel, indicating which sensor has triggered the alarm, and the associated concentration of refrigerant in PPM. This event will also send an Alarm Level One signal to the BAS through a digital output from the monitor relay. This alarm will remain active until the refrigerant concentration is reduced below set point.
			2. ALARM LEVEL TWO – This alarm shall indicate that one of the sensors has detected a refrigerant concentration that is approaching dangerous levels in the area being monitored. This alarm shall be set to 25% below the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992. This alarm will be displayed on the monitor interface, and will indicate which of the sensors has caused the alarm, and the highest concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. This alarm will also be sent to the BAS through the digital output of the relay. In this mode the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared
			3. ALARM LEVEL THREE – This alarm shall be set at the maximum calculated refrigerant level specified in ANSI/ASHRAE 15-1994 and ASHRAE 34-1992 whichever is the lowest concentration. The refrigerant monitor interface will display which sensor has caused the alarm, and the associated concentration in PPM. This event will also activate the beacon and audible alarm mounted on the refrigerant monitoring enclosure. If the audible alarm had been silenced by an earlier alarm, the activation of this level three alarm will cause the audible alarm to be activated again. The relay in the refrigerant monitoring panel shall activate the space ventilation system, and will disable all combustion or flame-producing equipment via hardwired control interlocks. In addition, this event and will de-energize the energy source for any hot surface (850°F) located in the space. Interlocks must also be provided to close any normally open doors or openings to the space for proper ventilation and isolation during this alarm condition. This alarm level will also signal the BAS through the digital output through the same relay. In this mode, the audible alarm can be silenced, but the beacon shall remain active until the fault is cleared.
		8. All alarm conditions shall be report to the BAS system as follows:
			1. ALARM LEVEL ONE - The lowest refrigerant alarm level shall detect the presence of refrigerant in low concentrations and energize a relay to signal a low level alarm to the BAS operator terminal(s). The alarm shall display an alarm message stating that there is a potential refrigerant leak in the designated area.
			2. ALARM LEVEL TWO - The second refrigerant level alarm shall be a high refrigerant alarm alert. This alarm shall energize a relay to signal the BAS system indicating a high level alarm on the BAS operator terminal(s). This BAS alarm shall state that high levels of refrigerant have been detected in the designated area.
			3. FAULT ALARM – Reports a high level alarm to the BAS operator terminal(s) that there is a fault in the refrigerant monitoring alarm system.

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**NOTE TO SPECIFIER**

Coordinate Fire Alarm interface with Division 28. Edit below as needed to indicate necessary interface.

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* 1. Smoke Control/Fireman’s Override Panel
		1. Integral enunciator/control panel part of complete engineered and UUKL 864 listed system.
		2. Provide clear, laminated graphic schematically representing the building air systems. Status LEDs shall be associated with graphic representations of fans. Override switches shall be provided as required by NFPA 110 to allow override of the fans and dampers applicable to the code requirements.
		3. Interface with Fire Alarm System as required to implement the specified requirements in the Sequence of Operations.
	2. NAMEPLATES
		1. Provide engraved phenolic or micarta nameplates for all equipment, components, and field devices furnished. Nameplates shall be 1/8 thick, black, with white center core, and shall be minimum 1 x 3 inches, with minimum 1/4" high block lettering. Nameplates for devices smaller than 1 x 3 inches shall be attached to adjacent surface.
		2. Each nameplate shall identify the function for each device.
	3. TESTING EQUIPMENT
		1. Test and calibrate all signaling circuits of all field devices to ascertain that required digital and accurate analog signals are transmitted, received, and displayed at system operator terminals, and make all repairs and recalibrations required to complete test. Test equipment required to perform these tests and calibrations. Test equipment used for testing and calibration of field devices shall be at least twice as accurate as respective field device (e.g., if field device is +/-0.5% accurate, test equipment shall be +/-0.25% accurate over same range).
1. EXECUTION
	1. INSPECTION
		1. 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.
	2. INSTALLATION OF CONTROL SYSTEMS
		1. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
		2. Refer to additional requirements in other sections of this specification.

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***NOTE TO SPECIFIER***

*Digital control stations should specifically be shown on the drawings. Select appropriate wall and floor locations that minimize wire and tube runs and coordinate these locations with other disciplines. Gateway and CSS devices should be located in environmentally controlled spaces similar to an IT closet with a dedicated terminal unit. If the project is a control renovation, locate spare breakers in a power panel where the control contractor can obtain 120V power and show it on the floor plans.*

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* 1. Digital control Stations, CONTROLLER QUANTITY AND LOCATION

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***NOTE TO SPECIFIER***

*Designate locations for control stations and specifically reserve wall and floor space and indicate it on the drawings and coordinate it with other trades. Preferably you will have the electrical contract provide power (normal, emergency, or uninterruptible as applicable) and then delete the requirement for this contractor to provide the power.*

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* + 1. 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.
		2. Where a DCS is referenced, provide at least one controller, and additional controllers as required, in sufficient quantity to meet the requirements of this Specification. Restrictions in applying controllers are specified in Section 251404: BAS Field Panels. Extend power to the DCS from an acceptable power panel. To distribute panels to other locations, extend power to those locations also. Ensure adequate locations for the panels that do not interfere with other requirements of the project and maintain adequate clearance for maintenance access.
		3. Locate DCSs as referenced. Provide enough controllers to ensure a completely functioning system, according to the point list and sequence of operations.
		4. Provide a minimum of the following:
			1. One DCS (including at least one controller) in each chilled water plant mechanical room.
			2. One controller for each air handler located in applicable mechanical room.
			3. One controller shall be provided for each terminal unit unless indicated otherwise.
	1. SURGE PROTECTION
		1. Provide 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% above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

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***NOTE TO SPECIFIER***

*Include this section only for R&A projects.*

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* 1. DEMOLITION AND REUSE OF EXISTING MATERIALS AND EQUIPMENT

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***NOTE TO SPECIFIER***

*Reuse of existing controls must be carefully coordinated by the AE. What stays and goes must be clear. As applicable, expand/edit this section to indicate what is allowed for reuse. The bottom line is assumptions will generally have to be made for bidding, but final acceptance of an existing device will not occur until the contractor tests it.*

