

Design and Construction Standards

Division 25 Integrated Automation

General

In general, follow the guidelines below when designing, specifying and installing Electronic Safety and Security. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.

The intent of this section is to define the Integration of the Facility Management and Control Systems. This system will allow for a consistent graphical display of control menu and functionality regardless of the control system vendor at each Eastern Michigan University (EMU) facility.

Additionally all pertinent energy consumption data will be metered and transmitted to the EMU Virtual Wide Area Network for use in monitoring and energy reducing strategies.

Section 25 00 00 Integrated Automation Facility Control

1. Reference associated divisions 22, 23, 26, 27, or others controlled with Integrated Automation.
2. SUMMARY
 - a. This section describes the Systems Integration scope of work for the project. This section also coordinates the responsibilities of the Mechanical and Electrical trade contractors pertaining to control products or systems, furnished by each trade, that will be integrated by this Division
 - b. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the EMU.
 - c. It is the EMU's goal to implement an open system that will allow products from various suppliers to be integrated into a unified system in order to provide flexibility for expansion, maintenance, and service of the system. EMU shall be the named license holder of all software associated with any and all incremental work on the project(s).
3. SYSTEM DESCRIPTION
 - a. The FMCS shall be comprised of Java Application Control Engine or Controllers (JACE) within each facility. The JACE shall connect to the EMU's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each JACE is capable

communicate to LonMark/LonTalk (IDC) and/or BACnet (IBC) controllers and other open and legacy protocol systems/devices provided under Division 15900 Temperature Control System.

- b. The FMCS shall be based on the Niagara^{AX} Framework (or “Niagara^{AX}”), a Java-based framework developed by Tridium. Niagara^{AX} provides an open automation infrastructure that integrates diverse systems and devices (regardless of manufacturer, communication standard or software) into a unified platform that can be easily managed in real time over the Internet using a standard Web browser. Systems not developed on the Niagara^{AX} Framework platform are unacceptable.

4. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products and services by one of the following:
 - i. Tridium Vykon
 - ii. Other Owner Approved Equal

5. SUBMITTAL

- a. Eight copies of shop drawings of the entire FMCS shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.
- b. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol. Though the Division 15900 contractors shall provide these diagrams for their portions of work, the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Virtual Local Area Network (VLAN).
- c. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or EMU.
- d. Upon completion of the work, provide a complete set of ‘as-built’ drawings and application software on compact disk. Drawings shall be provided as AutoCADTM or VisioTM compatible files. Eight copies of the ‘as-built’ drawings shall be provided in addition to the documents on compact disk. Division 15900 and 16000 contractors shall provide as-builts for their portions of work. The Division 17000 contractor shall be responsible for as-builts pertaining to overall FMCS architecture and network diagrams. All as built drawings shall also be installed into the FMCS server in a dedicated directory.

6. SPECIFICATION NOMENCLATURE
- a. Acronyms used in this specification are as follows:
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| EMU | Eastern Michigan University |
| FMCS | Facility Management and Control System |
| TCS | Temperature Control System |
| JACE | Java Application Control Engine |
| IDC | Interoperable Digital Controller |
| IBC | Interoperable BACnet Controller |
| GUI | Graphical User Interface |
| WBI | Web Browser Interface |
| POT | Portable Operator's Terminal |
| PMI | Power Measurement Interface |
| DDC | Direct Digital Controls |
| LAN | Local Area Network |
| WAN | Wide Area Network |
| OOT | Object Oriented Technology |
| PICS | Product Interoperability Compliance Statement |
7. DIVISION OF WORK
- a. The Division 22 & 23 contractors shall be responsible for all new controllers (IDC & IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.
- b. The Division 25 contractor shall be responsible for the Java Application Control Engine(s) (JACE), software and programming of the JACE, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the JACE to the local or wide area network.
- c. The Division 25 contractor shall integrate the Modbus electrical meters as supplied by the Division 26 & 27 contractors.
8. RELATED WORK SPECIFIED ELSEWHERE
- a. Division 22 (Plumbing) & 23 (HVAC) Temperature Control:
- i. Providing control devices and systems including but not limited to:
1. Interoperable Digital Controllers and programming
 2. Interoperable BACnet Controllers and programming
 3. Control panels, devices and wiring
 4. Local controller and control device networks
- ii. Division 26 (Electrical) & 27(Communications):
1. Provide and install electrical meter with Modbus protocol after each large electrical feed to the facility.
 2. Interoperable Modbus Devices and programming
 3. Local device networks
 4. Other equipment and wiring as specified in Division 26 & 27.
9. AGENCY AND CODE APPROVALS

