Section 260913

Electrical Power Monitoring System (EPMS)

PART 1 – GENERAL

A.   SCOPE

A. Contractor shall provide an Electrical Power Monitoring System (EPMS) for all the power equipment as well as other monitoring systems that provide Electrical, HVAC and life/safety functions for a facility/campus operation, critical site operation or process operation as indicated on the drawings.

B.   RELATED SECTIONS

A. Section [261116] – Secondary Unit Substations
B. Section [261213] – Medium Voltage Transformers
C. Section [261216] – Dry Type Medium Voltage Transformers
D. Section [261219] – Pad Mount Transformers
E. Section [261323] – MV Metal Enclosed Switchgear
F. Section [261326] – MV Metal Clad Switchgear
G. Section [262300] – Low Voltage Switchgear
H. Section [262313] – Paralleling LV Switchgear
I.   Section [262413] – Switchboards
J. Section [262416] – Panelboards
K. Section [262419] – LV Motor Control Centers
L. Section [262600] – Power Distribution Units
M. Section [262923] – Variable Frequency Motor Controllers
N. Section [263213] – Engine Generators
O. Section [263353] – Static Uninterruptible Power Supply
P. Section [263600] – Transfer Switches
Q. Section [264313] – LV Surge Protection

C.   REFERENCES

A. The EPMS shall comply with the applicable portions of ANSI/IEEE 802.3 and NEMA standards. In addition, the master control unit shall comply with FCC Emission Standards specified in Part 15, Subpart J for Class A application.

D.   SUBMITTALS – FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer:

1. System description including an overview of the system provided with detailed description of system architecture. A customized system diagram showing location of computers, repeaters, gateways and

assemblies/devices to be connected to the system, as well as types of wiring required (twisted pair, coax, fiber), and a general layout of wiring referencing the specific building/facility layout shall also be part of this description.

2. Bill of material including a complete listing of all hardware, software, training, software configuration, and startup services being supplied under this contract.

3. Hardware and software description shall be provided in detail for all communications hardware, software, including sensor devices and gathering data to be transmitted over the network, and master display unit. This description will include a list of all the communicating devices to be connected to the network. Typical software screen displays shall be provided in printout form and/or on disk.

4. Detailed One-Line diagrams depicting the EPMS connectivity for the Web-Server, Data Acquisition Devices, monitored equipment and sensors.

5. Standard/Optional Software Dashboard(s).

6. Detailed points list for each device, sensor or other system listing each data point to be acquired and monitored by the EPMS. 3rd Party OEM's to provide a data register list for the intelligent devices in their equipment to the EPMS vendor upon request.

7. System testing and commissioning description.

8. Training syllabus for on-site training of end-users.

B. The Proposal shall include a compliance review of the specification and any other related documentation. Notations utilizing C for Compliance, D for compliance with deviation and E for Exception shall be listed beside each paragraph of the specification.

E.   SUBMITTALS – FOR INFORMATION

A. The Contractor shall provide a submittal for information to include a detailed listing of customer required actions, with timetable, to insure trouble-free startup of the EPMS. This information shall include any equipment access requirement, office requirements and manpower requirements. This submittal shall include the projected system startup time-line, including training dates. In addition, a proposed detailed wiring specification in compliance with these plans and specifications shall be included. The communication wiring specification shall include proposed communication cable, including general cable ratings, communication characteristics, cable routing proposed, termination requirements, and splicing/connections proposed to be made.

F.   SUBMITTALS – FOR CONSTRUCTION

A. Final submittal data shall include a systems operation manual which includes all the information required by Section 1.04.

B. In addition, the systems operation manual shall include the following information:

1. A system description overview, descriptive bulletins and/or sales aids covering all components in the system

2. A maintenance section including all instruction leaflets and technical data necessary to set up, change setup parameters and maintain the communicating devices and sensors

C. An original licensed copy of all software manuals shall be included.

D. A section on communication wiring which includes:

1. Type of communication wire utilized

2. General cable ratings and communications characteristics

3. Cable routing diagram including terminations and splicing connections made

E. A detailed startup report, including a list of trained customer personnel shall be provided.

G. QUALIFICATIONS

A. The manufacturer of the equipment shall have been regularly engaged in the manufacture of the specified remote devices for a period of at least fifteen (15) years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications. The manufacturer shall have at least fifteen (15) years demonstrated capability in EPMS design, installation and startup.

B. The manufacturer shall submit a list of existing operating installations.

C. The manufacturer shall have a cybersecurity evaluation program that has been certified by UL under UL2900.

D. Vendor shall publish cybersecurity notifications and known vulnerabilities for the latest version of software.

E. Vendor shall have an established cybersecurity issue ("bug") reporting program in support of adhering to cybersecurity industry best practices.

H. REGULATORY REQUIREMENTS

I. DELIVERY, STORAGE & HANDLING

J. FIELD MEASUREMENTS

K. OPERATION AND MAINTENANCE MANUAL

PART 2- PRODUCTS

2.01   MANUFACTURERS

    A.   Eaton Foreseer Software

    B.   _____

    C.   _____

2.02   SYSTEM DESCRIPTION

    A.   Provide an Integrated EPMS for the power equipment as well as other monitoring systems that provide Electrical, HVAC and life/safety functions for a facility/campus operation, critical site operation or process operation as indicated on the drawings.

    B.   The EPMS shall be comprised of Web-Server software for dynamic graphical representation, managing data input/output and storage and sub-set/sub-function user-access. Data Acquisition Devices for acquiring data from monitored equipment, sensors, instrumentation and other site management/monitoring system and various communication /conversion devices for transmitting data and providing connectivity for the overall system.