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* + 1. Inspect devices and determine if any devices need replacement or repair. Prepare an itemized list of suggested repairs/replacement. This repair/replacement will be at the discretion of the USPS and will be accomplished by expanding this contract.
		2. Existing wire, conduit, and control panel cabinets may be reused at the USPS Project Engineer’s discretion, but only if such materials or equipment comply with the applicable specification for new materials and equipment. Such materials shall not be reused if visibly damaged or otherwise unsuitable for the intended service.
		3. Where such materials are reused, the shop drawings shall reflect the existing wiring designation. If existing labeling is illegible or otherwise does not comply with the applicable specification for labeling, wiring runs shall be relabeled in accordance with the requirements specified elsewhere.
		4. Existing pneumatic tubing located between the existing BAS panels and the pneumatic operators shall not be reused; however, conduit for such tubing may be reused. All other pneumatic tubing may be reused, but only if such materials comply with the applicable specification for new materials. Materials shall not be reused if visibly damaged or otherwise unsuitable for the intended service. All pneumatic tubing to be reused shall be pressure tested and all leaks shall be repaired. All reused pneumatic tubing shall be purged with dry air or nitrogen.
		5. The existing pneumatic main air supply system shall be modified as required and reused to serve existing pneumatic controls that are to remain, and shall be extended as necessary to serve new pneumatic controls. Where existing pneumatic controls are removed, main air piping shall be removed back to the point of connection to the main air supply which remains in use, and shall be capped or plugged.
		6. Existing valves and dampers and their operators may be reused only when pre-approved by the USPS. Lubricate all damper linkages of dampers being controlled under this project.
		7. Other materials and equipment not specifically mentioned herein may be reused only if specifically allowed by indications on the drawings.
		8. For HVAC systems which are indicated to receive a new BAS, all existing materials and equipment associated with the existing pneumatic controls and EMCS shall be removed unless otherwise specified or indicated to remain, or unless reused in accordance with the above requirements, except for the following: 1) conduit and electrical boxes (but not wiring within conduit) may remain in place if not reused (leave a pull line); 2) inaccessible pneumatic tubing may remain in place if not reused. Existing materials and equipment to be removed shall be removed subject to the requirements in paragraph “Sequence of Work”. For HVAC systems, which are not to receive a new DDC BAS, the existing pneumatic control system shall remain fully functional.

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***NOTE TO SPECIFIER***

*Include the following only when applicable. This will depend on the necessity of continuous operations and this is only a template. This item will typically have to be extensively customized for each project.*

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* 1. SEQUENCE OF WORK For Existing Systems Conversion [R&A projects only]
		1. General: All work involving changeover of control functions from existing pneumatic control system to the new DDC BAS shall be performed in accordance with the following sequence in order to minimize the duration of equipment outages. The following descriptions are intended to indicate the sequence in which the work shall be performed, not to define fully the scope of the work.
		2. Install operator’s terminal, peripherals, graphic software, and LAN prior to placing any equipment under the control of the new BAS.
		3. Work which requires shutting down a pump motor, fan motor, or chiller shall be considered a utility shutdown and shall be subject to the restrictions specified in Section 015000 - Temporary Facilities and Controls.
		4. The following sequence applies to an individually controlled HVAC subsystem, such as an air handling unit. Only one such system shall be placed under manual control (as described below) at any given time.
			1. Install controllers adjacent to (or within) existing control panels. Programming shall be complete (except for loading and debugging) prior to installation. Install all field devices, which do not require interruption of the existing control system.
			2. Install all conduit, wiring, and pneumatic tubing which does not require interruption of the existing control system.
			3. Provide temporary variable pressure type hand pumps at each pneumatically controlled output, for temporary use by the USPS’s maintenance and operation personnel. Schedule this step at least 48 hours in advance with the Building Engineer.
			4. Remove existing controls including wiring, conduit, and tubing (except materials to be reused in accordance with provisions specified elsewhere) which must be removed to facilitate installation of new BAS materials and equipment.
			5. Remove existing digital control system points (if applicable). Install and calibrate remainder of new BAS materials and equipment for this subsystem. Load controller software. Connect controller(s) to LAN.
			6. Perform all field testing and calibration that does not require connection of permanent pneumatic outputs.
			7. Remove temporary hand pumps and install permanent pneumatic output connections. Place the system under the control of the new DDC/BAS equipment. Conclude field testing and submit field testing report prior to placing the next subsystem under temporary manual control. The USPS shall be given a password with a priority level that allows monitoring (but not control until notification of substantial completion has been approved).
			8. Remove remaining existing pneumatic and digital control system materials and equipment (except materials to be reused in accordance with provisions specified elsewhere). All existing digital controls equipment for those subsystems that have not yet been converted shall remain intact, on-line, and fully functional.
		5. Schedule work in USPS occupied spaces 3 days in advance with the USPS’s representative.
	2. CONTROL POWER SOURCE AND SUPPLY

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***NOTE TO SPECIFIER***

*Coordinate with Division 26 requirements.*

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* + 1. Extend all power source wiring required for operation of all equipment and devices provided under Sections 250504 through 251404 and the Sequences of Operation [unless specifically shown on the drawings for specific locations].

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***NOTE TO SPECIFIER***

*The following will have to be customized for each system and project. Consider from where to power 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’s power sources by the controller. The object here 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.*

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* + 1. General requirements for obtaining power include the following:
			1. 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 of the correct voltage to supply the control system, 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.
			4. Standalone Functionality: Refer to Section 251404.

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***NOTE TO SPECIFIER***

*Carefully coordinate the training requirements with the needs of the USPS facilities staff. Expansions of existing systems obviously require less training than brand new systems. The following generally outlines an on-site training session for which you always want some basic site-specific training on-site. The more advanced training may be better provided off site on a case-by-case basis. Edit to suit project.*

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* 1. BAS Start Up, Commissioning and Training
		1. Refer to Section 250804
	2. SEQUENCE OF OPERATION
		1. DESCRIPTION OF WORK

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***NOTE TO SPECIFIER***

*Select the following paragraphs which are dependent upon new construction or retrofit facilities.*

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* + - 1. [This Subsection includes control sequences for HVAC systems, subsystems, and equipment. As requirements for monitoring and integration of multiple building systems and utilities for energy consumption.]
			2. [This Subsection includes control sequences for HVAC systems, subsystems, and equipment. As requirements for monitoring and integration of multiple building systems and utilities for energy consumption. This Subsection and Related Sections as listed above will be responsible for continued services to the existing building systems to remain in operation, to proposed systems partially completed and shall provide control and monitoring during the phased construction.]
		1. OUTDOOR AIR CONDITION MONITORING
			1. The controller will read the outside air temperature and humidity and calculate the outside air enthalpy, and will make these values available to the system.
			2. If the outside air temperature sensor is out of the normal set point parameter after a time delay (adj.), the controller will generate a sensor failure
		2. OPTIMAL START PROGRAM (OSP)
			1. The Building Automation System (BAS) or Energy Management System (EMS) shall control the various Day/Night zones based upon an operator interactive time-of-day (TOD) program.
			2. The TOD program shall interact with an optimal start program (OSP) such that start times shall be assigned by the OSP to achieve the target occupancy space temperature (72° F winter, 75° F summer) at the precise time of building occupancy.
			3. Refer to the various sequences of operation to determine the amount of Day/Night zones required.
			4. During morning warm-up, all outside air dampers shall be full closed.

