

**SECTION 25 10 10  
ADVANCED UTILITY METERING SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. This Section includes the following for the advanced metering of the new switchboard. The metered systems include the electrical power system. The new meter will be part of the existing Corporate-Wide utility metering system, rendering the VA accurate and automated metering of its facilities' energy and water flows. Metering systems are comprised of:

1. Electric meters.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage cable.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.
- E. Section 26 11 16, SECONDARY UNIT SUBSTATIONS: Unit secondary substation.
- F. Section 26 18 41, MEDIUM-VOLTAGE SWITCHES: High voltage switches.
- G. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Secondary distribution switchgear.

**1.3 DEFINITIONS**

- A. AMR: Automatic meter reading is the technology of automatically collecting consumption, diagnostic, and status data from water and energy metering devices (water, gas, electric, steam) and transferring that data to a central database for billing, troubleshooting, and analyzing.
- B. AUMS: Advanced Utility Metering System: the system described by this Section.
- C. BACnet: BACnet is a Data Communications Protocol for Building Automation and Control Networks. It is defined by ASHRAE/ANSI Standard 135 (ISO 16484-5) standard protocol.

- D. Data Over Cable Service Interface Specification (DOCSIS): an international standard defining communications and operation support interface requirements for a data over cable system, by the Cable Television Laboratories, Inc. consortium
- E. Data Head (on meters): converts analog and pulse signals to digital signals for transmission to the Site Data Aggregation Device. Also provides for limited storage of the digital signals.
- F. Device Accuracy: accuracy in this section is based on actual flow, not full scale or full range. Device accuracy measures the conversion of flow information to analog or pulse signals.
- G. Ethernet: Local area network, based on IEEE 802.3 standards.
- H. 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.
- I. Gateway: Bi-directional protocol translator connecting control systems that use different communication protocols.
- J. GB: gigabyte. When used to describe data storage, "GB" represents 1024 megabytes.
- K. HTML: Hypertext markup language.
- L. I/O: Input/output.
- M. KB: Short for kilobyte. When used to describe data storage, "KB" represents 1024 bytes.
- N. KY Pulse: A term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay changing status in response to the rotation of the disk in the meter.
- O. LAN: Local area network. Sometimes plural as "LANs."
- P. LCD: Liquid crystal display.
- Q. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- R. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- S. LonWorks: Network technology developed by the Echelon Corporation.
- T. 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.

- U. MB: megabyte. When used to describe data storage, "MB" represents 1024 kilobytes.
- V. Mbps: Megabytes per second, equal to 8 megabits per second
- W. Modbus TCP/IP: An open protocol for exchange of process data.
- X. 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.
- Y. OTDR: Optical Time Domain Reflectometer. A test instrument that analyzes the light loss in an optical fiber. Used to find faults, splices and bends in the line, it works by sending out a light pulse and measuring its reflection. Such devices can measure fiber lines that are longer than 150 miles
- Z. PC: Personal computer
- AA.PICS, Protocol Implementation Conformance Statement: A written document that identifies the particular options specified by BACnet that are implemented in a device.
- BB.REO: Resident Engineer Office: the VA office administering the construction contract.
- CC.Reporting Accuracy: this is the root-mean-square sum of all of the metering devices' inaccuracies: measurement inaccuracy, mechanical inaccuracy, analog-to-digital or pulse integration inaccuracy, etc., up to the meter's data head.
- DD.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.
- EE.Router: A device that connects two or more networks at the network layer.
- FF.RS-232: A Telecommunications Industry Association standard for asynchronous serial data communications between terminal devices.
- GG.RS-485: A Telecommunications Industry Association standard for multipoint communications using two twisted-pairs.
- HH.TB: terrabyte. When used to describe data storage, "TB" represents 1024 gigabytes.
- II.TCP/IP: Transport control protocol/internet protocol.
- JJ.Turn-down: the maximum flow divided by the minimum flow through a meter; used along with accuracy requirements. For example, a meter

shall be accurate to within 2% of actual flow with throughout a 20:1 turndown

KK.THd: Total harmonic distortion.

LL.UPS: Uninterruptible power supply; used both in singular and plural context.

MM.UTP: Unshielded twisted pair cabling, used to limit crosstalk and electromagnetic interference from the environment

NN.WAN: Wide area network.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A firm experienced at least three years in manufacturing and installing power monitoring and control 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, Article 100, by a testing agency, and marked for intended use.
- D. System Modifications: Make recommendations for system modification in writing to the VA. No system modifications shall be made without prior written approval of the VA. Any modifications made to the system shall be incorporated into the Operations and Maintenance Instructions, and other documentation affected. Provide to the VA software updates for all software furnished under this specification during this contract's construction and verification periods and for the first two years after government acceptance. All updated software shall be verified as part of this contract.