    C.   Examples of equipment, sensors, instrumentation, meters and other systems monitored by the EPMS:

        1.   Power - Uninterruptible Power Supplies, Power Distribution Units, Static Transfer Switches, Branch Circuit Monitoring, Generators, Switchgear, Switchboards, Automatic Transfer Switches, Utility Input Power, Power Quality/Quantity Instrumentation, Protective Relays, Breaker Trip Units, and Meters, etc.

        2.   Other Systems - Leak Detection, Fire Detection/Suppression, Battery Monitoring, Fuel Management, Building Management, Security Systems etc.

    D.   Data Acquisition/Control: Where ever possible, data acquisition shall be obtained through direct TCP/IP or serial network interface to equipment, instrumentation and other systems monitored to provide requirements for software connectivity and provide proprietary or open protocol information and other documentation necessary to allow the EPMS supplier to develop a communication interface in order to acquire data from their equipment or system to the EPMS. Communication ports required shall utilize TCP/IP, RS-232C, RS-422, RS-485 as required. Other forms of data acquisition shall be analog (4-20ma, 0-5VDC etc.) for all measured values and digital (dry contact etc.) for all alarm and status readings.

E. EPMS Connectivity: The EPMS shall be completely Web enabled for connectivity to the Network. Network access shall be available through standard web browsers. The Web-Server connectivity to the data acquisition devices shall be through LAN/WAN TCP/IP, HTML, serial RS-485/422/232.

F. The EPMS is based on a Web-Server architecture and shall acquire data directly from power and environmental equipment, sensors and other monitoring systems. The data shall be compared to pre-established alarm thresholds and, if outside of parameters, the system shall alert appropriate personnel in an automated process. The system shall supply software tools to assist in rapid response to events as well as proactive management of the installed site(s). These tools shall include real-time data display, multiple alarm notification capabilities, automated and queried data analysis routines from an on-line database and automated reports. All of these capabilities shall be accessible through an intuitive graphical user interface designed as a native 64-bit, MS-Windows Web based application which provides a representation of the site or sites' global location, building plan and floor plans, location of monitored equipment within those floor plans and an easy to use navigation system within those representations. Customer to provide floor and site plans to EPMS vendor in .dwg format or incorporation in graphic screens. Also, dynamic one-line diagrams of equipment shall be available to provide system views such as power distribution when supported by device communication or dry contact input as shown on the drawings. A semi-custom dashboard providing an overview of the sites overall status will be included. Custom dashboards to manage critical items such as Utility Outage Management and Power Capacity shall be available.

G. The EPMS shall provide complete flexibility as to the system architecture. At a minimum the following configurations must be supported:

   1. Single Site: Configured as a local site system with the Web-Server deployed at an individual site. The data is accessed and stored at the local level. Configuration represents graphical views and access to all data on this Server. System will allow for multiple browser connections for on- or off-site personnel.

   2. Multiple Sites: Configured as a local Web-Server site system with Servers deployed at each individual site where the data is access and stored. Web-Server configuration is expanded to provide access to any Server on the network or via Internet with proper authorization. Once connected, the individual site servers shall have complete functionality with any Server on the system. Data Acquisition Devices may be deployed at smaller sites to transmit data to any Server on the network.

   3. Enterprise System / Enterprise Server: The EPMS shall be configured with a single Web-Server cable of supporting up to 500,000 inputs located at a command center receiving data from multiple remote locations without Servers. This architecture will provide for data access from Data Acquisition Devices located throughout the enterprise via TCP/IP intranet or internet. Data is accessed by these devices and forwarded to the

Enterprise Server located at the command center where it is managed and stored. The Web-Server can be configured to display the entire enterprise, regions with appropriate sites or individual sites depending on the user requirements.

4. Enterprise System / Manager of Mangers: The EPMS shall be configured as a distributive system with Servers deployed at remote sites for local data access and storage. The Enterprise Server at the command center shall be able to receive data and alarms from the remote Servers so that information is accessed, managed and stored at both the local sites and the command center. This configuration will allow for hot redundancy of the Enterprise Server so that there will be no interruption of operation when multiple Enterprise Servers are utilized. When using multiple servers, they shall automatically synchronize all alarm thresholds/properties so that a change on the primary server is reflected on the redundant server without user intervention.

5. All system configurations listed above shall support sub-set/sub-function availability at the web user level to both internal and external customers for the purpose of monitoring, data analysis and alarm management within the sub-set or sub-function responsibility.

2.03   WEB / SERVER / CLIENT HARDWARE

A. The Web-Server hardware shall be designed for real-time, dedicated monitoring on a 24 hour, seven days per week basis. Web-Server shall auto-reboot upon power loss and restore with all applicable programs initiated without user intervention. The Web-Server shall run as a service.

B. Server Class Machine Configurations:

1. Low-End Configuration (<100 Devices):
    i. (1) Intel Xeon E-2124 3.3GHz, 8M cache, 4C/4T, turbo (71W)
    ii. (1) 16GB 2666MT/s DDR4 ECC UDIMM
    iii. (1) 2TB 7.2K RPM SATA 6Gbps 3.5in Cabled Hard Drive
    iv. (2) Gigabit Ethernet ports, on motherboard
    v. (1) 290W power supply

2. Typical Configuration (100-300 Devices)::
    i. (1) Intel Xeon E-2174G 3.8GHz, 8M cache, 4C/8T, turbo (71W)
    ii. (2) 8GB 2666MT/s DDR4 ECC UDIMM
    iii. (2) 1TB 7.2K RPM SATA 6Gbps 512n 3.5in Hot-plug Hard Drive
    iv. RAID 1
    v. Intel Ethernet I350 Dual Port 1GbE BASE-T Adapter, PCIe Low Profile