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***NOTE TO SPECIFIER***

*Edit the following paragraphs based on the job requirements. Day night zones should be arranged with respect to the air handlers serving various areas. Areas with VAV air handlers may be subdivided based on system size and area functions served. Representative areas are shown in the schedule, more may be added as needed. Consult with USPS*

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* + 1. DAY/NIGHT ZONE CONTROL
			1. The facility shall be divided into day/night zones as indicated below. The unoccupied heating temperature setpoint for all zones is [55°] F. The unoccupied cooling setpoint is indicated in the table.
			2. The BAS/EMS shall control the building zones on the following occupied schedule:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Area** | **Weekday** | **Saturday** | **Sunday** | **Unoccupied Cooling** |
| Workroom | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | 88°F |
| Docks | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | NA |
| Administration | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | 88°F |
| Data Centers | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | 74°F |
| Cafeteria | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | 88°F |
| Lobbies | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | [\_\_\_\_\_\_\_\_] | 88°F |

* + 1. GENERAL MOTOR STARTING REQUIREMENTS
			1. Motors shall be started with a minimum delay of 5 seconds (adj.) between motors except when simultaneous operation sequence is required.
			2. Motors equipped with VFD’s shall initially start at 30% speed (adj.) and then ramp up to the required operating speed.
			3. Relief fan motors shall not be allowed to start until the associated damper end switch is proven open.
			4. AHU and return/relief fan motors shall not be allowed to start until the associated return damper end switch is proven open.

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**NOTE TO SPECIFIER**

Verify manufacturer information, Product numbers, and availability at time of Project Manual preparation for Project.

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* + 1. ELECTRIC MAIN UTILITY METERING

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***NOTE TO SPECIFIER***

*Select one of the four following paragraphs based on the job requirements. This may require coordination with the electrical and IT infrastructure designers. Consult with USPS Project Manager.*

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* + - 1. [Provide required interfaces and programming to collect data from smart meters on the incoming mains installed by others. Provide the meter points and trending as indicated in the attached points list.]
			2. [Provide required interfaces and programming to collect data from the existing smart meters on the incoming mains. Provide the meter points and trending as indicated in the attached points list.]
			3. [Provide a smart meter as specified in section 251104 for each main incoming electrical feed. Provide the meter points and trending as indicated in the attached points list.]
			4. [Coordinate with the electric service provider to obtain a kWh pulse from the electrical providers metering equipment. Obtain the K-Factor of the meter pulses from the utility supplier. Provide a calculation of demand and accumulate total kWh.]
			5. Provide the meter points and trending as indicated in the attached points list
			6. Phase Monitoring
				1. The BAS shall monitor the incoming power, if there is a phase voltage loss or phase voltage unbalance the BAS shall shut off all motorized equipment and the chiller, and issue an alarm. The BAS station shall have an icon to manually restart all equipment previously shut off.
				2. The system under voltage trip point on the voltage monitor shall be set to 420 volts (87.5% of nominal 480 volts).

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**NOTE TO SPECIFIER**

*Select one of options below based on the job requirements. A load shedding program may be established in conjunction with the local power supplier or may be developed with within the project. This may require coordination with the electrical and lighting control designers. Consult with USPS* *Project Manager.*

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* + 1. ELECTRICAL LOAD MANAGEMENT
			1. [BAS shall provide load management capability as indicated below for peak avoidance and for peak alarm condition.]
			2. [BAS shall use the data from the smart meter to establish a predicted demand warning and alarm setpoints for use in demand management. These setpoints shall be operator adjustable.]
			3. Upon peak power warning condition indication provided by [Electrical Utility Demand Indication device (pulse output)] [Predicted demand warning condition from metered services].
				1. The BAS shall reset space temperature by 1 Deg. F. (increase or decrease based on cooling or heating mode of operation). Fan speed shall be reduced to maintain set point.
				2. The BAS shall initiate a [10%] shed request to Lighting control system.
			4. Upon peak power alarm condition indication provided by [Electrical Utility Demand Indication device (pulse output)] [Predicted demand alarm condition from metered services].
				1. The BAS shall reset space temperature by 2 degrees F. (increase or decrease based on cooling or heating mode of operation). Fan speed shall be reduced to maintain set point.
				2. The fan speed of all units controlled by VFD’s shall be reduced to 70%.
				3. During chilled water system operation, the chilled water setpoint shall be increased by [3 degrees F].
				4. The BAS shall initiate a [20%] shed request to Lighting control system.
			5. Coordinate input requirements to BAS with Division 26.
			6. On “Off Peak” time period, controls shall return to comfort set points.
			7. On restart from power failure, mechanical systems shall start in a staggered sequence to avoid peak current draw.
		2. GAS UTILITY METERING

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**NOTE TO SPECIFIER**

*Select one of the following paragraphs based on the job requirements. This may require coordination with the mechanical or plumbing designers. Consult with USPS* *Project Manager.*

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* + - 1. [Provide connection to gas meter provided by others to monitor the meter pulse contact. Coordinate with the meter provider to obtain meter K factor.]
			2. [Provide new gas meter as specified in section 251104.]
			3. [Arrange with the gas service provider to obtain a gas contact pulse for each gas meter serving the facility. Obtain the K-Factor of the meter pulses from the utility supplier.]
			4. Provide for each gas meter an accumulation of the total gas consumption and a calculation of the 15 minute gas demand use.
			5. For facilities with more than one gas meter provide a total consumption of all gas meters and total 15 minute demand calculation.
			6. Provide the meter points and trending as indicated in the attached points list
		1. WATER UTILITY METERING

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**NOTE TO SPECIFIER**

Select one of the following paragraphs based on the job requirements. This may require coordination with the mechanical or plumbing designers. Consult with USPS Project Manager.

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* + - 1. [Provide connection to water meter provided by others to monitor the meter pulse contact. Coordinate with the meter provider to obtain meter K factor.]
			2. [Provide new water meter as specified in section 251104.]
			3. [Arrange with the water service provider to obtain a gas contact pulse for each gas meter serving the facility. Obtain the K-Factor of the meter pulses from the utility supplier.]
			4. Provide for each water meter an accumulation of the total water consumption and a calculation of the 15 minute water demand use.
			5. For facilities with more than one water meter provide a total consumption of all water meters and total 15 minute demand calculation.
			6. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control
		1. STEAM UTILITY METERING

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**NOTE TO SPECIFIER**

Select one of the following paragraphs based on the job requirements. This may require coordination with the mechanical or plumbing designers. Consult with USPS Project Manager.