- a. All products of the FMCS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
 - i. UL-916; Energy Management Systems
 - ii. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 “signal Equipment”
 - iii. CE
 - iv. FCC, Part 15, Subpart J, Class A Computing Devices
10. **SOFTWARE LICENSE AGREEMENT**
- a. Software licensing for the JACE or Supervisor shall give the EMU the capability to control their system and determine which contractors can bid and engineer their system.
 - b. It shall be possible to insure the EMU can prevent unauthorized partners from accessing the system for engineering changes.
 - c. Software licensing shall have the freedom to individually manage authorized parties and independent parties.
 - d. The software licensing shall have no restrictions on which brand of JACE, Supervisor or System Programming tools can interact with the system. Station Compatibility must = ALL and Tool Compatibility must = ALL.
 - e. The EMU shall accept the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to EMU as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

Section 25 10 00 & 25 30 00 Integrated Automation Network and Equipment

1. **MATERIALS**
 - a. All commutation with head and equipment are to minimize the amount of network resources used.
 - b. All wiring shall be in accordance with the NEC and all other applicable codes.
 - c. The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices and other devices as specified herein.
 - d. The installed system shall provide secure password access to all features, functions and data contained in the overall FMCS.
2. **OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES**
 - a. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate OBIX (XML), OPC, SNMP, Lon works, BACnet IP, BACnet MSTP, Modbus TCP/IP or Modbus RTU communication protocols in one open, interoperable system.

- b. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file and a resource file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified. For each Modbus device supplier must provide a Registry of data points available on the system.
 - c. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.
 - d. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
 - e. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
 - i. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
 - ii. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.
3. NETWORKS
- a. The Virtual Local Area Network (VLAN) shall be a 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Java Application Control Engines (JACEs), user workstations and, if specified, a local server. The VLAN will be managed by the EMU Facilities Information Management department. The EMU Facilities Information Management department will control the access to the FMCS residing at each facility.
 - b. Local area network minimum physical and media access requirements:
 - i. Ethernet; IEEE standard 802.3
 - ii. Cable; 100 Base-T, UTP-8 wire, category 5
 - iii. Minimum throughput; 100 Mbps.

4. NETWORK ACCESS
 - a. Remote Access.
 - i. For Local Area Network installations, provide access to the VLAN from a remote location, via the Internet. The EMU Facilities Information Management department shall provide a connection to the Internet to enable this access via high speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer's Intranet to a corporate server providing access to an Internet Service Provider (ISP). Customer agrees to pay monthly access charges for connection and ISP. The EMU Facilities Information Management department shall provide client software to the users they wish to have access to the VLAN.
5. JAVA APPLICATION CONTROL ENGINE (JACE)
 - a. The Division 25 contractor shall supply one or more Java Application Control Engines (JACE) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided under Divisions 22, 23, 26 & 27. It is the responsibility of the Division 25 contractor to coordinate with the Division 22, 23, 26 & 27 contractors to determine the quantity and type of devices.
 - b. The Java Application Control Engine (JACE) shall provide the interface between the VLAN and the field control devices, and provide global supervisory control functions over the control devices connected to the JACE. It shall be capable of executing application control programs to provide:
 - i. Calendar functions
 - ii. Scheduling
 - iii. Trending
 - iv. Alarm monitoring and routing
 - v. Time synchronization
 - vi. Integration of LonWorks controller data and BACnet controller data
 - vii. Network Management functions for all LonWorks based devices
 - c. The Java Application Control Engine must provide the following hardware features as a minimum:
 - i. One Ethernet Port – 10/100 Mbps
 - ii. One RS-232 port
 - iii. One LonWorks Interface Port – 78KB FTT-10A
 - iv. One RS-485 ports
 - v. Battery Backup
 - vi. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 - vii. The JACE must be capable of operation over a temperature range of 32 to 122°F
 - viii. The JACE must be capable of withstanding storage temperatures of between 0 and 158°F