#### **1.5 PERFORMANCE**

- A. The advanced utility metering system shall conform to the following:
  - 1. Site Data Aggregation Device Graphic Display: The system shall display up to 4 graphics on a single screen with a minimum of (20) dynamic points per graphic. All current data shall be displayed within (10) seconds of the request.
  - 2. Site Data Aggregation Device Graphic Refresh: The system shall update all dynamic points with current data within ten seconds. Data refresh shall be automatic, without operator intervention.

3. Meter Scan: All changes of metered values shall be transmitted over the high-speed network such that any data used or displayed at a controller or Site Data Aggregation Device will be current, within the prior ten seconds.
4. Alarm Response Time: The maximum time from when meter goes into alarm to when it is annunciated at the workstation shall not exceed ten seconds.
5. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values within the below minimum turn-down envelope reported by the meters:

Measured Variable	Units Measured	Minimum Turn-Down of Meter	Reporting Accuracy (Note 1)
Electricity	V, A, W, etc.	n/a	±0.5% of measured value

**Table 1.5: Meter Performance Criteria**

Table Notes:

1. This table shows reporting accuracy, not merely the meter's accuracy. Reporting accuracy includes meter accuracy and data conversion accuracy. See Article 1.3 in this Section for definition. Accuracy is shown against the measured value, not against the full range of the meter.
2. kW: kilowatt

#### **1.6 WARRANTY**

- A. Labor and materials for advanced utility metering systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Advance utility metering system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and metering devices.

#### **1.7 SUBMITTALS**

- A. Product Data: for each type of product indicated, Attach copies of approved Product Data submittals for products (switchboards and switchgear) that describe advance utility metering features to illustrate coordination among related equipment and utility metering and control.
- B. Shop Drawings: include plans, elevations, sections, details, and attachments to other work.

1. Outline Drawings: Indicate arrangement of meters, components and clearance and access requirements. Clearly identify system components, internal connections, and all field connections.
  2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, 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: Power, signal, and communications wiring. Coordinate nomenclature and presentation with a block diagram. Show all communications network components and include a communications single-line diagram indicating device interconnection and addressing information for all system devices. Identify terminal blocks used for interconnections and wire type to be used.
  5. UPS sizing calculations for workstation.
- C. Software Upgrade Kit: For Owner to use in modifying software to suit future utility metering system revisions.
- D. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.
- E. Qualification Data: For installer and manufacturer
- F. Other Informational Submittals:
1. System installation and setup guides, with data forms to plan and record options and setup decisions.
- G. Revise and update the Contract Drawings to include details of the system design. Drawings shall be on 17 by 11 inches sheets. Details to be shown on the Design Drawing include:
1. Details on logical structure of the network. This includes logical location of all network hardware.
  2. Manufacturer and model number for each piece of computer and network hardware.
  3. Physical location for each piece of network or computer hardware.
  4. Physical routing of LAN cabling.
  5. Physical and qualitative descriptions of connectivities.

**1.8 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For advanced utility metering system components and meters, to include in emergency, operation, and maintenance manuals. Include the following:
  - 1. Software licenses.
  - 2. 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. Field quality-control test reports.

**1.9 LICENSING AGREEMENT**

- A. Licenses procured as part of this work become the property of the government upon acceptance of the work. Licenses shall have no expiration.
- B. Technical Support: Beginning with Government Acceptance, provide software support for one year.
- C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Government Acceptance. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

**1.10 MAINTENANCE AND SERVICE**

- A. Preventive Maintenance Requirements: provide a preventative maintenance plan for new meter. Perform maintenance procedures for a period of 1 year after government acceptance, at frequencies and using procedures required by the meter and component manufacturers. At a minimum and if the manufacturer is silent on its preventative maintenance requirements, frequencies, deliverables and activities shall comply with the following:
  - 1. Preventive Maintenance Work Plan: prepare a Preventive Maintenance Work Plan to schedule all required preventive maintenance. VA approval of the Work Plan shall be obtained. Adhere to the approved work plan to facilitate VA verification of work. If the Contractor finds it necessary to reschedule maintenance, a written request shall be made to the VA detailing the reasons for the proposed change at least five days prior to the originally scheduled date.

Scheduled dates shall be changed only with the prior written approval of the REO.