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* + - 1. [Provide connection to steam meter provided by others to monitor the meter pulse contact or 4-20 ma signal. Coordinate with the meter provider to obtain meter K factor.]
			2. [Provide new steam metering system as specified in section 251104]
			3. [Arrange with the steam service provider to obtain a contact pulse for each steam meter serving the facility. Obtain the K-Factor of the meter pulses from the utility supplier.]
			4. Provide for each steam meter an accumulation of the total consumption and a calculation of the 15 minute steam demand use if consumption is provided by pulse signal
			5. For facilities with more than one meter provide a total consumption of all meters and total 15 minute demand calculation.
			6. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.

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**NOTE TO SPECIFIER**

In all the sections below insert required sequence of operation to meet the requirements of the system design and best energy conservation practices. Include in the final section energy monitoring paragraphs. Consult USPS Project Manager.

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* + 1. CHILLER PLANT CONTROL
			1. [Sequence of operations.]
			2. Energy Monitoring:

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**NOTE TO SPECIFIER**

Select the submetering options below to meet the requirements of the system design and M&V plan. Balance metering cost to value received. System point list will need to be edited based on option selected. Consult USPS Project Manager.

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* + - * 1. [Provide an interface to the chiller control panels though a gateway or direct BACnet interface.]
				2. [Install a kW transducer on the chiller feeds to monitor the chiller power]
				3. [Install BTU metering system as specified in Section 251404] [for each chiller] [for total chilled water system]
				4. [Provide a calculation of the total chilled water system energy demand and accumulated energy consumption and trend as indicated. Total chilled water system demand includes all chiller, dedicated chiller pump and chilled water system pumping power.]
				5. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.
		1. CHILLED WATER PUMPING CONTROL
			1. [Sequence of operations.]
			2. Energy Monitoring:

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**NOTE TO SPECIFIER**

AE should only utilize BTU meter below if facility is fed from and charged by a District Utility system providing hot or chilled water system. Use and specification shall be provided only in close coordination with the USPS Project Manager. This metering type is atypical for nearly all facilities and would only be used as a check against utility charges if an auxiliary contact is not provided by the utility company or if secondary confirmation of charges is requested by the USPS Project Manager. Omit this metering section if district hot water or chilled water are not provided.

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* + - * 1. Provide for the [main][ and ][secondary] chilled water system a BTU monitoring system to measure energy delivered to the facility as specified in Section 251404.
				2. [Through the chilled water pump VFD communication interface provide points and trending as indicated in the attached points list.]
				3. Through the BTU meter communication interface provide the points and trending as indicated in the attached points list.
				4. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.
		1. CONDENSER WATER CONTROL TOWER CONTROL
			1. [Sequence of operations.]
			2. Energy Monitoring:

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**NOTE TO SPECIFIER**

Select the submetering option below to meet the requirements of the system design and M&V plan. Balance metering cost to value received. System point list will need to be edited based on option selected. Consult USPS Project Manager.

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* + - * 1. [Provide a KW transducer for [total system power feeder] [per each tower fan] as specified in Section 251404.]
				2. [Through the tower fan VFD communication interface provide points and trending as indicated in the attached points list.]
				3. [Provide a calculation of the total condenser water system energy demand and accumulated energy consumption and trend as indicated. Total condenser water system demand includes all tower fans and condenser water system pumping power.]
				4. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.
		1. HEATING HOT WATER SYSTEM CONTROL
			1. [Sequence of operations.]
			2. Energy Monitoring:

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**NOTE TO SPECIFIER**

AE should only utilize BTU meter below if facility is fed from and charged by a District Utility system providing hot or chilled water system. Use and specification shall be provided only in close coordination with the USPS Project Manager. This metering type is atypical for nearly all facilities and would only be used as a check against utility charges if an auxiliary contact is not provided by the utility company or if secondary confirmation of charges is requested by the USPS Project Manager. Omit this metering section if district hot water or chilled water are not provided.

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* + - * 1. Provide for the [main][ and ][secondary] water system a BTU monitoring system to measure energy delivered to the facility as specified in Section 251404.
				2. [Through the hot water pump VFD communication interface provide points and trending as indicated in the attached points list.]
				3. Through the BTU meter communication interface provide the points and trending as indicated in the attached points list.
				4. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.

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***NOTE TO SPECIFIER***

*Repeat the section below as required for the different system configurations. Consult USPS*

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* + 1. VAV AIR HANDLER SYSTEM CONTROL
			1. [Sequence of operations.]
			2. Energy Monitoring:

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***NOTE TO SPECIFIER***

*Select the submetering option below to meet the requirements of the system design and M&V plan. Balance metering cost to value received. System point list will need to be edited based on option selected. Consult USPS Project Manager.*

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* + - * 1. Through the system VFD communication interface provide points and trending as indicated in the attached points list
				2. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.
		1. SINGLE ZONE AIR HANDLER SYSTEM CONTROL
			1. [Sequence of operations.]
			2. Energy Monitoring:

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***NOTE TO SPECIFIER***

*Select the submetering option below to meet the requirements of the system design and M&V plan. Balance metering cost to value received. System point list will need to be edited based on option selected. Consult USPS Project Manager.*

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* + - * 1. Through the system VFD communication interface provide points and trending as indicated in the attached points list
				2. Provide monitoring of all other system points as indicated on the attached point list and other system parameters as needed for operator control.
		1. MISCELLANEOUS SYSTEMS MONITORING
			1. [Sequence of operations.]
			2. Energy Monitoring:

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***NOTE TO SPECIFIER***

*Select the submetering option below to meet the requirements of the system design and M&V plan. Balance metering cost to value received. System point list will need to be edited based on option selected. Consult USPS Project Manager.*

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* + - * 1. Provide monitoring of system points as indicated on the attached point list and other system parameters as needed for operator control.
		1. LIGHTING SYSTEMS MONITORING
			1. The BAS shall monitor the lighting system though the BACnet interface
			2. Provide programming to totalize the lighting system demand kW as received though a BACnet object from the lighting control system
			3. Provide all programming required to establish trend objects for the lighting system as indicated on the attached points list.

