

SECTION 260913 – ENERGY METERING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL SYSTEM DESCRIPTION

- A. Furnish and install a complete and functioning Energy and Power Management System (EPMS) as detailed on the drawings and described in this specification. The system shall be dedicated to energy metering; consisting of energy meters, flow meters, remote devices, network gateways, inter-communication wiring, software and ancillary equipment. All meters and instrumentation shall be dedicated to and directly connected to the metering system network. The system shall be designed, manufactured and marketed solely for the purposes of energy metering and monitoring; adaptation of HVAC control systems for energy metering shall be expressly prohibited.

1.3 SUMMARY

- A. Section includes the following for metering of energy consuming systems:
 - 1. Energy Metering System Software.
 - 2. Communication network and interface modules for RS-485 Modbus RTU and IEE 802.3 data transmission protocols between energy meters and head end software.
 - 3. Energy Metering Network Gateways
 - 4. Meter Network Data Transmission And Lan Cables
- B. Related Sections:
 - 1. Section 220519 "Meters And Gages For Plumbing Systems" for metering equipment/instrumentation in domestic water systems.
 - 2. Section 230519 "Meters And Gages For Hvac/Mechanical Systems" for metering equipment/instrumentation in chilled water, heating water & steam systems.
 - 3. Section 260519 "Low-Voltage Electrical Power Conductors And Cables".
 - 4. Section 260523 "Control-Voltage Electrical Power Cables".
 - 5. Section 262713 "Electricity Meters" for electrical power system meters.
 - 6. Section 271513 "Communications Copper Horizontal Cabling"

1.4 DEFINITIONS

- A. Ethernet: Local area network based on IEEE 802.3 standards.

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- B. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- C. HTML: Hypertext markup language.
- D. I/O: Input/output.
- E. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of energy that is based on a relay changing status in response to the rotation of the disk in the meter.
- F. LAN: Local area network; sometimes plural as "LANs."
- G. LCD: Liquid crystal display.
- H. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.
- I. Modbus RTU: An open protocol for exchange of process data.
- J. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- K. PC: Personal computer; sometimes plural as "PCs."
- L. rms: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.
- M. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
- N. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
- O. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- P. THD: Total harmonic distortion.
- Q. UPS: Uninterruptible power supply; used both in singular and plural context.
- R. WAN: Wide area network.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Attach copies of approved Product Data submittals for all energy metering system products that describe energy monitoring and metering to illustrate coordination among related equipment.

- B. Shop Drawings: For energy monitoring and metering equipment. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Outline Drawings: Indicate arrangement of components and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, meters, instruments and other devices to be used. Describe characteristics of network and other data communication lines.
 - 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 4. Wiring Diagrams: For power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
 - 5. Surge Suppressors: Data for each device used and where applied.

- C. Training course materials: Submit all training course materials for review and approval prior to scheduling training with owner. Include all videos, slideshows, manuals and materials to be used during training.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and Manufacturer.
- B. Field quality-control reports.
- C. Other Informational Submittals:
 - 1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals:
 - 1. Operating and applications software documentation.
 - 2. Software licenses.
 - 3. Software service agreement.
 - 4. Installation and operating documentation, manuals, software and all installed peripherals. Software shall include system restore, emergency boot diskettes/CD/DVD, and drivers for all installed hardware. Provide separately for each application.
 - 5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy submittal.

- B. Software and Firmware Operational Documentation:

1. Self-study guide describing the process for setting equipment's network address; setting Owner's options; procedures to ensure data access from any PC on the network, using a standard Web browser; and recommended firewall setup.
 2. Software operating and upgrade manuals.
 3. Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.
 4. Device address list and the set point of each device and operator option, as set in applications software.
 5. Graphic file and printout of graphic screens and related icons, with legend.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future system revisions.
- D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.
- 1.8 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- 1.9 QUALITY ASSURANCE
- A. Installer Qualifications: Manufacturer's factory authorized representative who is trained and approved for installation of units required for this project. Installer shall provide records of at least five (5) successful in-service installations.
- B. Manufacturer Qualifications: A firm experienced in manufacturing energy monitoring and metering equipment similar to that indicated for this Project and with a record of successful in-service performance.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Nationally Recognized Testing Laboratory, and marked for intended location and application.
- 1.10 COORDINATION
- A. Coordinate features of distribution equipment and power monitoring and metering components to form an integrated interconnection of compatible components.
1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution, metering and control components that are monitored by or connected to the energy metering system.
- 1.11 SOFTWARE SERVICE & SUPPORT AGREEMENT
- A. Technical Support: Beginning with Substantial Completion and Owner's Acceptance, provide manufacturer's factory software/hardware support for two (2) years. Technical support shall

give owner priority access via dedicated toll free phone number, phone and web based support services, remote access to EMCS by manufacturer's technical department.

- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two (2) years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric Power Monitoring Expert (PME) System or comparable product by one of the following or approved equal:
 - 1. Eaton Corporation; Cutler-Hammer.
 - 2. E-Mon, Energy Monitoring
 - 3. Schneider Electric, Power Management.

2.2 SYSTEM TECHNICAL DESCRIPTION

- A. System shall provide centralized, graphic based energy metering and management for viewing, trending, and adjusting all meters connected to the system.
- B. System shall provide owner with the ability to add manual meter reading data into the trend/historical database. Provide programming and graphics to allow for input, reporting and viewing of manually input data through the engineering client workstation or application. Manually input consumption and demand data shall be incorporated into system/building/campus energy and cost reports.
- C. System software shall be installed on the building energy engineer's workstation(s) or virtualized in an owner's central server, as directed by the owner.
 - 1. Engineering Client: Provide two (2) engineering interface applications/licenses. Engineering interface shall provide full access to software functionality, including but not limited to; adjusting meter parameters, generating custom reports and graphs, manipulating data groups, viewing and re-setting alarms, adjusting graphics, generating new graphics screens.
 - 2. View Client: Provide five (5) web portal applications/licenses. View client application shall provide remote monitoring and access to real time meter data, reporting, trend data, and historical meter and system data.

- D. System shall be initially configured to capture, trend and save demand and consumption data from all meters at fifteen (15) minute intervals (adjustable from one (1) minute to one (1) hour). Software shall be configured to automatically save all trend data to owner's designated network server location on a daily basis.
- E. All trend data shall be saved and stored for minimum of (3) years.
- F. Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.
 - 1. Calculate and Record the Following:
 - a. Consumption.
 - b. Peak demand periods.
 - c. Power quality
 - 2. Measure and Record Metered Data for the Following as indicted on drawings:
 - a. Electricity.
 - b. Domestic water.
 - c. Natural gas.
 - d. Heating Water
 - e. Chilled Water
 - f. Steam.
- G. Software: Calculate allocation of consumption, demand and cost for:
 - 1. Automatically Import Energy Usage Records to Allocate Energy Consumption, Demand and Associated Cost for the Following:
 - a. At least 400 Individual Meters.
 - b. At least 4 Individual Buildings.
 - c. At Least 40 meter groups.
- H. Electrical Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:
 - 1. Voltage regulation and unbalance.
 - 2. Continuous three-phase rms voltage.
 - 3. Periodic max./min./avg. voltage samples.
 - 4. Harmonics.
 - 5. Voltage excursions.
- I. System: Report equipment status and alarms.
- J. The system shall support integration with other third party intelligent electronic devices (IEDs) not directly supported natively.
- K. The system shall support the concept of hierarchies to organize devices structurally into various levels. Examples include Building/System/Sub-System. Or Buildings/Floors/System. The system shall include the ability to:

1. Aggregate data at any location in the hierarchy.
2. Track hierarchy configuration changes over time.
3. Allow administrators to update names in a given hierarchy at any time (even in the past) to ensure accurate reporting of associated data points (for example, report on energy consumption for a Tenant who has re-located, expanded, added, or removed circuits during the billing period).
4. Export the hierarchy structure to Excel format.
5. Bulk-import capability to create and edit large hierarchies without manual per-device setup.