#### 1.11 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced, unless otherwise noted. Publications are referenced in the text by the basic designation only.
- B. Consumer Electronics Association (CEA)
- 709.1B-2002.....Control Network Protocol Specification
- 709.3-1999.....Free-Topology Twisted-Pair Channel Specification
- 852-A-2004.....Tunneling Component Network Protocols Over Internet Protocol Channels
- C. Federal Communications Commission (FCC)
- EMC-2002.....FCC Electromagnetic Compliance Requirements
- D. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- 100-2000.....The Authoritative Dictionary of IEEE Standards Terms
- 802.1D-2004.....Media Access Control Bridges
- 802.2-2003.....Standards for Local Area Networks: Logical Link Control
- 802.3-2005.....Information Technology - Telecommunications and Information Exchange between Systems. Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications (ANSI)
- 1100-2005.....Recommended Practice for Powering and Grounding Electronic Equipment (ANSI)
- C37.90.1-2002.....Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- C57.13-2008.....Standard Requirements for Instrument Transformers

- C62.41.1-2002.....Guide on the Surges Environment in Low-Voltage(1000 V and Less) AC Power Circuits
- C62.41.2-2002.....Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
- E. International Electrotechnical Commission (IEC)
- IEC 61000-2005.....Electromagnetic Compatibility (EMC)- Part 4-5: Testing and Measurement Techniques; Surge Immunity Test
- F. National Electrical Contractors Association
- NECA 1-2006.....Good Workmanship in Electrical Construction
- G. National Electrical Manufacturers Association (NEMA)
- 250-2008.....Enclosures for Electrical Equipment (1000 Volts Maximum)
- C12.1-2008.....Electric Meters; Code for Electricity Metering
- C12.20-2002.....Electricity Meter - 0.2 and 0.5 Accuracy Classes
- C62.61-1993.....Gas Tube Surge Arresters on Wire Line Telephone Circuits
- ICS 1-2008.....Standard for Industrial Control and Systems General Requirements
- H. National Institute of Standards and Technology (NIST)
- 800, Part 39-2008.....[DRAFT] Managing Risk from Information Systems: An Organizational Perspective
- 800, Part 46-2009.....Guide to Enterprise Telework and Remote Access Security
- 800, Part 52-2009.....Recommended Security Controls for Federal Information Systems and Organizations
- (FIPS) 200-2006.....Minimum Security Requirements for Federal Information and Information Systems
- I. National Fire Protection Association (NFPA)
- 70-2008.....National Electrical Code (NEC)
- 101-06.....Life Safety Code
- J. Telecommunications Industry Association, (TIA/EIA)
- H-088C3.....Pathway Design Handbook
- 232-F-2002.....Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

- 485-A-2003.....Electrical Characteristics of Generators and  
Receivers for Use in Balanced Digital  
Multipoint System
- 568-C.1-2009.....Commercial Building Telecommunications Cabling  
Standard
- 606-A-2002.....Administration Standard for the  
Telecommunications Infrastructure
- 607-A-2002.....Commercial Building Grounding (Earthing) and  
Bonding Requirements for Telecommunications
- K. Underwriters Laboratories, Inc. (UL):
- 916-2007.....Energy Management Equipment
- 5085-3-2007.....UL Standard for Safety Standard Low Voltage
- 1244-2000.....Electrical and Electronic Measuring and Testing  
Equipment
- 1581-2006.....Electrical Wires, Cables, and Flexible Cords

## **PART 2 - PRODUCTS**

### **2.1 ADVANCED UTILITY METERING SYSTEM**

#### A. Functional Description

1. Meter and record load profiles. Chart energy and water consumption patterns.
  - a. Calculate and record the following:
    - 1) Load factor.
    - 2) Peak demand periods.
    - 3) Consumption correlated with facility activities.
  - b. Measure and record metering data for the following:
    - 1) Electricity.
  - c. Software: calculate allocation of utility costs.
    - 1) Verify utility bills and analyze alternate energy rates.
  - d. Electric Power Quality Monitoring: Identify power system anomalies and measure, display, capture waveforms, 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. samples.
    - 4) Harmonics.
    - 5) Voltage excursions.