System Point Lists

* + 1. Purpose: The following point list tables identify the general system control and monitoring points expected to be implemented for each system. Additional points may be needed to fully implement the control sequences and calculation algorithms. This should be included in the submittals specified in other sections. All additional points shall be follow the point naming convention established in related sections.
		2. Point List table descriptions
			1. Point ID: system point name following point naming standard established in related sections.
			2. Description: Additional descriptive information relating to the point to expound on the system Point ID.
			3. Control SP: For points in control loops, the control loop setpoint.
			4. Alarm Data: Identification of alarm levels for the point identified. Provide alarm objects for set with the identified parameters
			5. Trend Data: Indication of which points shall be trended and in what manner. All trends are stored in the file panel local memory.
				1. Type: COV - change in value, value recorded and time stamped when value changes by a set threshold; Time – value recorded and time stamped at set time intervals.
				2. Freq.: Set frequency interval, in minutes, a time based trend is stored.
				3. Min Storage: The minimum number of samples either time based or COV to be stored in the field panel.
			6. Graphic Display: This group is and indication of where points shall be shown on system graphics and trend graph groupings. This is a general assignment of system points to graphic displays and graphs. Additional points may need to be shown to ease of operator functionality. All graphics and graphs shall be mocked up and submitted for approve before final programming.
				1. System Diagram: The graphic screen, at a minimum on which the point is to be presented.
				2. Trend graph: The trend graph grouping to which the point should be assigned. Trend graphs shall have their vertical scale set to include the typical range of the operating parameters measured. Scales shall be fixed to allow vertical units to be easily read values. On trend groupings with diverse parameters, a second vertical axis shall be set to all reasonable comparisons of the relationships between parameters.
			7. EEMS: This group is an indication of which points shall be collected by the EEMS server for remote monitoring, display, alarm and historical archiving.
				1. Server points: The indicated points’ BACnet objects and any associated alarm and trend objects will be retrieved for real time display at the EEMS server.
				2. Trend Archive: The indicated points will be formatted into trend archiving in the EEMS.

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***NOTE TO SPECIFIER***

*The following are typical point lists for an incoming utility and equipment monitoring. This may be edited depending on the type of meters existing in the building or specified elsewhere. Insert alarm limits as required for the project. There may be more than one incoming electric main to some facilities. Indicate so in the table by adding similar points for ELEC.MAIN2. For the gas, water, steam mains, indicate in specification sections that the contractor needs to coordinate with the local gas company to modify their meter to provide a contact pulse initiator if one is not present.*

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**Points List – Incoming Utilities**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Unit** |   |  | **Alarm Data** | **Trend data** | **Graphic Display** | **EEMS** |
| Point ID ?= State, .Facility ID AB.CCCCCCCC | Description | ControlSP | HiAlrm | SP | LowAlarm | SP | StatusAlarm | SeeNote | Type | Freq. | Min.StorageNote 3 | TotalizeNote 2 | SystemDiagram | TrendGraph | ServerPoints | Trend Archive |
| **Electric Mains** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |
| ?.UTL.ELE.M1.PHA.V | M1.PHA.V |   | X |   | X |   |   |   | TIME | 5 | 2300 |   |  | 1 | X | X |
| ?.UTL.ELE.M1.PHA.A | M1.PHA.A |   | X |   |   |   |   |   | TIME | 5 | 2300 |   |  | 1 | X | X |
| ?.UTL.ELE.M1.PHA.KW | M1.PHA.KW |   |  X |   |   |   |   |   | TIME | 5 | 2300 | kWh |  | 2 | X | X |
| ?.UTL.ELE.M1.PHB.V | M1.PHB.V |   | X |   | X |   |   |   | TIME | 5 | 2300 |   |  | 1 | X | X |
| ?.UTL.ELE.M1.PHB.A | M1.PHB.A |   | X |   |   |   |   |   | TIME | 5 | 2300 |   |  | 1 | X | X |
| ?.UTL.ELE.M1.PHB.KW | M1.PHB.KW |   | X |   |   |   |   |   | TIME | 5 | 2300 | kWh |  | 2 | X | X |
| ?.UTL.ELE.M1.PHC.V | M1.PHC.V |   | X |   | X |   |   |   | TIME | 5 | 2300 |   |  | 1 | X | X |
| ?.UTL.ELE.M1.PHC.A | M1.PHC.A |   | X |   |   |   |   |   | TIME | 5 | 2300 |   |  | 1 | X | X |
| ?.UTL.ELE.M1.PHC.KW | M1.PHC.KW |   |  X |   |   |   |   |   | TIME | 5 | 2300 | kWh |  | 2 | X | X |
| ?.UTL.ELE.M1.TOT.KW | M1.TOT.KW |   | X |   |   |   |   |   | TIME | 5 | 2300 | kWh |  | 3 | X | X |
| ?.UTL.ELE.M1.TOT.KWH | M1.TOT.KWH |   |   |   |   |   |   |   | TIME | 15 | 1000 |   |  |  | X | X |
| ?.UTL.ELE.M1.TOT.KVAR | M1.TOT.KVAR |   |   |   |   |   |   |   | TIME | 5 | 2300 |   |  | 3 | X | X |
| ?.UTL.ELE.M1.TOT.KVARH | M1.TOT.KVARH |   |   |   |   |   |   |   | TIME | 15 | 1000 | kVARH |  |  | X | X |
| ?.UTL.ELE.M1.TOT.KVA | M1.TOT.KVA |   |   |   |   |   |   |   | TIME | 5 | 2300 |   |  | 3 | X | X |
| ?.UTL.ELE.M1.TOT.KVAH | M1.TOT.KVAH |   |   |   |   |   |   |   | TIME | 15 | 1000 |   |  |  | X | X |
| ?.UTL.ELE.M1.TOT.PF | M1.TOT.PF |   |   |   | X  |   |   |   | TIME | 5 | 2300 |   |  | 3 | X | X |
|   |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |
| **Gas Mains** |   |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |
| ?.UTL.GAS.M1.USE | CONSUMPTION |   |   |   |   |   |   |   | TIME | 15 | 1000 | CCF |  |  | X | X |
|   | (Accumulate gas meter pulses) |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |
| ?.UTL.GAS.M1.DMD | 15 MIN USE |  | X |   |   |   |   |   | TIME  | 15 | 1000 | CCF  |  | 4 | X | X |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Water Mains** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ?.UTL.WTR.M1.TOT | CONSUMPTION |   |   |   |   |   |   |   | TIME | 15 | 1000 | MGAL |  |  | X | X |
|   | (Accumulate water meter pulses) |   |   |   |   |   |   |   |   |   |   |   |  |  |  |  |
| ?.UTL.WTR.M1.DMD | 15 MINUTE USE |  | X  |   |   |   |   |   | TIME | 15 | 1000 | GAL |  | 5 | X | X |

Note 1: Repeat the utility points indicated for each main feed

Note 2: Totalize as follows: Run hours to the 0.1 hour; kWh to the integer kWh; Gas to integer CCF

Note 3: Trend data shall be retained in field panel for the sample quantity indicated and backed up to server at a minimum on a daily basis.

**Trend Graph Descriptions**: Trend graphs shall display 7 days historical trend data Provide a link on the system or data table graphics.