2.3 SYSTEM REQUIREMENTS

- A. **Monitoring:** Include multiple PC-based software packages (or virtualized server based graphics software and database with Engineering and View Client applications licenses as specified). Installation type and locations shall be coordinated with and as directed by owner's IT Manager. All software package and web applications shall include full graphics capability and Web access. Software and/or web applications shall be installed on owner's existing or supplied PCs and/or servers. All equipment shall be connected to the data transmission network.
- B. **Data Transmission:** Data from meters to Energy Metering Network Gateways shall be transmitted on a dedicated communication network as specified and indicated on contract drawings. Data from Energy Metering Network Gateways to energy metering software/servers shall be through the owner's LAN/Ethernet. Contractor shall provide interconnection communication cabling, conduits hardware and accessories to connect energy metering system to the owner's LAN/Ethernet Switch locations as indicated on drawings.
- C. **Surge Protection:** For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 1. **Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines:** Comply with requirements as recommended by manufacturer for type of line being protected.
- D. **Addressable Devices:** All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.
- E. The system shall be capable of supporting Modbus communicating devices and be capable of functioning as a Modbus master to read/write registers in Modbus devices for all metering, monitoring and control applications.
- F. The system shall be capable of Modbus device definition (device drivers) creation to enable integration of third-party Modbus protocol devices.
- G. The system shall include a monitoring and analysis application with tools for Water, Air, Gas, Electric, and Steam (WAGES) energy analysis, power quality analysis, power system monitoring and include the following capabilities:

1. Auto-diagram creation capability to create a comprehensive set of linked hierarchical graphical diagrams showing devices and their associated device specific diagrams in the network.
2. Ability to import custom graphics or images to create electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, and mimic displays.

2.4 ENERGY AND POWER MANAGEMENT SOFTWARE

- A. Software: Configured to run on a single PC or virtualized on owner's central server (as directed by owner) with multiple Web enabled client PCs with Engineering and View applications each with capability for accessing multiple devices simultaneously. Database (trend/historical data) shall reside on owner's central server, and be fully accessible by Engineering and View client applications. Software shall include interactive graphics client and shall be Web enabled. For virtualized applications, workstations/PCs shall not require any software except for an Internet browser to provide connectivity and full functionality. Include a firewall recommended by manufacturer. 100 Base-T Ethernet, Modbus TCP/IP and RS-485 digital communications.
- B. Operating System Software: Based on Microsoft Windows operating system. Software shall have the following features:
 1. Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.
 2. Graphical user interface to show pull-down menus and a menu tree format.
 3. Capability for future additions within the indicated system size limits.
- C. Programming and Graphics: Provide site specific customized graphics and programming package complete with site/building/system and meter level graphic pages and reports as complying with the owner's requirements and as required in this specification section. Programming and graphics package shall be by the energy metering system equipment manufacturer's factory representative.

2.5 APPLICATIONS SOFTWARE

- A. Basic Requirements:
 1. Fully compatible with and based on the approved operating system.
 2. Password-protected operator login and access; three levels, minimum.
 3. Password-protected setup functions.
 4. Context-sensitive online help.
 5. Capability of creating, deleting, and copying files; and automatically maintaining a directory of all files, including size and location of each sequential and random-ordered record.
 6. Capability for importing custom icons into graphic views to represent alarms and I/O devices.
 7. Automatic and encrypted backups for database and history; automatically stored at a central server on the owner's LAN and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.
 8. Operator audit trail for recording and reporting all changes made to user-defined system options.