3. High-End Configuration (>300+ Devices):
    i. (2) Intel Xeon Silver 4110 2.1G, 8C/16T, 9.6GT/s, 11M Cache, Turbo, HT (85W) DDR4-2400
    ii. Dual, Hot Plug, Redundant Power Supply (1+1), 550W
    iii. (2) 16GB RDIMM, 2666MT/s, Dual Rank
    iv. (2) 1TB 7.2K RPM SATA 6Gbps 512n 3.5in Hot-plug Hard Drive
    v. RAID 1
    vi. Intel Ethernet I350 Dual Port 1GbE BASE-T Adapter, PCIe Low Profile

C. Client Workstation:
1. Intel Xeon E-2224G, 4 Core, 8MB Cache, 3.5 Ghz, 4.7Ghz Turbo w/UHD Graphics 630
2. Dell Precision Tower 3630 Heatsink (80)
3. Windows 10 Pro for Workstation (up to 4 Cores) Multi-English, French, Spanish
4. Radeon Pro WX 7100, 8GB, 4 DP
5. Precision 3630 Tower with 460W up to 90% efficient PSU (80Plus Gold) with SD card reader v2
6. 8GB 2x4GB 2666MHz DDR4 non-ECC Memory
7. 3.5" 500GB 7200rpm SATA Hard Disk Drive

2.04   ANCILLIARY DEVICES

A. The EPMS vendor shall offer a variety of Data Acquisition products in order to acquire, convert and route the data from monitored equipment, sensors and other instrumentation to the appropriate Server. All or part of the following materials must be available as components of the final system configuration depending upon the specific equipment monitored,   sensors installed, and data acquisition network:

1. Serial Converters:

   a. 4-wire RS232-485 converters: Full Duplex, 64 KBPS, 110 VAC input power, 4000-foot maximum transmission distance.

   b. 2-wire RS232-485 converters: Half Duplex, 115200 Baud max., 1500 Vrms max. common voltage, 110 VAC input power, 4000 ft max transmission distance.

   c. RS232-422 converters: Full Duplex, 34.8 KBPS, DTE/DCE select, terminator select, 110 VAC input power, 4000-foot maximum transmission distance.

2. Serial to Ethernet multiplexers: 100bT Ethernet to 1,4 ,8,16 or 32 port serial connectors, RS232/RS422/RS485 selectable output.

3. Cable: Serial Data Acquisition Network cabling shall be shielded twisted 2-Pair, 22 AWG, 7 /30 strand or equivalent. IP Cable shall be CAT5e or greater. Cabling to be installed consistent with the latest version of TD17513 Eaton Electrical Field Devices Communication Wiring Specification Application Notes.

4. Data Acquisition Networked Device: Dual 10/100 Base-T Ethernet Ports. Data access for up to 5,000 data points of any mix of analog and digital. This device shall have no moving parts and will self-configure in the event of replacement. This device shall support all Device Drivers listed in Appendix A for direct data acquisition from equipment.

5. Remote I/O Device: Shall be modular in design to accept from 4 to 40 analog and/or 16 to 80 digital inputs in a single enclosure. Communication output is ModbusTCP utilizing 10Base-T Ethernet, individually IP addressable.

6. Sequence of Event Recorder: Up to 32 digital inputs per module with the ability to time and date stamp events to 1 ms. Communication is ModbusTCP utilizing 10Base-T Ethernet, individually IP addressable. Time synchronization accomplished between SER units supported by IRIG-B, NTP or PTP.

7. Network time server that provides PTP, NTP and IRIG-B synchronization signal to devices capable of receiving timing signals. Cabling from time server to remote devices receiving time signals by installing contractor.

2.05   NETWORKS/COMMUNICATIONS

A. Data Acquisition Network: The System shall gather data from all monitored equipment and Data Acquisition Devices via a serial RS-232/422/485, TCP/IP or HTML network. The data acquisition network configuration shall be designed to maximize data throughput at the fastest rate possible. Each network leg into the Server(s) can be individually configured to poll for measured values such as voltage, current, flow, frequency, temperature, status and time intervals in addition to a variety of other equipment readings.

1. The configuration of each network leg into the Server(s) is via "Device Drivers". Device Drivers provide a high-level communications link between the Server(s) and the monitored equipment and other systems. Device Drivers shall be available for connected devices, including ones using proprietary protocols or open protocols such as Modbus, BACnet, OPC or SNMP.

2. The Server will allow mass configuration of at least up to 15 devices at a time including network settings, IP addresses as well as device configuration details.

3. The Server data acquisition network shall be configurable with any mix of fiber, CAT5e and twisted paired cables needed to optimize the facility's device integration.

4. Networking options shall be available for high-speed data collection with transmission speeds ranging from 9.6 to 1Gbps Baud.

5. Server(s) shall poll their device-input channels for current data and alarm status. The scan rate shall accommodate the manufacturer's maximum data output specifications for each piece of equipment being monitored.

6. The Server data acquisition network shall be designed with a high degree of flexibility to meet immediate connectivity requirements as well as expansion demanded by future growth.

7. The Server data acquisition network architecture shall allow the user to temporarily   disable a single data collection node for the purpose of adding sensors, without   disrupting normal data acquisition.

8. The communications between the Data Acquisition Devices as described in 2.04.A. 5-11 and the Server(s) shall be accomplished through direct serial connection, TCP/IP or HTML.

9. Server to have the capability to expose real time data to 3rd party systems via a NIC utilizing either Modbus TCP/IP, BACnet I/P, or OPC. EPMS vendor to supply a data register map to 3rd parties so that 3rd party can issue read commands as needed.