#### B. Communications Components and Networks

1. Site Data Aggregation Device and its networked meters shall communicate using BACNet protocol. Backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2008, BACnet Annex J.
    - a. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.
    - b. Each controller shall have a communication port for connection to an operator interface.
  2. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard LAN and WAN and Internetworked LAN.
  3. Communication protocol; LANs complying with RS-485 or RS-485 accessed through Ethernet, 100 Base-TX Ethernet, and Modbus TCP/IP.
  4. Network Hardware
    - a. Building Point of Connection Hardware
      - 1) Active equipment and communication interfaces.
      - 2) Switches, hubs, bridges, routers and servers.
    - b. IP Network Hardware
      - 1) Wire and Cables, copper connectivity devices.
      - 2) Fiber Optic Patch Panel.
      - 3) Fiber Optic Media Converter
      - 4) Ethernet Switch
      - 5) IP Router
  5. Communication Security
    - a. Remote teleworking and remote access of the network shall be through a firewall, at the Site Data Aggregation Device, complying with the requirements associated with Level 1 security in the Federal Information Processing Standard 140-2 (2002), Security Requirements for Cryptographic Modules.
    - b. Direct access to network shall be restricted as described in
- 2.2 SITE DATA AGGREGATION DEVICE - PERSONAL COMPUTER WORKSTATION**
- A. Tie into existing workstations, currently running metering program.
- 2.3 CABLE SYSTEMS - TWISTED PAIR AND FIBER OPTIC**
- A. General:

1. All metallic cable sheaths, etc. (i.e.: risers, underground, station wiring, etc. shall be grounded.
2. Install temporary cable and wire pairs so as to not present a pedestrian safety hazard. Provide for all associated work for any temporary installation and for removal when no longer necessary. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and approved by the VA prior to installation.
3. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
4. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
5. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
6. Label system's cables on each end. Test and certify cables in writing to the VA before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges specified. The cable tests shall demonstrate the operation of this cable at not less than 10 mega (m) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of  $10^{-6}$  at the maximum rate of speed. Make available all cable installation and test records at acceptance testing by the VA and shall thereafter be maintained in the Facility's Telephone Switch Room. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.
7. Coordinate with the Electrical Contractor to install the telephone entrance cable to the nearest point of entry into the Facility and as shown on the drawings. Coordinate with the VA and the Electrical Contractor to provide all cable pairs/circuits from the Facility point of entry to the Telephone Switch Room all telephone, FTS, DHCP, ATM, Frame Relay, data, pay stations, patient phones, and any low voltage circuits as described herein.

8. Provide all cable pairs/circuits from the Server Room and establish circuits for cabling as described herein.
9. Provide proper test equipment to demonstrate that cable pairs meet each OEM's standard transmission requirements, and guarantee the cable will carry data transmissions at the required speeds, frequencies, and fully loaded bandwidth.

B. LAN COPPER CABLES

1. Comply with Section 27 15 00 "Communications Horizontal Cabling."
2. RS-485 Cable:
  - a. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.
3. Unshielded Twisted Pair Cables: Category 5e or 6 as specified for horizontal cable for data service in Section 27 15 00 "Communications Horizontal Cabling."
4. Cabling products shall be tested and certified for use at data speeds up to at least 100 Mbps. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media. Short lengths of media and transceivers may be used in these applications. Provide separately orderable media, taps and connectors.
5. Ethernet Switch shall be IEEE Std 802.3 bridges which shall function as the center of a distributed-star architecture and shall be "learning" bridges with spanning tree algorithms in accordance with IEEE Std 802.1D. The switch shall support the connected media types and shall have a minimum of 150% the required ports and no fewer than 4 ports. One port shall be switch selectable as an uplink port.
6. Provide IP router network equipment. The routers shall be fully configurable for protocol types, security, and routing selection of sub-networks. The router shall meet all requirements of RFC 1812.

C. LOW-VOLTAGE WIRING

1. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
  - a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
  - b. Ordinary Switching Circuits: Three conductors, unless otherwise indicated.

- c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

#### **2.4 GROUNDING**

- A. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with VA 27 05 26 Grounding and Bonding for Communications Systems and with VA 26 05 26 Grounding and Bonding for Electrical Systems.

#### **2.5 METER COMMUNICATION**

- A. Provide a BACNet network allowing communication from the meters' data heads to the Site Data Aggregation Device.
- B. Provide data heads at meter, converting analog and pulsed information to digital information. Data heads shall allow for up to 24 hours of data storage (including time stamp, measured value, and scaling factor).
  1. Each data head shall reside on a BACnet network using the MS/TP Data Link/Physical layer protocol. Each data head shall have a communication port for connection to an operator interface.
  2. Environment: Data Head hardware shall be suitable for the conditions ranging from -29°C to 60°C (-20°F to 140°F). Data Heads used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at conditions ranging from -29°C to 60°C (-20°F to 140°F).
  3. Provide a local keypad and display for interrogating and editing data. An optional system security password shall be available to prevent unauthorized use of the keypad and display.
  4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  5. Memory. The building controller shall maintain all BIOS and data in the event of a power loss for at least 72 hours.
  6. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