- B. Server Functions:
 - 1. Support other client PCs on the LAN.
 - 2. Maintain recorded data in databases accessible from other PCs on the LAN.
- C. Data Formats:
 - 1. User-programmable export and import of data to and from commonly used Microsoft Windows spreadsheet, database, billing, and other applications; using dynamic data exchange technology.
 - 2. Option to convert reports and graphics to HTML format.
 - 3. Interactive graphics.
 - 4. Option to send preprogrammed or operator designed e-mail reports.
- D. Metered Data: Display metered values in real time.
- E. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.
- F. Graphics: Interactive color-graphics platform with pull-down menus, active content and mouse-driven generation of power system graphics, in formats widely used for such drafting. Provide custom graphics and hierarchy as follows:
 - 1. Site Plan Graphic Screens:
 - a. Aerial photo containing Camden Station, Warehouse, Oriole Park and Ravens Stadium. Selection of building in site plan view shall re-direct user to building level graphic screen.
 - b. Include display of total campus energy consumption values for each measured utility. (Electricity, Gas, Steam, Chilled Water, Hot Water & Domestic Water).
 - c. Provide active selectable link for re-directing user to campus level reports.
 - 2. Building Level Graphic Screens.
 - a. Include building base outline and display of current energy consumption and demand values for each measured utility (Electricity, Gas, Steam, Chilled Water, Hot Water & Domestic Water)
 - 1) Each graphically displayed utility value shall be accompanied by an active selection link for re-directing users to “System Level Graphic Screens”
 - 2) Selection of any measured utility indicated on building level graphic screen shall re-direct user to “System Level Graphic Screens”.
 - b. Provide active selectable link for re-directing user to building level reports.
 - 3. System Level Graphic Screens:
 - a. Include complete building floor plans (from owner supplied .pdf or CADD file). Graphically indicate instrumentation (all meters, sensors, displays) on floor plan. Include piping for hydronic systems. Graphics for meters, sensors and displays shall be selectable active links for re-directing user to “Meter Level Graphics Screens”
 - b. For electrical systems, include link to one-line diagram graphic screen containing all meters (diagram to be provided in .pdf or CADD format by owner). Graphics for meters on one line diagram(s) shall be selectable active links for re-directing user to “Meter Level Graphics Screens”.

- c. Selection of any metered value on system level graphic screens shall re-direct user to “Meter Level Graphic Screens”.
 - d. Provide active selectable link for re-directing user to system reports.
 4. Meter Level Graphic Screens:
 - a. Graphically display total system current energy, flow, temperature, demand data (as applicable) for system being displayed.
 - b. Graphically display meters associated with selected system on a single screen.
 - c. Graphically display all available meter output data for all system meters.
 - d. Provide active selectable link for re-directing user to meter alarms and error logs.
 - e. Clearly identify each meter and its service where multiple meters are employed to capture a single utility.
 - f. Provide active selectable link for re-directing user to meter reports.
- G. User-Defined Monitoring and Control Events: Display and record with date and time stamps accurate to 0.1 second, and including the following:
 1. Operator log on/off.
 2. Attempted operator log on/off.
 3. All alarms.
 4. Equipment operation counters.
 5. Out-of-limit and no-response events.
- H. Trending Reports: Display data acquired from different meters or devices, in historical format over user-defined time; unlimited as to interval, duration, or quantity of trends.
 1. Spreadsheet functions of sum, delta, percent, average, mean, standard deviation, and related functions applied to recorded data.
 2. Charting, statistical, and display functions of standard Windows-based spreadsheet.
 3. At a minimum, reports shall be generated for the following trends:
 - a. Daily
 - b. Weekly
 - c. Monthly
 - d. Annual trends
 4. Reports shall tailored per the owner’s direction and include but are not limited to:
 - a. Campus energy consumption by utility.
 - b. Building energy consumption by utility.
 - c. System energy consumption, by building
 - d. Tennant energy consumption by utility.
 - e. Meter energy consumption, by meter.
 - f. Power quality for electrical meters.
 5. Generate line or bar type time-history graphic for consumption and demand to accompany each report.
- I. Alarms: Display and record alarm messages from discrete input and controls outputs, according to user programmable protocol.
 1. Functions requiring user acknowledgment shall run in background during computer use for other applications and override other presentations when they occur.