10. Deployed in environments requiring compliance to the NIST Cybersecurity Framework, NIST SP800-53, NIST SP800-82, IEC 62443, and other cybersecurity standards.

2.06   WEB-SERVER SOFTWARE – BASIC FUNCTIONALITY

A. The Web-Server software shall be a native 64-bit, MS-Windows application developed specifically for the use in the PEMS system.

B. All customized aspects of the Web-Server, including alarm channel assignments and alarm set   points shall be configurable and modifiable from the Web-Server without the need for programming skills. These modifications shall not require the system to be taken off-line.

C. The Web-Server shall poll all Data Acquisition Devices and monitored equipment for current values, change of state and alarm status.

D. Data input capacity of the Server shall be scalable to accommodate from 32 data points up to 500,000 on a single Server. Each server shall accommodate up to 5000 device addresses. Should more than 5000 devices be installed on a given LAN/WAN, then the use of a Manager of Manager architecture or the use of Data Acquisition Engines may be employed.

E. The Web-Server must be capable of acquiring and displaying data up to once every 200ms, depending on the network architecture, and scan rate supported by the equipment's device driver.

F. The Web-Server continually checks all channels for user defined alarm conditions, automatically reporting any excursions.

G. The Web-Server shall allow the user to define channel descriptions, units, true/false messages and other properties such as hysteresis and scaling. All settings are available to the user also via a Web Browser thin client.

H. Any Web-Server shall be capable of interfacing with any signal from any support system or sensor including all analog, digital and documented Device Drivers listed in Appendix A.

I. The web-Server shall be supplied with the latest version of Windows Server operating system.

J. The Web-Server shall be capable of directly receiving data from equipment or Data Acquisition Devices from remote locations.

K. The Web-Server shall be capable of being configured as an Enterprise Server and receive Data from other Servers or from Data Acquisition Networked Devices.

L. The Web-Server must support a wide array of mathematical, transcendental and conditional functions that allow users to create derived or calculated data based on actual data points from monitored equipment or sensors. Examples of derived channels include rate of   change, if/then comparisons, energy efficiency calculations, power capacity scenarios etc.

M. Derived channels from the Enterprise Server shall be able to link to derived channels from remote Servers in order to expand the creation of information through shared data from   other Servers related to the operation of the entire enterprise. These channels must be created dynamically without taking the system off-line.

N. There shall be no distance limitation between any remote site and a Web-Server.

O. The Web-Server shall have the ability to archive data to an online database.

   1. Digital channels shall archive each change of state.
   2. Analog data archiving selections shall include user-selected options of minimum, maximum, average and first or last values.
   3. The minimum rate at which average data shall be archived to the database shall   be one   minute for each analog data channel.
   4. All data channels from all devices shall be archived.
   5. The Server(s) shall be capable of supporting a minimum of three (3) years of   historical   data on an on-line database.
   6. The Web-Server shall support user installed Windows SQL database as an on-line database in lieu of the standard database shipped with the Web-Server.

P. The Web-Server shall have the ability to integrate with the latest version of MS SQL Server database for on-line data storage. The database shall be able to be stored offline through other storage devices attached to the local area network.

Q. The Web-Server(s) shall support an automatic back-up feature. Archived data may be transferred to a user defined networked back-up device.

R. The user may select back-up times for the Web-Server, which will then occur automatically.

2.07   WEB-SERVER SOFTWARE – USER INTERFACE FUNCTIONALITY

A. Web-Server software shall be available as both a native 64-bit, MS-Windows application capable of running also in 64-bit environments and a Web based

browser application providing a professional graphical user interface designed to support all of the Web-Server functions detailed in this specification. It shall have the flexibility to allow each user to display information based on their personal preference.

B. The Web-Server shall be designed with a multi-level hierarchy with a "drill down" features offering a global view of the site(s), building floor plans from CAD files, graphical renderings of monitored equipment, data displays depicting real time operating detail and   data for each individual data point.

C. The Web-Server shall be able to display the information from multiple sites / Servers.

D. Full authentication and authorization for web-based viewing of data available from the Web-Server must be supported using HTTPS protocol, TLS 1.2 and OpenSSL 1.1.1.

E. The Web-Server password structure shall permit administrators to determine if a user will be allowed to manage alarms, access reports, change Server(s) functionality, change control parameters and modify views.

F. The user interface shall support internationalization and localization for left-to-right written languages. The software shall support the ability to change the displayed language at any time without having to log in or out of the session. A user shall be able to add additional translations to support custom text.

G. The Web-Server User Interface shall support Dashboards, floor plans, one-line diagrams and equipment views.

    1. The Web-Server User Interface shall include a semi-custom dashboard providing the user with an overview of the critical elements of each facility or location.

    2. The Web-Server User Interface shall be capable of configuring and displaying customized floor plans, equipment diagrams, equipment views, and one-line diagrams. These graphical views shall be easily modified.

    3. The Web-Server User Interface shall provide on-line tools so that animated, dynamic one-line diagrams and floor plans may be developed. For example, animation includes change of color to represent changes in power flow or open/close position reflects change in a circuit breaker.

    4. The User Interface visual displays shall depict the layout of the site, critical support equipment, and sensors. The views can be updated and modified to accommodate changes and growth.

    5. Equipment and sensors shall be geographically and realistically represented and located on floor plans, based on user supplied CAD .dwg files.

6. The equipment views shall represent the current real-time value for all channels and the alarm condition of the associated channel.

7. The Web-Server User Interface shall support Flash animation and AVI files to enhance the dynamic appearance of the appropriate views.