## 2.6 ELECTRICAL POWER METERS AND SUB-METERS

### A. ELECTRICAL METER APPLICATIONS

1. Energy meters in the advanced utility metering system shall have models available for amperage ranges of 100-2400 amperes.
  - a. The RS-485 communications shall provide communications links up to 10,000 feet long.
2. Power meter shall be installed as part of the advanced utility metering system.
  - a. All setup parameters required by the power meter shall be stored in nonvolatile memory and retained in the event of a control power interruption.
  - b. The power meter may be applied in three-phase, three- or four-wire systems.
  - c. The power meter shall be capable of being applied without modification at nominal frequencies of 50, 60, or 400 Hz.
  - d. The power meter shall provide for onboard data logging, able to log data, alarms, waveforms and events.

### B. Physical and Common Requirements

1. Electrical power meters shall be separately mounted, and enclosed in a NEMA 250, Type 1 enclosure. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - a. Ambient conditions of 0 to 140 deg F dry bulb and 20 to 95 percent relative humidity, noncondensing.

### C. Current and voltage ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall be not less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Voltage inputs from standard instrument potential transformers with 120 volt secondary output. The power meter shall support PT primaries through 3.2 MV.
4. The power meter shall operate properly over a wide range of control power including 90-457 VAC or 100-300 VDC.

### D. Electrical measurements and calculated values

1. Power meters shall include the following rms Real-Time Measurements:
  - a. Current: Each phase, neutral, average of three phases, percent unbalance.
  - b. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
  - c. Power: Per phase and three-phase total.
  - d. Reactive Power: Per phase and three-phase total.
  - e. Apparent Power: Per phase and three-phase total.
  - f. True Power Factor: Per phase and three-phase total.
  - g. Displacement Power Factor: Per phase and three-phase total.
  - h. Frequency.
  - i. THD: Current and voltage.
  - j. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
  - k. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
  - l. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
2. Power meters shall perform the following demand current calculations, per phase, three-phase average and neutral:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Peak.
3. Power meters shall perform the following demand real power calculations, three-phase total:
  - a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
4. Power meters shall perform the following demand reactive power calculations, three-phase total:
  - a. Present.
  - b. Running average.

- c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
5. Power meters shall perform the following demand apparent power calculations, three-phase total:
- a. Present.
  - b. Running average.
  - c. Last completed interval.
  - d. Predicted.
  - e. Peak.
  - f. Coincident with peak kVA demand.
  - g. Coincident with kVAR demand.
6. Power meters shall perform the following average true power factor calculations, demand coincident, three-phase total:
- a. Last completed interval.
  - b. Coincident with kW peak.
  - c. Coincident with kVAR peak.
  - d. Coincident with kVA peak.
7. Power Analysis Values:
- a. THD, Voltage and Current: Per phase, three phase, and neutral.
  - b. Displacement Power Factor: Per phase, three phase.
  - c. Fundamental Voltage, Magnitude and Angle: Per phase.
  - d. Fundamental Currents, Magnitude and Angle: Per phase.
  - e. Fundamental Real Power: Per phase, three phase.
  - f. Fundamental Reactive Power: Per phase.
  - g. Harmonic Power: Per phase, three phase.
  - h. Phase rotation.
  - i. Unbalance: Current and voltage.
  - j. Harmonic Magnitudes and Angles for Current and Voltages: Per phase, up to 31st harmonic.
8. Power meters shall perform one of the following demand calculations, selectable by the User; meters shall be capable of performance of all of the following demand calculations.
- a. Block interval with optional subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

- 1) Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
  - 2) Fixed block that calculates demand at end of the interval.
  - 3) Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
- b. Minimum and maximum values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:
- 1) Line-to-line voltage.
  - 2) Line-to-neutral voltage.
  - 3) Current per phase.
  - 4) Line-to-line voltage unbalance.
  - 5) Line-to-neutral voltage unbalance.
  - 6) Power factor.
  - 7) Displacement power factor.
  - 8) Total power.
  - 9) Total reactive power.
  - 10) Total apparent power.
  - 11) THD voltage L-L.
  - 12) THD voltage L-N.
  - 13) THD current.
  - 14) Frequency.
- c. Harmonic calculation: display and record the following:
- 1) Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
  - 2) Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by the VA.
- E. Waveform Capture:
1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.