2. System shall automatically generate and transmit email notification of alarms to owner designated recipients.
- J. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.
1. Tabular data shall be in the comma-separated values.
- K. Activity Billing and Analysis:
1. Automatically compute and prepare activity demand and energy-use statements based on metering of energy use and peak demand integrated over user-defined interval.
 2. Intervals shall be same as used by utilities (where applicable) or as defined by owner..
 3. Import metered data from saved records that were generated by metering and monitoring software.
 4. Maintain separate directory for each activity's historical billing information.
 5. Prepare summary reports in user-defined formats and time intervals.
- L. Reporting: User commands initiate the reporting of a list of current alarm, supervisory and trouble conditions in system or a log of past events.
1. Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.
 2. Sort and report by device name and by function.
 3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
 4. Differentiate alarm signals from other indications.
 5. When system is reset, report reset event with same information concerning device, location, date, and time.
 6. System shall automatically generate and transmit email notification of alarms to owner designated recipients.

2.6 COMMUNICATION COMPONENTS AND NETWORKS

- A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol.

2.7 ENERGY METERING NETWORK GATEWAY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Schneider Electric COMX510 or comparable product by one of the following or approved equal:
1. Eaton Corporation; Cutler-Hammer.
 2. E-Mon, Energy Monitoring
 3. Schneider Electric, Power Management.
- B. Separately mounted, permanently installed Energy Metering Network Gateway serving to collect and stores WAGES (Water, Air, Gas, Electricity, Steam) meter data. The device serves as a storage location and gateway between the EPMPs device network and owner's LAN.

- C. Instrument for power monitoring and control.
 - 1. Enclosure: NEMA 250, Type 1.
- D. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability.
 - 1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
- E. Power-Distribution Equipment Monitor: Web enabled, with integral network port and embedded Web server with factory-configured firmware and HTML-formatted Web pages for viewing of power monitoring and equipment status information from connected devices equipped with digital communication ports.
- F. Inputs, provided with the following at minimum:
 - 1. Modbus Port: One (1) 4-pin screw connector and One (1) RJ45 port
 - 2. Digital: Six (6) IEC62053-31 Class A-compatible inputs with LED status indicator and pulse reception.
 - 3. Analog: Two (2) for connection of 0-10V and 4-20mA instruments.
 - 4. Ethernet Port: Two (2), configurable as a switch or separated (one IP address for each port). Ports shall be configurable as:
 - a. DHCP client
 - b. DHCP server
 - c. Static IP address
- G. Communication Devices within the Equipment: Addressed at factory and tested to verify reliable communication with network server.
- H. Server Configuration:
 - 1. Initial network parameters set using a standard Web browser. Connect via a local operator interface, or an RJ-45 port accessible from front of equipment.
 - 2. Network server shall be factory programmed with embedded HTML-formatted Web pages that are user configurable and that provide detailed communication diagnostic information for serial and Ethernet ports as status of RS-485 network; with internal memory management information pages for viewing using a standard Web browser.
 - 3. Login: Password protected; password administration accessible from the LAN using a standard Web browser.
 - 4. Operating Software: Suitable for local access; firewall protected.
 - 5. Path and configure addresses for all connected meters.
 - 6. Scale all inputs and verify proper measurement value.
- I. Data Access:
 - 1. Network server shall include embedded HTML pages providing real-time information from devices connected to RS-485 network ports via a standard Web browser.