G. Alarm Management: The Web-Server software shall provide the means to easily Identify problems and provide on-line information for users to resolve existing and potential failures.

1. The Web-Server shall include a stop light color scheme (green, yellow, and red) for easy identification of alarm conditions. Equipment icons within floor plan views of the Web-Server software shall also support the above stop light color scheme.

2. Each analog channel shall be measured against four alarm limits (hi-hi, hi, lo and lo-lo) configurable at the Web-Server. Green shall indicate normal state, yellow shall Indicate a hi or lo level alarm, and red shall indicate a hi-hi or lo-lo level alarm. Blue shall indicate an acknowledged alarm condition; purple will indicate a device manually disabled condition and gray will indicate a loss of communication.

3. Operator alarm response instructions shall be configurable for each alarm threshold of every channel.

4. Alarm Management shall be capable of enhanced user fields for alarm notification, filtering, grouping and sorting.

5. An Alarm Management screen shall display the server name, time of the alarm, the alarm priority, the   alarm value, the current value, device name, device type, location and group. Each active alarm shall be automatically prioritized based on a numeric value assigned by the user. Alarms may be sorted by their attributes in ascending or descending order. Alarm filters shall be available to allow the user to select specific alarms or groups of alarms to display on the Alarm Management screen.

6. Alarm Management Profiles shall save preferred filter, column sorting and column display settings. Each user shall be able to save multiple profiles and define their default.

7. The Alarm Management screen shall provide a search capability.

8. Alarm Group Name properties shall be set or changed for multiple devices from a CSV file format.

9. The Alarm Management screen shall be accessible with a mouse click or single keystroke from any level of the system software.

10. A specific Alarm Information screen shall display the individual alarm, alarm level (yellow/red); time of occurrence, value or status that caused alarm, current value or status and user message. The user message must support up to 256 characters.

11. From the Alarm Information screen, the alarm may be acknowledged or re-armed.

12. Alarm processing shall be able to be disabled for any data channel without affecting the real time data acquisition or archiving function.

13. It shall be possible to acknowledge and re-arm active alarms in either the Alarm Management or the Alarm Information Screen. It shall be possible to select multiple alarms for acknowledgment and rearming from the Alarm Management Screen. The Web-Server shall provide alarm notification when minimized and when the user is utilizing another software application. This notification will automatically appear to inform the user of the presence of an alarm.

14. The EPMS system shall be capable of supporting data acquisition hardware to time stamp events and alarms from monitored equipment through-out the site from 1msec-1 second.

15. Alarm Notification Popup shall be definable by alarm priority.

16. Audible Alarm Notification she be definable by alarm priority. A user preferred alarm sound can be uploaded in MP3 or WAV file format.

H. Message Management: The system shall include an independent messaging system that allows the user to define a list of message destinations, i.e. emails, paging telephone numbers, and SNMP traps to be sent in the event that an alarm condition occurs. Message Management shall be available from the Web-Server or other installation location.

1. The Message Management shall support automatic message escalation such that the paging will automatically escalate through a pre-defined user hierarchy until an alarm is acknowledged.

2. The system shall support alpha/numeric paging and the industry standard TAP paging protocol to ensure compatibility with any paging system. Alpha paging shall support unique and explicit alarm messages for up to 256 characters and up to four levels of messages for every monitored point.

3. If e-mail is utilized, the system shall support Microsoft Windows Messaging. Message Management uses the default Profile to send Windows Messages to the user defined service.

4. All alarm messaging shall be automatic with user defined unanswered message times prior to automatic sending of the next message on the list. Automatic escalation shall be provided such that messaging continues until an alarm is acknowledged.

5. Each of the channels shall accommodate an independent list such that the personnel or service vendors responsible for the alarmed equipment/area shall be promptly notified of the event. Each system shall be capable of supporting a unique list for any combination of channels.

6. Each system shall support a minimum of ten addresses/numbers for each monitored point.

7. Each entry on the list shall have the option to select different message destinations based on the time of the day.

8. There shall be a simple mouse click method to automatically remove an individual from a phone book as temporarily unavailable, regardless of the number of call lists that   person appears on.

9. The Message Management will support Simple Network Management Protocol (SNMP) trap functionality.

10. The system shall support a Command Line Interface feature for any alarm event to be sent to an external Management System(s) in order to provide enterprise-wide notification of critical events.

11. Message Management will provide a default feature to allow users to establish alarm operation as described above one channel. This channel will serve as the default for all other devices and channels without the need for setting up each individual channel.

12. Message Management shall be capable of sending an alarm notification in the case of a loss of connectivity to the server alerting the user to the possibility that the server or server hardware may be non-functional.

I. Custom Applications: The system can accommodate the development of custom applications.

1. Scheduled Maintenance dashboard application for presetting scheduled maintenance windows to disarm selected devices that maintenance will be performed on. Disarmed devices allow continued monitoring and archiving while disabling alarms unnecessarily notifying personnel.

2. Brach Circuit Monitoring application shall have a graphical user interface for depicting the panel and including breaker sizes, number of poles per breaker, and breaker load assignments.

J. Data Analysis: The system shall include online data analysis for real time and historical review for all data points monitored.

1. The default time period for graphing data shall be 24 hours.

2. Each Web-Server shall be able to select any point to graph against any other point from any connected Server. Web-Server software shall support up to 20 different traces in any graph window simultaneously and from any Server(s) without requiring the user to predefine any combination.

3. Both analog and digital data traces shall be simultaneously supported.

4. Each Web-Server shall be able to graph data from any monitored point by simply pointing and clicking on a data value or group of values. Graphing shall be available via context sensitive "right mouse click" functions. The historical data can be graphed at the Web-Server within

the total time frame of the database (1-5 years), determined by the user with a maximum interval of 180 days on any one graph.