2. Capture and store disturbance waveform captures of voltage and current channels, initiated automatically based on an alarm event. Each capture shall be fully configurable for duration with resolution of at least 128 data points per cycle, for all channels simultaneously. Waveform shall be configurable to capture pre-event cycles for analysis.
3. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

F. Meter accuracy:

1. Comply with ANSI C12.20, Class 0.5; and IEC 60687, Class 0.5 for revenue meters.
2. Accuracy from Light to Full Rating:
  - a. Power: Accurate to 0.5 percent of reading.
  - b. Voltage and Current: Accurate to 0.5 percent of reading.
  - c. Power Factor: Plus or minus 0.005, from 0.5 leading to 0.5 lagging.
  - d. Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

G. Meter input, sampling, display, output, recording and reading Capabilities

1. Input: One digital input signal.
  - a. Normal mode for on/off signal.
  - b. Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.
  - c. Conditional energy signal to control conditional energy accumulation.
  - d. GPS time synchronization.
2. Sampling:
  - a. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
  - b. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.
3. Display Monitor:
  - a. Backlighted LCD to display metered data with touch-screen or touch-pad selecting device.
  - b. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.

- c. Display four values on one screen at same time.
    - 1) Coordinate list below with meter capabilities specified in subparagraphs above.
    - 2) Current, per phase rms, three-phase average //and neutral//.
    - 3) Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
    - 4) Real power, per phase and three-phase total.
    - 5) Reactive power, per phase and three-phase total.
    - 6) Apparent power, per phase and three-phase total.
    - 7) Power factor, per phase and three-phase total.
    - 8) Frequency.
    - 9) Demand current, per phase and three-phase average.
    - 10) Demand real power, three-phase total.
    - 11) Demand apparent power, three-phase total.
    - 12) Accumulated energy (MWh and MVARh).
    - 13) THD, current and voltage, per phase.
  - d. Reset: Allow reset of the following parameters at the display:
    - 1) Peak demand current.
    - 2) Peak demand power (kW) and peak demand apparent power (kVA).
    - 3) Energy (MWh) and reactive energy (MVARh).
4. Outputs:
- a. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
  - b. Closed in either a momentary or latched mode as defined by user.
  - c. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
  - d. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.
  - e. One relay output module, providing a load voltage range from 20- to 240-V ac or from 20- to 30-V dc, supporting a load current of 2 A.
  - f. Output Relay Control:
    - 1) Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
    - 2) Normally open and normally closed contacts, field configured to operate as follows:

- a) Normal contact closure where contacts change state for as long as signal exists.
- b) Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.
- c) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
- d) End of power demand interval when relay operates as synchronization pulse for other devices.
- e) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
- f) Output controlled by multiple alarms using Boolean-type logic.

5. Onboard Data Logging:

- a. Store logged data, alarms, events, and waveforms in 2 MB of onboard nonvolatile memory.
- b. Stored Data:
  - 1) Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 to 52 days of 15-minute interval data, depending on number of quantities selected.
  - 2) Custom Data Logs: three user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
    - a) Schedule interval.
    - b) Event definition.
    - c) Configured as "fill-and-hold" or "circular, first-in first-out."
  - 3) Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
  - 4) Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."
- c. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

6. Alarms.

- a. User Options:
  - 1) Define pickup, dropout, and delay.
  - 2) Assign one of four severity levels to make it easier for user to respond to the most important events first.
  - 3) Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.
- b. Alarm Events:
  - 1) Over/undercurrent.
  - 2) Over/undervoltage.
  - 3) Current imbalance.
  - 4) Phase loss, current.
  - 5) Phase loss, voltage.
  - 6) Voltage imbalance.
  - 7) Over kW demand.
  - 8) Phase reversal.
  - 9) Digital input off/on.
  - 10)End of incremental energy interval.
  - 11)End of demand interval.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION REQUIREMENTS**

##### **A. Cabling**

1. Install Category 6 UTP system as detailed in TIA-568-C.1, TIA/EIA-568-B.2, or TIA-568-C.3.
2. Screw terminals shall not be used except where specifically indicated on plans.
3. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations.
4. Do not untwist Category 6 UTP cables more than 12 mm (1/2 inch) from the point of termination to maintain cable geometry.
5. Provide service loop on each end of the cable, 3 m (10 feet) at the server rack and 304 mm (12 inches) at the meter.
6. Do not exceed manufacturers' cable pull tensions for copper cables.
7. Provide a device to monitor cable pull tensions. Do not exceed 110 N (25 pounds) pull tension for four pair copper cables.
8. Do not chafe or damage outer jacket materials.
9. Use only lubricants approved by cable manufacturer.
10. Do not over cinch cables, or crush cables with staples.

11. For UTP cable, bend radii shall not be less than four times the cable diameter.
12. Cables shall be terminated; no cable shall contain unterminated elements.
13. Cables shall not be spliced.
14. Label cabling in accordance with paragraph Labeling in this section.