- ix. The JACE must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
- d. The JACE shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the JACE shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.
- e. The JACE shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.
- f. Event Alarm Notification and actions
 - i. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - ii. The JACE shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
 - iii. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - 1. To alarm
 - 2. Return to normal
 - 3. To fault
 - iv. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
 - v. Provide timed (schedule) routing of alarms by class, object, group, or node.
 - vi. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- g. Control equipment and network failures shall be treated as alarms and annunciated.
- h. Alarms shall be annunciated in any of the following manners as defined by the user:
 - i. Screen message text
 - ii. Email of the complete alarm message to multiple recipients.
Provide the ability to route and email alarms based on:
 - 1. Day of week
 - 2. Time of day
 - 3. Recipient
 - iii. Pagers via paging services that initiate a page on receipt of email message
 - iv. Graphic with flashing alarm object(s)
 - v. Printed message, routed directly to a dedicated alarm printer
- i. The following shall be recorded by the JACE for each alarm (at a minimum):
 - i. Time and date

- ii. Location (building, floor, zone, office number, etc.)
 - iii. Equipment (air handler #, accessway, etc.)
 - iv. Acknowledge time, date, and user who issued acknowledgement.
 - v. Number of occurrences since last acknowledgement.
 - j. Alarm actions may be initiated by user defined programmable objects created for that purpose.
 - k. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
 - l. A log of all alarms shall be maintained by the JACE and/or a server (if configured in the system) and shall be available for review by the user.
 - m. Provide a “query” feature to allow review of specific alarms by user defined parameters.
 - n. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
 - o. An Error Log to record invalid property changes or commands shall be provided and available for review by the user
6. Data Collection and Storage
- a. The JACE shall have the ability to collect data for any property of any object and store this data for future use.
 - b. The data collection shall be performed by log objects, resident in the JACE that shall have, at a minimum, the following configurable properties:
 - i. Designating the log as interval or deviation.
 - ii. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
 - iii. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
 - iv. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
 - v. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
 - c. All log data shall be stored in a relational database in the JACE and the data shall be accessed from a server (if the system is so configured) or a standard Web browser.
 - d. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
 - e. All log data shall be available to the user in the following data formats:
 - i. HTML
 - ii. XML
 - iii. Plain Text
 - iv. Comma or tab separated values
 - f. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

- d. The Web browser client shall support at a minimum, the following functions:
- i. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
 - ii. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
 - iii. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
 - iv. Storage of the graphical screens shall be in the Java Application Control Engine (JACE), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
 - v. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
 - vi. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 1. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
 - a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
 - b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
 2. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
 3. View logs and charts
 4. View and acknowledge alarms
 5. Setup and execute SQL queries on log and archive information
 - vii. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
 - viii. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by

specifying the Uniform Resource Locator (URL) for the desired link.

10. SYSTEM PROGRAMMING

- a. The Graphical Development Tool (GDT) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GDT shall be through password access as assigned by the system administrator.
- b. The GDT shall be available in two versions; a thick-client version licensed to the computing platform on which it is installed and a thin-client version, capable of providing the complete set of engineering functions through a standard Web Browser. Programming and development tools not capable of providing all engineering and application development functions with a standard Web Browser are not acceptable.
- c. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and user interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide “real-time” data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.
- d. Programming Methods
 - i. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user’s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.
 - ii. Configuration of each object will be done through the object’s property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
 - iii. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow

the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

- iv. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.
- v. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

11. OBJECT LIBRARIES

- a. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
- b. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
- c. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.
- d. All control objects shall conform to the control objects specified in the BACnet specification.
- e. The library shall include applications or objects for the following functions, at a minimum:
 - i. Scheduling Object. The schedule must conform to the schedule object as defined in the BACnet specification, providing 7-day plus holiday & temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on-off events.
 - ii. Calendar Object. . The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
 - iii. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals
 - iv. Temperature Override Object. Provide a temperature override object that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) to maintain occupant comfort or for equipment freeze protection.