5. The X-axis time frame shall be user alterable from one minute to 180 days and shall be configurable from an easy to use menu displaying a beginning date calendar and an ending data calendar for setting the time period.

6. The time interval shall be easily selected through a calendar menu at the Web-Server. No programming, construction of data tables, or exporting of data from the Server(s) to other graph programs shall be required.

7. The Y-axis scale for any analog channel shall be user modifiable to optimize visual resolution. In addition, the Y-axis function shall support an auto-scale capability.

8. The Web-Server shall support the ability to "step through" each data point comprising any graph to see the value, date and time, which is plotted for that point. The Functionality shall be accessible via tool bars or pull-down menus.

9. Standard statistical information such as mean, median, range, standard deviation and trend shall be available on-line, for any analog data graph desired by the user and displayed simultaneously for each trace displayed.

10. Through either a menu selection or a point and drag mouse function, any graph shall support an instant zoom in or zoom out feature to allow users to expand or reduce the time frame.

11. The established alarm limits for any channel on a graph shall be displayed upon user request.

12. The Web-Server shall also provide the ability to graphically plot data in real time as it is received from the Server(s).

13. In addition to graphing historical data, the Web-Server shall be able to project analog graphs to the number of days graphed for the historical data based on the trend of the data. The Web-Server shall have the ability to display the intersect between the future data trend for the primary trace and the alarm limits. The graph will also display the date and time of a potential alarm excursion.

14. The Web-Server shall have the ability to project analog data 180 days ahead based on historical data analysis and enable the user to set threshold alarm points for potential future events and overlaps.

15. The Web-Server shall be able to access data from Servers at different locations and conduct all of the functionality listed in this section.

16. The Web-Server shall be able to save any user defined graphing configuration including x and y axis settings as well as multiple channel displays in both a relative and fixed time frame.

K. Reports: The Web-Server shall provide the following automated reports:

1. Alarm report for one, seven and thirty days. These reports will show time of occurrence, time of alarm acknowledgment, time of alarm rearm by data point. Alarm reports can be selected based on time interval, specific data points, specific equipment or any combination.

2. Custom alarm report supporting user entered time frame and monitored device selection.

3. Notes report for one, seven, and, thirty days date and time stamped for all notes entered by the user.

4. Custom notes report supporting user entered time frame and monitored device selection.

5. System diagnostic reports and Up/Down Log.

6. Audit Report which logs any changes to the system by user, date and time.

7. Channel Report which lists all of the data channels configured on the system.

8. Channel Data Report list the min/max/average readings for a user specified time period.

L. The software shall have full editing capabilities to allow the user to edit the views, add data points and change any other aspect of the Web-Server display without interruption to the monitoring function.

M. The Web based editor shall provide top line editing so that what the user displays in the edit mode is what will appear on the Web-Server view.

N. The Web-Server software shall require authentication and authorization based on archived directory, domain services or both in order to allow editing. Editing rights shall be granted based on specified functions such as channel creation, alarm set-up, graphic, etc.

O. The Web-Server shall provide for dynamic data updates which means data is updated upon any change in value/status. Manual updating will not be accepted.

P. The Web-Server shall support SSL for security with 128-bit encryption.

Q. The Web-Server shall provide an extensive power quality analysis and display capability when connected to the equipment / instrumentation listed in Appendix A, 12 "Power Quality".

R. Power quality display shall consist of the follow functions when supported by devices monitored:

1. Real time and historical wave form capture with simultaneous display of voltage and current for all phases.

2. Real time and historical harmonic display to the 127th level.

3. Real time and historical THD display.

4. Real time Phasor display.

5. Automate display of wave form upon an event or user defined trigger.

6. Sag/swell display over user defined trigger or event.

S. The Web-Server shall be capable of user defined graphs and reports based on accessing data from any Server on the system both actual and derived in order to expand the informational displays of the systems. Once defined this information shall be displayed as part of the on-line graphical interface. Examples include:

1. Power Balance: Display showing real time and historical amperage levels at any electrical device.

2. Power Capacity: Display showing real time and historical kVA usage by device as compared to the rated capacity. This allows for planning future growth or need to add equipment.

3. Power Density: Display showing square footage of an area or entire floor and calculating kVA usage verses capacity as watts per square foot.

4. Energy Allocation: Display showing historical energy usage by room, department or floor in order to determine energy consumption.

5. Maintenance Scheduler: Displays equipment by type or location based on pre-defined recurring or periodic maintenance schedules. The System will automatically disarm alarms during maintenance but will continue to monitor data, show which equipment is being serviced and when it returns to normal state.

T. The system, through the creation of derived channels, shall allow the end user to create these views as well as any other informational displays that can be defined through user defined and standard mathematical equations or comparative logic.

U. The system administrator shall have access to a tree view at the web user interface level to perform the following functions without direct access to the Web-Server.

1. Create new Web Pages anywhere in the hierarchy.

2. Add new derived channels to any device.

3. Reboot the Web-Server application.

4. Reboot the Web-Server Operating System.

5. Start and stop the Database archiving.

6. Backup the Web-Server configuration.

7. Backup/restore the Web user interface configuration.

8. Manage alarms.

9. Run reports.

10. Implement changes to device properties.

11. Enable/disable devices.

12. Capture snapshots of communications between the Web-Server and any monitored device for the purpose of integration troubleshooting. This snapshot capability must be available from the Web-Server or the Web User Interface.