B. Labeling

1. Labels: Provide labeling in accordance with TIA/EIA-606-A. Handwritten labeling is unacceptable. Stenciled lettering for all circuits shall be provided using laser printer.
2. Cables: Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA/EIA-606-A.

- C. Grounding: ground exposed, non-current-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in metallic and nonmetallic raceways, telecommunications system grounds, and grounding conductor of nonmetallic sheathed cables, as well as equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Surge Protection

1. Provide surge protective devices on all metallic cables entering and leaving an interior environment to an exterior environment or vice versa, i.e. surge protective device at each interior location of a penetration to the exterior environment.

E. Network Hardware

1. System components and appurtenances shall be installed in accordance with the manufacturer's instructions. Necessary interconnections, services, and adjustments required for a complete and operable wired or wireless data transmission system shall be provided and shall be fully integrated with the configured network chosen for the project.

F. Computer Software

1. Modify existing software to accept new meter.

G. Electrical Meters

1. Power monitoring and control components shall all be factory installed, wired and tested prior to shipment to the job site.
2. All control power, CT, PT and data communications wire shall be factory wired and harnessed within the equipment enclosure.
3. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly

identify the interconnection requirements including wire type to be used.

4. All wiring required to externally connect separate equipment lineups shall be furnished and installed at the site as part of the contractor's responsibility.
5. Contractor interconnection wiring requirements shall be clearly identified on the power monitoring and control system shop drawings.

### **3.2 ADJUSTING AND IDENTIFICATION**

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.

### **3.3 FIELD QUALITY CONTROL**

- A. The power monitoring and control system vendor must be able to provide development, integration and installation services required to complete and turn over a fully functional system including:
  1. Project management to coordinate personnel, information and on-site supervision for the various levels and functions of suppliers required for completion of the project.
  2. All technical coordination, installation, integration, and testing of all components.
  3. Detailed system design and system drawings.
- B. Cabling, equipment and hardware manufacturers shall have a minimum of 5 years experience in the manufacturing, assembly, and factory testing of components which comply with EIA TIA/EIA-568-B.1, EIA TIA/EIA-568-B.2 and EIA TIA/EIA-568-B.3.
- C. The network cabling contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified network cabling systems and equipment. The contractor shall demonstrate experience in providing successful systems within the past 3 years. Submit documentation for a minimum of three and a maximum of five successful network cabling system installations.
  1. Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

### 3.4 ACCEPTANCE TESTING

- A. Develop testing procedures to address all specified functions and components of the Advanced Utility Metering System (AUMS). Testing shall demonstrate proper and anticipated responses to normal and abnormal operating conditions.
  - 1. Provide skilled technicians to start and operate equipment.
  - 2. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.
  - 3. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for issues identified in testing.
  - 4. Provide all tools to start, check-out and functionally test equipment and systems.
  - 5. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for issues identified in any testing
  - 6. Review test procedures, testing and results with Government.
- B. Testing checklists: Develop project-specific checklists to document the systems and all components are installed in accordance with the manufacturers recommendation and the Contract Documents.
- C. Before testing, the following prerequisite items must be completed.
  - 1. All related equipment has been started and start-up reports and checklists submitted and approved as ready for testing:
  - 2. All associated system functions for all interlocking systems are programmed and operable per contract documents.
  - 3. All punchlist items for the AUMS and equipment are corrected.
  - 4. The test procedures reviewed and approved.
  - 5. Safeties and operating ranges reviewed.
- D. The following testing shall be included:
  - 1. Demonstrate reporting of data and alarm conditions for each point and ensure that alarms are received at the assigned location, including Site Data Collection Device.
  - 2. Demonstrate ability of software program to function for the intended application.
  - 3. Demonstrate via graphed trends to show the reports are executed in correct manner.
  - 4. Demonstrate that the meter readings are accurate using portable NIST traceable portable devices and calibrated valves in the piping system