Graph 1: Electric Phase Trends

Graph 2: Electric Phase Power

Graph 3: Electric Total Power

Graph 4: Gas Main Demand

Graph 5: Water Main Demand

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***NOTE TO SPECIFIER***

*The following are a typical point lists for a equipment/system monitoring. This may be edited depending on the type of systems and control sequences specified. Insert control and alarm setpoints according to USPS standards and as required for the project. Generally, the equipment abbreviations should match the design documents. Refer to the 15953 for point naming standards.*

***These point lists must be edited to fit the system design and balance cost with value gained***

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**Points List – Chilled Water Systems/ Chillers / Condenser Water/ Towers**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Unit** |   |  | **Alarm Data** | **Trend data** | **Graphic Display** | **EEMS** |
| Point ID ?= State, .Facility ID AB.CCCCCCCC | Description | ControlSP | HiAlarm | SP | LowAlarm | SP | StatusAlarm | SeeNote | Type | Freq. | Min.StorageNote 3 | TotalizeNote 2 | SystemDiagram | TrendGraph | Server Points | TrendArchive |
|  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ??.CHW.SYS.SWT | SUPPLY TEMP |  | X |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.CHW.SYS.RWT | RETURN TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.CHW.SYS.FLO | SYS FLOW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1, 2 | X | X |
| ??.CHW.SYS.TON | SYS TON |  |  |  |  |  |  |  | TIME | 5 | 2100 | KTon-Hrs |  | 1 | X | X |
| ??.CHW.SYS.TNHR | SYS PRODUCTION |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.CHW.SYS.TOT.KW | CHW SYS KW |  | X |  |  |  |  |  | TIME | 5 | 2100 | KWh |  | 1 | X | X |
| ??.CHW.SYS.TOT.KWH | CHW SYS KWH |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.CHW.SYS.PSI | SYS PRESSURE |  | X |  | X |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.CHW.SYS.PSD | SYS DIFF PRES |  | X |  | X |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.CHW.SYS.PSS | SYS PRES STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.CHW.CHP#.SS | START/STOP |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ??.CHW.CHP#.RT | RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 | Hours |  |  | X |  |
| ??.CHW.CHP#.PVO | VFD OUTPUT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ??.CHW.CHP#.SPD | SPEED % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.CHW.CHP#.KW | PUMP KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | kWh |  |  | X | X |
| ??.CHW.CHP#.KWH | PUMP ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.CHW.CHL#.SS | START/STOP |  |  |  |  |  |  |  | COV |  | 1000 |  |  |  | X |  |
| ??.CHW.CHL#.SWT | SUPPLY TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.CHW.CHL#.SWS | SUPPLY STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.CHW.CHL#.RWT | RETURN TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.CHW.CHL#.RT | RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 | Hours |  |  | X | X |
| ??.CHW.CHL#.KW | CHILLER KW |  | X |  |  |  |  |  | TIME | 5 | 2100 | kWh |  | 3 | X | X |
| ??.CHW.CHL#.KWH | CHILLER KWH |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.CHW.CHL#.SPD | SPEED % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ??.CHW.CHL#.FLO | SYS FLOW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.CHW.CHL#TON | SYS TON |  |  |  |  |  |  |  | TIME | 5 | 2100 | KTon-Hrs |  | 3 | X | X |
| ??.CHW.CHL#.TNHR | SYS PRODUCTION |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.CHW.CHL#.CST | COND SUP TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ??.CHW.CHL#.CRT | COND RTN TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ??.CDW.SYS.CST | COND SUP TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 4 | X |  |
| ??.CDW.SYS.CSS | COND SUP STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 4 | X |  |
| ??.CDW.SYS.CRT | COND RTN TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 4 | X |  |
| ??.CDW.SYS.BPV | BYPASS VALVE |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.CDW.SYS.TOT.KW | COND SYS KW |  | X |  |  |  |  |  | TIME | 5 | 2100 | KWh |  | 4 | X | X |
| ??.CDW.SYS.TOT.KWH | COND SYS KWH |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  | 4 | X | X |
| ??.CDW.CWP#.SS | START/STOP |  |  |  |  |  |  |  | COV |  | 200 | Hours |  |  | X |  |
| ??.CDW.CWP#.RT | RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.CDW.TWR#.FAN.SS | START/STOP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 4 | X |  |
| ??.CDW.TWR#.FAN.SPD | SPEED % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 4 | X | X |
| ??.CDW.TWR#.FAN.KW | FAN KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | kWh |  | 4 | X | X |
| ??.CDW.TWR#.FAN.KWH | FAN ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note 1: Repeat the utility points indicated for each main feed.

Note 2: Totalize as follows: Run hours to the 0.1 hour; kWh to the integer kWh; Ton-Hrs to the integer Ton-Hours

Note 3: Trend data shall be retained in field panel for the sample quantity indicated and backed up to server at a minimum on a daily basis.

**Trend Graph Descriptions**: Trend graphs shall display 7 days historical trend data Provide a link on the system or data table graphics.

Graph 1: System Operation

Graph 2: System Pumping

Graph 3: Chiller Operation

Graph 4: Condenser System Operation

**Points List – Hot Water Systems**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Unit** |   |  | **Alarm Data** | **Trend data** | **Graphic Display** | **EEMS** |
| Point ID ?= State, .Facility ID AB.CCCCCCCC | Description | ControlSP | HiAlarm | SP | LowAlarm | SP | StatusAlarm | SeeNote | Type | Freq. | Min.StorageNote 3 | TotalizeNote 2 | SystemDiagram | TrendGraph | Server Points | TrendArchive |
|  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ??.HHW.SYS.SWT.. | SUP WTR TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.HHW.SYS.SWS.. | SUP WTR STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.HHW.SYS.BPV.. | WTR MIX VALVE |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.HHW.SYS.RWT.. | RTN WTR TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.HHW.SYS.DT.. | WTR DT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.HHW.SYS.FLOW.. | WATER FLOW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X | X |
| ??.HHW.SYS.BTU.. | SYSTEM BTU |  |  |  |  |  |  |  | TIME | 5 | 2100 | MBTUH |  | 1 | X | X |
| ??.HHW.SYS.BTUH.. | SYSTEM BTUH |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.HHW.SYS.PSI | SYS PRESSURE |  | X |  | X |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.HHW.SYS.PSD | SYS DIFF PRES |  | X |  | X |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.HHW.SYS.PSS | SYS PRES STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.HHW.HWP#.SS.. | START/STOP |  |  |  |  |  |  |  | COV |  | 200 | HOURS |  |  | X |  |
| ??.HHW.HWP#.RT.. | RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.HHW.HWP#.PVO.. | VFD OUTPUT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.HHW.HWP#.SPD.. | SPEED % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.HHW.HWP#.KW.. | PUMP KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | kWh |  | 2 | X | X |
| ??.HHW.HWP#.KWH.. | PUMP ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.HHW.BLR#.STS.. | BLR# STATUS |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ??.HHW.BLR#.ALM.. | BLR# ALARM |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ??.HHW.BLR#.PMP.SS. | BLR# PUMP STAT |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note 1: Repeat the utility points indicated for each main feed.