2.08   REPORTING SOFTWARE FUNCTIONALITY

A. Displays a complete utility bill for master tenants with tenant locations. Master tenants without tenant locations will not be included in this report. Each master tenant page will contain content identical to the other tenant billing report, however each master tenant page can be followed by tenant locations. Pages being output will depend on parameters selected when generating the report. Tenant locations will have sections for reporting consumption and/or peak demand meter readings, and a detail section displaying a detailed line item for each type of charge that is being distributed to the tenant location. Specifically designed to be exported to Excel for easy calculation or many other formats such as XML, CSV, PDF, MHTML, TIFF or Word.

B. Displays a complete Capacity summary report is a measure (expressed as a percent) of how often a device operates during a specific period time using a ratio of the actual output to the maximum possible output during that time-period. To generate a capacity report of a device, the major focus areas should be the unit of the channels (should be Amperes) and the rating field value. The Capacity summary report, primarily gives top 5 utilization and bottom 5 utilization and Circuit utilization by hierarchy Folder and attribute in detail Specifically designed to be exported to Excel for easy calculation or many other formats such as XML, CSV, PDF, MHTML, TIFF or Word.

C. Compares consumption of electrical energy for IT and non-IT activities. Calculates DCiE and PUE at both a detailed and summary level. Reports on consumption, DCiE, PUE, temperature and humidity.

D. Displays consumption (kWh) summarized by the overall selected time-period. This report has collapsed summary line items complete with miniature graph, total consumption and maximum consumption for the sub-period. These collapsed line items can be expanded to display the detail data that each summary is based on. Specifically designed to be exported to Excel for easy calculation or many other formats such as XML, CSV, PDF, MHTML, TIFF or Word.

E. Shows consumption (kWh) and demand (kW) for a selected time-period. Demand costs can be specified as well. Available units include cubic-feet, pounds-mass, us gallons, volt-amperes, volt-amperes reactive, or watts.

F. Generate standard Joint Commission compliance report to support hospital testing requirements. The report shall include all required and critical generator and automatic transfer switch (ATS) metrics. Generator and ATS pairings shall be listed with a summary of current and historical test result. Specifically designed to be exported to Excel for easy calculation or many other formats such as XML, CSV, PDF, MHTML, TIFF or Word.

G. Reveal where energy is being consumed and support ASHRAE 90.1 and LEED compliance reporting requirements. Dedicated and shared loads, either directly metered or estimated, shall be defined into custom groups and then reported at the building, load group and tenant levels. Report shall include total energy consumption, peak and average wattage, voltage and current for various sub-periods (hourly, daily, weekly, monthly, quarterly, annually). Specifically designed to be exported to Excel for easy calculation or many other formats such as XML, CSV, PDF, MHTML, TIFF or Word.

H. Custom Reports capability to create custom reports from derived channels.

I. Reports shall be configurable to automatically generate and then email or save to a storage location.

2.09 FABRICATION

A. All global monitoring equipment) shall be fully assembled at the Seller's facility prior to   delivery to the field.

B. The Web-Server software shall be fully configured in accordance with the contract drawing in the Seller facility prior to delivery to the field.

C. The Web-Server software shall be fully configured at the Seller facility. All global, floor plan and equipment views shall be complete with all links to the Server(s) established.

D. The minimum Web-Server configuration shall include the following:

1. One Global view showing all monitored sites.

2. One Semi-Custom Dashboard for each monitored site.

3. One Site view for each site displaying local monitoring by area/region.

4. One Floor Plan and/or one-line diagram from Buyer supplied Cad Files.

5. Equipment Views for all devices monitored through Device Drivers.

6. Software rendering of Data Panels for all digital and analog inputs.

7. System Channel / Server Health Report listing all channels configured and status of the Server operation.

2.10 SHOP QUALITY CONTROL

A. The Web-Server shall be built and fully verified at the Seller's facility prior to delivery to the field.

B. All Device Drivers, whether open or proprietary, shall be verified to match the output   revision level of all equipment to be monitored at any   particular site prior to shipment.

2.11   COMMUNICATIONS AND INTERFACE

A. Cybersecurity

a. The EPMS shall follow cybersecurity best practices to reduce risk to people, assets and processes.

b. The EPMS cybersecurity software shall be approved through an evaluation program that has been certified by UL under UL2900.

c. The EPMS vendor shall provide cybersecurity guidelines and recommendations on how to harden the EPMS installation.

d. EPMS Vendor shall optionally apply all cybersecurity guidelines and recommendations as applicable to the user's environment.

e. The EPMS software shall be cryptographic code signed to provide integrity and authenticity of the platform.

f. The EPMS shall use TLS 1.2 or higher for SQL Server connection and web server support.

g. The EPMS shall use OpenSSL 1.1.1 with TLS 1.3 support, or higher.

h. The EPMS shall utilize Apache 2.4.41 or newer and Python version 3.8 or newer to addresses known security issues.

PART 3- EXECUTION

3.01   PREPARATION

A. Prior to the Seller's installation, all locations for equipment specified in this document to be deployed at a site must be selected and 90% installation drawings completed and submitted to the Buyer.

B. The Seller shall provide a project manager which will conduct an on-site "Kick-Off" meeting to review the system and its' configuration for the Buyer and/or his contractor. Review of the scope of work and a site walk-through shall be performed. The project manager will provide continued management throughout the installation process and final Buyer acceptance

C. Buyer/Buyer's Contractor shall provide 110VAC power to all equipment as shown on the Seller's contract drawings.

D. UPS power is required for the Server(s) as well as all the Data Acquisition Devices and converters listed in this specification section.

E. All equipment specified in this specification section shall be shipped to a location specified by the Buyer for installation by the Buyer or his contractor.

F. Seller shall manage and coordinate system delivery with all subcontractors, including the Buyer/Buyer's Contractor and manages the subcontractor's installation process.