5. Demonstrate that the systems perform during power loss and resumption of power.
- E. Copper cables: Contractor shall provide all necessary testing equipment to test all copper network circuit cables. Tests shall conform to EIA/TIA 568B Permanent Link testing criteria. All testers are to be EIA/TIA 568B, Level IIe compliant. The primary field test parameters are:
1. Wire map: The wire map test is intended to verify pair to pin termination at each end and check for installation connectivity errors. For each of the conductors in the cable, the wire map indicates:
    - a. Continuity to the remote end
    - b. Shorts between any two or more conductors
    - c. Crossed pairs
    - d. Reversed pairs
    - e. Split pairs
    - f. Any other mis-wiring
  2. Length requirements: The maximum physical length of the basic link shall be 94 meters (including test equipment cords).
  3. Insertion Loss: Worst case insertion loss relative to the maximum insertion loss allowed shall be reported.
  4. Near-end crosstalk (NEXT) loss: Field tests of NEXT shall be performed at both ends of the test configuration.
  5. Power sum near-end crosstalk (PSNEXT) loss
  6. Equal-level far-end crosstalk (ELFEXT): Field tests of ELFEXT shall be performed at both ends of the test configuration
  7. Power sum equal-level far-end crosstalk (PSELFEXT): Must be determined from both ends of the cable. Power sum Near End Crosstalk is not a category 3 parameter. For all frequencies from 1 to 100 MHz, the category 5e PSELFEXT of the cabling shall be measured in accordance with annex E of ANSI/TIA/EIA-568-B.2 and shall meet the values determined using equations (12) and (13) for the permanent link. PSELFEXT is not a required category 3 measurement parameter.
  8. Return loss: Includes all the components of the link. The limits are based on the category of components and cable lengths. Return loss must be tested at both ends of the cable. Cabling return loss is not a required measurement for category 3 cabling.

9. Propagation delay and delay skew: Propagation delay is the time it takes for a signal to propagate from one end to the other. Propagation delay shall be measured in accordance with annex D of ANSI/TIA/EIA-568 B.2. The maximum propagation delay for all category permanent link configurations shall not exceed 498 ns measured at 10 MHz. Delay skew is a measurement of the signaling delay difference from the fastest pair to the slowest. Delay skew shall be measured in accordance with annex D of ANSI/TIA/EIA-568-B.2. The maximum delay skew for all category permanent link configurations shall not exceed 44 ns.
10. Administration: In addition to Pass/Fail indications, measured values of test parameters should be recorded in the administration system. Any reconfiguration of link components after testing may change the performance of the link and thus invalidates previous test results. Such links shall require retesting to regain conformance.
11. Test equipment connectors and cords: Adapter cords that are qualified and determined by the test equipment manufacturer to be suitable for permanent link measurements shall be used to attach the field tester to the permanent link under consideration.
12. Test setup: The permanent link test configuration is to be used by installers and users of data telecommunications systems to verify the performance of permanently installed cabling. A schematic representation of the permanent link is illustrated in figure 1. The permanent link consists of up to 90 m (295 ft) of horizontal cabling and one connection at each end and may also include an optional transition/consolidation point connection. The permanent link excludes both the cable portion of the field test instrument cord and the connection to the field test instrument.
13. Replace or repair and cables, connectors, and/or terminations found to be defective.
14. Repair, replace, and/or re-work any or all defective components to achieve cabling tests which meet or exceed 568B permanent link requirements prior to acceptance of the installation or payment for services.

### **3.5 DEMONSTRATION AND INSTRUCTION**

- A. Furnish the services of a factory-trained engineer or technician for a total of one one-hour class to instruct designated Facility Information

Technologies personnel. Instruction shall include cross connection, corrective, and preventive maintenance of the wired network system and connectivity equipment.

- B. Before the System can be accepted by the VA, this training must be provided and executed. Training will be scheduled at the convenience of the Facilities Contracting Officer and Chief of Engineering Service.
- C. On-site start-up and training of the advanced utility metering system shall include a complete working demonstration of the system with simulation of possible operating conditions that may be encountered.
  - 1. Include any documentation and hands-on exercises necessary to enable electrical and mechanical operations personnel to assume full operating responsibility for the advanced utility monitoring system after completion of the training period.
- D. Include 6 days on-site start-up assistance and 3 days on-site training in two sessions separated by minimum 1 month.
- E. Regularly schedule and make available factory training for VA staff training on all aspects of advanced utility metering system including:
  - 1. Comprehensive software and hardware setup, configuration, and operation.
  - 2. Advanced monitoring and data reporting.
  - 3. Advanced power quality and disturbance monitoring.
- F. Before the system is accepted by the VA, the contractor shall walk-through the installation with the VA's representative and the design engineer to verify proper installation. The contractor may be requested to open enclosures and terminal compartments to verify cable labeling and/or installation compliance.
- G. As-built drawings shall be provided noting the exact cable path and cable labeling information. Drawings in .DWG format will be available to the contractor. As-builts shall be submitted to the VA on disk saved as .DXF or .DWG files. Redline hardcopies shall be provided as well. CAD generated as-built information shall be shown on a new layer named AS\_BUILT.

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