Note 2: Totalize as follows: Run hours to the 0.1 hour; kWh to the integer kWh; BTUh to the 0.1 MBTUH

Note 3: Trend data shall be retained in field panel for the sample quantity indicated and backed up to server at a minimum on a daily basis.

**Trend Graph Descriptions**: Trend graphs shall display 7 days historical trend data Provide a link on the system or data table graphics.

Graph 1: System Temperatures: scale system BTU on secondary axis

Graph 2: System Operation combine all pumps on one graph.

Graph 3:

**Points List – VAV Air Handlers**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Unit** |   |  | **Alarm Data** | **Trend data** | **Graphic Display** | **EEMS** |
| Point ID ?= State, .Facility ID AB.CCCCCCCC | Description | ControlSP | HiAlarm | SP | LowAlarm | SP | StatusAlarm | SeeNote | Type | Freq. | Min.StorageNote 3 | TotalizeNote 2 | SystemDiagram | TrendGraph | Server Points | TrendArchive |
|  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ??.AH.AHU#.MODE | AHU MODE |  |  |  |  |  |  |  | COV |  | 300 |  |  | 1 | X |  |
| ??.AH.AHU#.RAT | RA TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.AH.AHU#.RAH | RA HUMIDITY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.AH.AHU#.RAE | RA ENTHALPY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.AH.AHU#.RAC | RA CO2 |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.AH.AHU#.RCF | RA CFM |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.AH.AHU#.RF.SS | R FAN STATUS |  |  |  |  |  |  |  | COV |  | 200 | HOURS |  |  | X |  |
| ??.AH.AHU#.RF.VDO | R FAN VFD CNTRL |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ??.AH.AHU#.RF.SPD | R FAN VFD % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.AH.AHU#.RF.KW | R FAN KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | KWH |  | 3 | X | X |
| ??.AH.AHU#.RF.KWH | R FAN ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.AH.AHU#.RF.RT | R FAN RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.AH.AHU#.RF.ALM | R FAN VFD ALARM |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ??.AH.AHU#.MAT | MIXED AIR TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1,2 | X | X |
| ??.AH.AHU#.MAS | MIXED AIR STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.AH.AHU#.MAD | MIXED AIR DMPR |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.AH.AHU#.LTD | LTD |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ??.AH.AHU#.FLT.DP | FLTR DIFF PRES |  | X |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.AH.AHU#.OAD | OA DMPR |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.AH.AHU#.OAF | OA FLOW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1,3 | X | X |
| ??.AH.AHU#.OAS | OA FLOW STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.AH.AHU#.OAT | OA TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.AH.AHU#.OAE | OA ENTHALPY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.AH.AHU#.HCV | HTG COIL VLV |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ??.AH.AHU#.CCV | CLG COIL VLV |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ??.AH.AHU#.SF.SS | S FAN STATUS |  |  |  |  |  |  |  | COV |  | 200 | HOURS |  |  | X |  |
| ??.AH.AHU#.SF.VDO | S FAN VFD CNTRL |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ??.AH.AHU#.SF.SPD | S FAN VFD % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.AH.AHU#.SF.KW | S FAN KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | KWH |  | 3 | X | X |
| ??.AH.AHU#.SF.KWH | S FAN ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.AH.AHU#.SF.RT | S FAN RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.AH.AHU#.SF.ALM | S FAN VFD ALARM |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ??.AH.AHU#.SAT | SUP AIR TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ??.AH.AHU#.SAS | SUP AIR STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ??.AH.AHU#.SAH | SUP AIR HUMIDT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.AH.AHU#.SAE | SUP AIR ENTH |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.AH.AHU#.SCF | SUP AIR CFM |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.AH.AHU#.SSP | SUP STATIC PRES |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.AH.AHU#.SSS | SUP STATIC STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ??.AH.AHU#.SSA | SUP STATIC ALARM |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.AH.AHU#.SDS | SUP DUCT STATIC |  |  |  |  |  |  |  | COV |  | 200 |  |  | 3 | X |  |
|  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALTERNATIVE POINTS - RELIEF/EXHAUST FANS |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ??.AH.AHU#.REF.SS | RLF FN STATUS |  |  |  |  |  |  |  | COV |  | 200 | HOURS |  |  | X |  |
| ??.AH.AHU#.REF.VDO | RLF FN VFD CNTRL |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.AH.AHU#.REF.SPD | RLF FN VFD % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X | X |
| ??.AH.AHU#.REF.KW | RLF FN KW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X | X |
| ??.AH.AHU#.REF.KWH | RLF FN ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.AH.AHU#.REF.RT | RLF FN RUN TIME |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X | X |
| ??.AH.AHU#.REF.ALM | RLF FN VFD ALRM |  |  |  |  |  | X |  | COV |  | 200 |  |  |  | X |  |
| ??.AH.AHU#.REF.DMPR | RELIEF DMPR |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note 1: AHU modes shall include all specified modes of system operation. (Occupied, Unoccupied, Warm-up, Economizer, etc.)

Note 2: Totalize as follows: Run hours to the 0.1 hour; kWh to the integer kWh;

Note 3: Trend data shall be retained in field panel for the sample quantity indicated and backed up to server at a minimum on a daily basis.

**Trend Graph Descriptions**: Trend graphs shall display 7 days historical trend data Provide a link on the system or data table graphics.