G. All wiring as specified on the contract drawings shall be run by the Buyer or his contractor to the equipment specified in this specification section.

H. All Data Acquisition Network cabling shall be shielded 2/4-Pair, 22AWG, CAT5/6 or fiber depending upon installation drawings.

I. All Data Acquisition Network cables shall be installed in protected locations or in dedicated conduits where exposed.

J. The Seller shall edit and manage revisions of all documentation and process all change orders.

K. All wire terminations as specified on the contract drawings shall be made by the Buyer or the installing contractor to the equipment specified in this specification section unless otherwise arranged with the Seller.

L. The Seller shall verify all equipment that shall be monitored to confirm interface compliance to this specification section.

3.02   INSTALLATION

A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of Specification Section [260913] and Drawings.

B. Examine equipment exterior and interior prior to installation. Report any damage and do not install any equipment that is structurally, moisture, or mildew damaged.

C. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

D. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

E. Install equipment in accordance with reviewed product data, final shop drawings, manufacturer's written instructions and recommendations, and as indicated on the Drawings.

F. Functional testing, commissioning, and first parameter adjusting shall be carried out by a factory trained manufacturer's representative field service engineer. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment. Report to the Engineer any discrepancies or issues with the installation.

G. Provide final protection and maintain conditions in a manner acceptable to the manufacturer that shall help ensure that the equipment is without damage at time of Substantial Completion.

3.03 SYSTEM COMMISSIONING

A. Factory-trained personnel shall perform on-site commissioning using automated commissioning tools to improve consistency and quality of commissioning.

B. Central engineering resources in conjunction with onsite factory trained personnel shall be involved in preparing a client's system for startup.

C. A trained and certified project manager shall be provided during project installation and commissioning.

D. Commissioning shall include a detailed scope of work checklist document with delivered functionality listed and checked.

E. The EPMS solution shall be fully tested in a test-bed environment with hardware devices representative of a large scale functional power distribution system (including both physical and simulated devices) such as advanced power quality meters, low voltage main meters, low voltage feeder meters, circuit breaker trip units, transformer monitoring units, protective relays, branch circuit power meters, etc. Documented test results including system response times, network performance, and recommended network architectures shall be published and provided upon request.

F. Commissioning shall include a full working demonstration of the system under normal operating conditions and simulated scenarios.

G. For control applications such as automatic transfer, commissioning shall include a thorough verification of the approved sequence of operation in both manual and automatic modes. Testing of source outage and breaker exercising shall be included in test procedures.

H. For control applications, such as automatic transfer, source interruptions are necessary. The owner must schedule appropriate times for such commissioning and must plan for time (typically a day) for system pre-testing and a day for acceptance testing. Weekends are preferred due to minimized impact on operations.

3.04 DEMONSTRATION

A. The Seller shall conduct full commissioning of the installed system after installation is complete and Buyer accepts system.

B. Verifying all channels for proper readings for first of kind hardware types to verify device driver compatibility.

C. Performing any Server(s) software edits or channel updates.

D. Overview of Server(s) operation with Buyer or his agent.

3.05   TRAINING

A.   The EPMS system supplier shall perform an introductory two-day training session for the Buyer and/or his agents on the system and installed Web-Server software. At a minimum, subjects will include all aspects of the Web-Server operation such as navigation, alarm management, message management, data graphing and analysis etc., editing functions for the Web-Server, how to add data points and/or equipment to the monitoring system, data back-up routines, report generation and operation via the Internet. Training to take place during standard business hours over two consecutive days.

B.   Training manuals shall be provided for each student and include an agenda, defined objectives for each lesson, a detailed description of the subject matter for each lesson, and descriptive labs to complete the hands-on exercises.

C.   Training content shall cover the following as a minimum:

a.   The function and operation of the EPMS system and software.

b.   The definition and use of various system data (such as energy, demand, power factor, load profile, time of use, KYZ, etc.)

c.   The system architecture and communication methods of the EPMS system

d.   The function and operation of electric meters

D.   Training sessions shall be provided as follows:

a.   Self-paced on demand training on energy management, metering infrastructure, and power quality.

b.   At project site, hands-on training using power monitoring equipment involving hardware and relevant software to train the Owner to implement operate and maintain the power monitoring system.

c.   Video recording services to coincide with custom client onsite training with professional postproduction services providing the customer with a polished training DVD custom to training on the client system.

d.   Instructor led remote web-based training wherein the user has real time interaction with trainer and gets hands on training using virtual servers to performs labs and exercises.

e.   At EPMS system supplier's facility, hands on training on how to design, implement, and operate power monitoring system.

E.   The Seller shall perform an introductory two-day training session for the Buyer and/or his agents on the system and installed Web-Server software. At a minimum, subjects will include all aspects of the Web-Server operation such as navigation, alarm management, message management, data graphing and analysis etc., editing functions for the Web-Server, how to add data points and/or equipment to the monitoring system, data back-up routines, report generation and operation via the Internet. Training to take place during standard business hours over two consecutive days.

F. Advanced training provided by the system manufacturer must be available as an option to be conducted based on a pre-approved syllabus by the Buyer.

3.06 SUPPORT

a. EPMS vendor shall provide remote technical phone support.

b. EPMS vendor shall offer on-site emergency response contracts.

c. EPMS vendor shall provide updates under contract for the current version of software.

d. EPMS vendor shall provide optional on-site preventative maintenance and hardware inspection. The system log files, system reports, and database will be reviewed, and software patches and updates applied. Vendor shall provide system status report to user.

e. EPMS vendor shall provide optional hands-on refresher training during on-site inspections.

END OF SECTION