- v. Start-Stop Time Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start / stop time object properties based on the previous day's performance.
- vi. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.
- f. The library shall include control objects for the following functions. All control objects shall conform to the objects as specified in the BACnet specification.
 - i. Analog Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
 - ii. Analog Output Object - Minimum requirement is to comply with the BACnet standard for data sharing.
 - iii. Binary Input Object - Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment run-time by counting the amount of time the hardware input is in an "on" condition. The

- user must be able to specify either input condition as the “on” condition.
- iv. Binary Output Object - Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as interstart delay must be provided. The BACnet Command Prioritization priority scheme shall be incorporated to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide sixteen levels of priority as a minimum. Systems not employing the BACnet method of contention resolution shall not be acceptable.
 - v. PID Control Loop Object - Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable as well as to be disabled to allow proportional control only, or proportional with integral control, as well as proportional, integral and derivative control.
 - vi. Comparison Object - Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
 - vii. Math Object - Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
 - viii. Custom Programming Objects - Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including math and logic functions, string manipulation, and e-mail as a minimum. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for re-use.
 - ix. Interlock Object - Provide an interlock object that provides a means of coordination of objects within a piece of equipment such as an Air Handler or other similar types of equipment. An example is to link the return fan to the supply fan such that when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects

- within the air handler unit are inhibited from alarming thereby eliminating nuisance alarms during the off period.
- x. Temperature Override Object - Provide an object whose purpose is to provide the capability of overriding a binary output to an “On” state in the event a user specified high or low limit value is exceeded. This object is to be linked to the desired binary output object as well as to an analog object for temperature monitoring, to cause the override to be enabled. This object will execute a Start command at the Temperature Override level of start/stop command priority unless changed by the user.
 - xi. Composite Object - Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering, or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the “contained” application that are represented on the graphical shell of this container.
- g. The object library shall include objects to support the integration of devices connected to the Java Application Control Engine (JACE). At a minimum, provide the following as part of the standard library included with the programming software:
- i. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.
 - ii. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file, resource file and documentation for the device to facilitate device integration.
 - iii. For BACnet devices, provide the following objects at a minimum:
 - 1. Analog In
 - 2. Analog Out
 - 3. Analog Value
 - 4. Binary
 - 5. Binary In
 - 6. Binary Out
 - 7. Binary Value
 - 8. Multi-State In
 - 9. Multi-State Out
 - 10. Multi-State Value
 - 11. Schedule Export

12. Calendar Export
 13. Trend Export
 14. Device
 - iv. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
 - v. For BACnet devices, provide the following support at a minimum
 1. Segmentation
 2. Segmented Request
 3. Segmented Response
 4. Application Services
 5. Read Property
 6. Read Property Multiple
 7. Write Property
 8. Write Property Multiple
 9. Confirmed Event Notification
 10. Unconfirmed Event Notification
 11. Acknowledge Alarm
 12. Get Alarm Summary
 13. Who-has
 14. I-have
 15. Who-is
 16. I-am
 17. Subscribe COV
 18. Confirmed COV notification
 19. Unconfirmed COV notification
 20. Media Types
 21. Ethernet
 22. BACnet IP Annex J
 23. MSTP
 24. BACnet Broadcast Management Device (BBMD) function
 25. Routing
12. Lon Works NETWORK MANAGEMENT
- a. The Graphical User Interface software (GUI) shall provide a complete set of integrated Lon works network management tools for working with Lon works networks. These tools shall manage a database for all Lon Works devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between Lon Works devices, known as “binding”. Systems requiring the use of third party Lon Works network management tools shall not be accepted.
 - b. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.
 - c. The network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

- d. These tools shall provide the ability to “learn” an existing Lon Works network, regardless of what network management tool(s) were used to install the existing network, so that existing Lon Works devices and newly added devices are part of a single network management database.
 - e. The network management database shall be resident in the Java Application Control Engine (JACE), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.
13. MODBUS SYSTEM DEVICES
- a. The Java Application Control Engine shall support the integration of device data from Modbus RTU, ASCII, or TCP control system devices. The connection to the Modbus system shall be via an RS-232, RS485, or Ethernet IP as required by the device.
 - b. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the Modbus system data into the FPMS. Objects provided shall include at a minimum:
 - i. Read/Write Modbus AI Registers
 - ii. Read/Write Modbus AO Registers
 - iii. Read/Write Modbus BI Registers
 - iv. Read/Write Modbus BO Registers
 - c. All scheduling, alarming, logging and global supervisory control functions, of the Modbus system devices, shall be performed by the Java Application Control Engine.
 - d. The FMCS supplier shall provide a Modbus system communications driver. The equipment system vendor that provided the equipment utilizing Modbus shall provide documentation of the system’s Modbus interface and shall provide factory support at no charge during system commissioning.
14. LEGACY SYSTEM INTEGRATION
- a. The Java Application Control Engine shall support the integration of device data from the existing control system. The connection to the existing system shall be via an RS-232 or RS-485 connection between the Java Application Control Engine and the existing control system.
 - b. The EMU, and/or the existing control system representative shall ensure that the existing system’s database is setup to make all data to be integrated into the FMCS available at the RS-232 or RS-465 port. Any modifications to the existing system database to accomplish this shall be the responsibility of the EMU.
 - c. Provide the required objects in the library, included with the Graphical User Interface programming software, to support the integration of the existing system data into the FMCS. Objects provided shall include at a minimum:
 - i. LEGACY SYSTEM Generic AI Object
 - ii. LEGACY SYSTEM Generic AO Object