- J. Equipment Monitoring Options: Login shall be followed by a main menu for selecting summary Web pages that follow.
- K. Summary Web pages shall be factory configured to display the following information for each communicating device within the power equipment lineup:
 - 1. User-Configured Custom Home Page: Provide for the lineup, showing status-at-a-glance of key operating values.
 - 2. Circuit Summary Page: Circuit name, three-phase average rms current, power (kW), power factor, and breaker status.
 - 3. Load Current Summary Page: Circuit name, Phase A, B, and C rms current values.
 - 4. Demand Current Summary Page: Circuit name, Phase A, B, and C average demand current values.
 - 5. Power Summary Page: Circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
 - 6. Energy Summary Page: Circuit name, energy (kWh), reactive energy (kVARh), and time/date of last reset.
 - 7. Transformer Status Page: Transformer tag, coil temperatures, and cooling fan status.
 - 8. Motor-Control Center Status Page: Circuit name, three-phase average rms current, thermal capacity (percentage), and drive output frequency (Hz) contactor status.
 - 9. Specific Device Pages: Each individual communicating device shall display detailed, real-time information, as appropriate for device type.
 - a. Display historical energy data that shall be logged automatically for each device, as appropriate for device type.
 - b. Display historical data logged from each device in graphical time-trend plots. Value to be displayed on time-trend plot shall be user selectable. Time interval to be displayed on scale shall be for previous day or week.

2.8 METER NETWORK DATA TRANSMISSION AND LAN CABLES

- A. Comply with Section 271513 "Communications Horizontal Cabling." And Section 260523 "Control Voltage Electrical Power Cables".
- B. RS-485 Cable: Cabling between Meters and Energy Metering Network Gateways. Cable as specified in section 260523 "Control Voltage Electrical Power Cables".
- C. LAN Cables: Category 6 as for data service as specified in section 271513 "Communications Horizontal Cabling."

2.9 LOW-VOLTAGE WIRING

- A. Comply with Section 260523 "Control-Voltage Electrical Power Cables".
- B. Install wiring in existing raceway and cable tray and communication conduits where available and specified except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces. Where existing controls and communications cable trays and/or conduits are not available, all cabling in/through electrical rooms, mechanical rooms,

corridors, service areas, areas without suspended ceilings, etc., cabling shall be installed in dedicated conduit EMT conduit. Minimum conduit size shall be ½”.”

- C. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
 - 1. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
 - 2. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 METER & INSTRUMENT SETUP

- A. Path all connected meters to server. Provide logical names for each device in accordance with owner's facility and IT group requirements.
- B. Scale all instrument and meter inputs and verify flow/consumption values with calibrated instrumentation. Verify utility generated pulse input values and scaling with utility provider. Document all scaling values in O&M manual and at local meter/connection point.

3.3 CABLING

- A. Comply with NECA 1.
- B. Install cables and wiring according to requirements in Section 271500 "Communications Horizontal Cabling."
 - A. Wiring Method: Install wiring in existing raceway and cable tray and communication conduits where available and specified except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces. Where existing controls and communications cable trays and/or conduits are not available, all cabling in/through electrical rooms, mechanical rooms, corridors, service areas, areas without suspended ceilings, etc., cabling shall be installed in dedicated conduit EMT conduit. Minimum conduit size shall be ½”.
 - B. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

- C. Install LAN cables using techniques, practices, and methods that are consistent with specified category rating of components and that ensure specified category performance of completed and linked signal paths, end to end.
- D. Install cables without damaging conductors, shield, or jacket.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
- B. Label each power monitoring and control module with a unique designation.

3.5 GROUNDING

- A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.6 FIELD QUALITY CONTROL

- A. Provide manufacturer's graphic programming start-up and commissioning for Energy Metering System.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Electrical Tests: Use caution when testing devices containing solid-state components.
 - 2. Continuity tests of circuits.
 - 3. Set up trending and reporting and billing software, insert billing location names and initial constant values and variables needed for billing computations as directed by owner.
 - 4. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
 - a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
 - b. Test LANs according to requirements in Section 271500 "Communications Horizontal Cabling."
 - c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
 - d. Verify accuracy of graphic screens and icons.

- e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
 - f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
- D. Power monitoring and control equipment will be considered defective if it does not pass tests and inspections.
 - E. Prepare test and inspection reports.
 - F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
 - G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
 - H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
 - I. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. See Section 017900 "Demonstration and Training."
 - 1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 32 hours' training. Training shall be provided by a system manufacturer's factory representative who has provided customer training for no less than five (5) previous installations of similar size and scope. Training material shall be submitted for review and approval prior to training event.
 - 2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION 260913