Graph 1: Mixed Air Operation

Graph 2: System Temperatures/ Valve control

Graph 3: System Airflow/ Power

**Points List – Single Zone Air Handlers**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Unit** |   |  | **Alarm Data** | **Trend data** | **Graphic Display** | **EEMS** |
| Point ID ?= State, .Facility ID AB.CCCCCCCC | Description | ControlSP | HiAlarm | SP | LowAlarm | SP | StatusAlarm | SeeNote | Type | Freq. | Min.StorageNote 3 | TotalizeNote 2 | SystemDiagram | TrendGraph | Server Points | TrendArchive |
|  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ?.AH.AHU#.MODE.. | AHU MODE |  |  |  |  |  |  |  | COV |  | 300 |  |  |  | X |  |
| ?.AH.AHU#.RAT.. | RA TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ?.AH.AHU#.RAH.. | RA HUMIDITY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ?.AH.AHU#.RAE.. | RA ENTHALPY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ?.AH.AHU#.MAT.. | MIXED AIR TEMP |  |  |  | X |  |  |  | TIME | 5 | 2100 |  |  | 1,2 | X | X |
| ?.AH.AHU#.MAS.. | MIXED AIR STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ?.AH.AHU#.MAD.. | MIXED AIR DMPR |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ?.AH.AHU#.LTD.. | LTD |  |  |  |  |  | X |  | COV |  | 200 |  |  |  | X |  |
| ?.AH.AHU#.FLT.DP. | FLTR DIFF PRES |  | X |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ?.AH.AHU#.OAD.. | OA DMPR |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ?.AH.AHU#.OAF.. | OA FLOW |  |  |  | X |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ?.AH.AHU#.OAS.. | OA FLOW STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ?.AH.AHU#.OAT.. | OA TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ?.AH.AHU#.OAE.. | OA ENTHALPY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ?.AH.AHU#.HCV.. | HTG COIL VLV |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ?.AH.AHU#.CCV.. | CLG COIL VLV |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ?.AH.AHU#.SF.SS. | S FAN STATUS |  |  |  |  |  |  |  | COV |  | 200 | HOURS |  |  | X |  |
| ?.AH.AHU#.SF.VDO. | S FAN VFD CNTRL |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ?.AH.AHU#.SF.SPD. | S FAN VFD % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ?.AH.AHU#.SF.KW. | S FAN KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | KWH |  | 3 | X | X |
| ?.AH.AHU#.SF.KWH. | S FAN ENERGY |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ?.AH.AHU#.SF.RT. | S FAN RUN TIME |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ?.AH.AHU#.SF.ALM. | S FAN VFD ALARM |  |  |  |  |  | X |  | COV |  | 200 |  |  |  | X |  |
| ?.AH.AHU#.SAT.. | SUP AIR TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ?.AH.AHU#.SAS.. | SUP AIR STPT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ?.AH.AHU#.SAH.. | SUP AIR HUMIDT |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ?.AH.AHU#.SAE.. | SUP AIR ENTH |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ?.AH.AHU#.RMT.. | ROOM TEMP |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X | X |
| ?.AH.AHU#.RMCS.. | ROOM CLG STPT |  |  |  | X |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ?.AH.AHU#.RMHS.. | ROOM HTG STPT |  | X |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X | X |
| ?.AH.AHU#.RMH.. | ROOM HUMIDITY |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ?.AH.AHU#.RMC.. | ROOM CO2 |  | X |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ..... |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ALTERNATIVE POINTS - RELIEF/EXHAUST FANS..... |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ?.AH.AHU#.REF.SS. | RLF FN STATUS |  |  |  |  |  |  |  | COV |  | 200 | HOURS |  |  | X |  |
| ?.AH.AHU#.REF.VDO. | RLF FN VFD CNTRL |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X |  |
| ?.AH.AHU#.REF.SPD. | RLF FN VFD % |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 3 | X | X |
| ?.AH.AHU#.REF.KW. | RLF FN KW |  |  |  |  |  |  |  | TIME | 5 | 2100 | KWH |  | 3 | X | X |
| ?.AH.AHU#.REF.KWH. | RLF FN ENERGY |  |  |  |  |  |  |  | TIME | 15 | 100 |  |  |  | X | X |
| ?.AH.AHU#.REF.RT. | RLF FN RUN TIME |  |  |  |  |  |  |  | TIME | 1 | 100 |  |  |  | X | X |
| ?.AH.AHU#.REF.ALM. | RLF FN VFD ALRM |  |  |  |  |  |  |  | COV |  | 200 |  |  |  | X |  |
| ?.AH.AHU#.REF.DMPR. | RELIEF DMPR |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note 1: System modes and status shall include all specified modes of system operation. (Cool, Heat, Auto, Off) (Cool, Heat, Off))

Note 2: Totalize as follows: Run hours to the 0.1 hour; kWh to the integer kWh;

Note 3: Trend data shall be retained in field panel for the sample quantity indicated and backed up to server at a minimum on a daily basis.

**Trend Graph Descriptions**: Trend graphs shall display 7 days historical trend data Provide a link on the system or data table graphics.

Graph 1: Mixed Air Operation

Graph 2: System Temperatures

Graph 3: System Power/Flows

**Points List – Lighting Control Systems**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Unit** |   |  | **Alarm Data** | **Trend data** | **Graphic Display** | **EEMS** |
| Point ID ?= State, .Facility ID AB.CCCCCCCC | Description | ControlSP | HiAlarm | SP | LowAlarm | SP | StatusAlarm | SeeNote | Type | Freq. | Min.StorageNote 3 | TotalizeNote 2 | SystemDiagram | TrendGraph | Server Points | TrendArchive |
|  |   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| ??.LTG.WRM.SYS.KW. | SYS DEMAND |  | X |  |  |  |  |  | TIME | 5 | 2100 | KWH |  | 1,3 | X | X |
| ??.LTG.WRM.SYS.KWH. | SYS CONSUMPTION |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  |  | X | X |
| ??.LTG.WRM.SYS.SLD. | SYS SHEDDABLE |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X |  |
| ??.LTG.WRM.SYS.SKW. | SYS SHED KW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1 | X | X |
| ??.LTG.WRM.SYS.SCMD. | SYS SHED CMD |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 1,3 | X | X |
| ??.LTG.WRM.Zn#.STAT. | ZN# STATUS |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  |  | X |  |
| ??.LTG.WRM.Zn#.KW. | ZN# DEMAND |  |  |  |  |  |  |  | TIME | 5 | 2100 | KWH |  | 2,3 | X | X |
| ??.LTG.WRM.Zn#.KWH. | ZN# CONSUMPTION |  |  |  |  |  |  |  | TIME | 15 | 1000 |  |  | 2 | X | X |
| ??.LTG.WRM.Zn#.SLD. | ZN# SHEDDABLE |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.LTG.WRM.Zn#.SKW. | ZN# SHED KW |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
| ??.LTG.WRM.Zn#.SCMD. | ZN# SHED CMD |  |  |  |  |  |  |  | TIME | 5 | 2100 |  |  | 2 | X |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 | X |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

Note 1: Repeat the zone points for the number of zones in the systems.

Note 2: Totalize as follows: Run hours to the 0.1 hour; kWh to the integer kWh;

Note 3: Trend data shall be retained in field panel for the sample quantity indicated and backed up to server at a minimum on a daily basis.

**Trend Graph Descriptions**: Trend graphs shall display 7 days historical trend data Provide a link on the system or data table graphics.

Graph 1: System Operation Trends

Graph 2: Zone Operation Trends

Graph 3: Demand Graph: maximum 10 trends per graph; scale to make zone kW readable. Repeat system kW on each graph secondary axis.

END OF SECTION

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