- iii. LEGACY SYSTEM Generic BO Object
 - iv. LEGACY SYSTEM Generic BI Object
 - d. All scheduling, alarming, logging and global supervisory control functions (demand limiting, etc.), of the existing system devices, shall be performed by the Java Application Control Engine. Integration of the existing system's schedules, alarms, logs, etc. is neither required nor desired.
 - e. The FMCS supplier shall provide a legacy system communications driver. The EMU shall provide documentation of the existing system's protocol to facilitate the development of this driver. Costs for the development of the driver are to be arranged between the EMU and the FMCS supplier and are not included as part of this contract.
15. GRAPHICAL USER INTERFACE COMPUTER HARDWARE (DESKTOP) in Maintenance Office
- a. The browser workstation shall be compatible with the current EMU Physical Plant computer/network system as specified by the Physical Plant.
 - i. As of the date of author, minimum system requirements are:
 - 1. Intel Pentium based computer (minimum processing speed of 2.4 GHz with 1.0 GB RAM and a 100-gigabyte minimum hard drive). It shall include a DVD-ROM/CD-RW Combination Drive, 2-parallel ports, 2-asynchronous serial ports and 2-USB ports. A minimum 17" flat panel color monitor, 1280 x 1024 optimal preset resolution, 25 ms response time, shall also be included.
 - 2. Connection to the FMCS network shall be via an Ethernet network interface card, 10 Mbps.
16. INSTALLATION
- a. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.
 - b. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
 - c. Drawings of FMCS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.
 - d. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Temperature Control sub-contractor in accordance with the specifications in Divisions 15900 and 16000.
17. WIRING

- a. All electrical control wiring and power wiring to the JACE, computers and network components shall be the responsibility of the Div 16000 Electrical contractor.
 - b. The electrical contractor (Div. 16000) shall furnish all power wiring to JACE, computer.
 - c. All wiring shall be in accordance with the Project Electrical Specifications (Division 16000), the National Electrical Code and any applicable local codes. All FMCS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 16000) unless otherwise allowed by the National Electrical Code or applicable local codes. Where FMCS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.
18. WARRANTY
- a. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.
 - b. Within this period, upon notice by the EMU, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Division 25 contractor at no expense to the EMU.
19. WARRANTY ACCESS
- a. EMU shall grant to the Division 25 contractor, reasonable access to the FMCS during the warranty period. The EMU shall allow the contractor to access the FMCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.
20. ACCEPTANCE TESTING
- a. Upon completion of the installation, the Division 25 contractor shall load all system software and start-up the system. The Division 22 & 23 contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications. The Division 22 & 23 and 25 contractors are to coordinate the checkout of the system such that each Division has a representative present during system checkout.
 - b. The Division 22 & 23 contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation. The Division 25 contractor shall have a representative present during system checkout by the Division 22 & 23 contractor.
 - c. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of EMU's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the EMU's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

- d. System Acceptance: Satisfactory completion is when the Division 22, 23, 25, 26, and 27 contractors have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the EMU's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.
21. OPERATOR INSTRUCTION, TRAINING
- a. During system commissioning and at such time acceptable performance of the FMCS hardware and software has been established the Temperature Control sub-contractor shall provide on-site operator instruction to the EMU's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.
 - b. The Division 25 contractor shall provide 40 hours of instruction to the EMU's designated personnel on the operation of the FMCS and describe its intended use with respect to the programmed functions specified. Operator orientation of the FMCS shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
 - c. The training shall be in three sessions as follows:
 - i. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the EMUs' personnel can start to familiarize themselves with the system before classroom instruction begins.
 - ii. First Follow-Up Training: Two days (16 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
 - iii. Warranty Follow Up: Two days (16 hours total) in no less than 4 hour increments, to be scheduled at the request of the EMU during the one year warranty period. These sessions shall cover topics as requested by the EMU such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

End of Division 25 - Integrated Automation