SECTION 25 10 10
ADVANCED UTILITY METERING SYSTEM

SPEC WRITER NOTES:
1. Delete between //____// if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs. This specification section applies to and shall be included with all work to be performed under the 22, 23, 26, 32, and 33 Divisions of the Master Construction Specifications. The Section is general in nature, and should be edited to fit each project.
2. Provide schedule for each flow meter listing flow meter type, fluid type and characteristics, temperature and pressure of fluid, flow range (maximum and minimum flows), maximum pressure loss, minimum meter accuracy, English and metric measurement units.
3. The VA has in place a Corporate-Wide Advanced Utility Metering Database, which allows the VA to automatically query some of its facilities for their energy and water usage. This specification rolls-out Advanced Utility Metering Systems (AUMS) to all of its facilities. Each facility shall include an AUMS, periodically transmitting information in a format compatible with the existing VA Corporate-Wide Advanced Utility Metering Database .
4. This specification defines the structure for the roll-out of the AUMSs: each VISN or VAMC shall be provided (by this section, if not already in-place) a Site Data Aggregation Device (a PC workstation or server) ; communications between this Site Data Aggregation Device and the VA’s Corporate-Wide Advanced Utility Metering Database shall be via periodic TCP/IP communications; communications between the Site Wide Aggregation Device and the facility’s meters shall be via Ethernet cabling (separate from the IT system’s and the HVAC control system’s cabling), and wireless; and meters of the facility’s energy flows and water flows.
5. Communications (especially TCP/IP) shall comply with NIST-recommended security protocols.

6. Communications between meters and the Site Data Aggregation Device shall allow for real-time and high-sampling frequency automatic monitoring of energy flows throughout and within each facility as well as less-frequent interval or “billing” metering. The AUMS shall include capacity for future automatic control: dispatch of loads depending on thresholds being reached, alarm notices auto-sent under various conditions, and the like. The AUMS shall include various levels of operator interface and access, and shall allow for customizable viewports as required by the User.
7. This specification includes meters and communications systems which may not be relevant to the individual project. The specifying engineer shall survey the site and examine physical conditions and constraints relative the facility being designed. The specifying engineer shall coordinate the metering and communications scope with the facility engineer and the Resident Engineer. The specifying engineer shall only then edit this specification to include only those features relevant to and required by the AUMS.
8. Separate cabling or radio transmission (RF) from the meters to the Site Data Aggregation Device is required. The communications transmission shall not be run on the facility’s IT network. If the meters are existing and part of the facility’s direct digital control system, and if those existing meters are sufficient to this Section’s mission, the information may then be transmitted over the facility’s direct digital control system network to the facility’s ECC, and from there to the AUMS.
9. Show on drawings all communications cabling routing, meter and trim installation details and locations, as well as describing methods and means limitations for the implementation of the AUMS.
10. The specifying engineer shall have complete knowledge of the space and cable pathways (i.e. equipment rooms, TCs, conduits, wireways, etc.) of the Facility. The specifying engineer shall at a minimum design and install

the System using the Pathway Design Handbook H-088C3, TIA/EIA Telecommunications Building Wiring Standards, and VA's Facility Chief of Information Technologies(IT) instructions, as approved in writing by the VA.

11. Design a new system conforming to current and accepted digital industrial/commercial cable and RF distribution standards. The distribution cable installation shall be fully coordinated with the VA prior to the start of installation.
12. Specify cable in this system (i.e. backbone, outside plant, inside plant, and station cabling) to conform to this Section and to accepted industry and OEM standards with regards to size, color code, and insulation. The pair twists of any pair shall not be exactly the same as any other pair within any unit or sub-unit of cables that are bundled in twenty-five (25) pairs or less.
13. The System cables shall be protected conduit. The specifying engineer shall include Section 26 05 33 in the specifications for the work. Some areas of this Facility may be considered "plenum". If any of wire and cable used in support of the installation in those areas is not in conduit (this guidance does not grant relief from the protection): then the cabling must comply with national and relevant codes pertaining to plenum environments. Review the VA's cable and wire requirements with the VA prior to installation to confirm the type of environment present at each location.
14. Design outside- and inside-plant cables that furnish the number of cable pairs required in accordance with the System requirements described herein. Fully coordinate and obtain approval of the design with the original equipment manufacturer and the VA prior to installation.
15. Addition of advanced meters shall in no way affect any existing utility meter or its components. This meter shall be used as supplemental information. Know that meters installed adjacent other utility meters will not read exactly the

same. This difference is due to the different turn-down ratios, calibrations to different CT's, and also due to differing accuracies of the meters.

16. Existing meters already in place may serve the mission of this Section, provided that they comply with the communications and accuracy requirements of this Section. Confirm this re-use with the VA's Facility Engineer and REO.
17. Unless the construction is on a greenfield, most of the utilities metered by this Section are fundamental to the operation of the facility. Choose insertion-type meters and use hot-taps into active piping systems and other means to allow for meter insertion into the utility distribution systems without forcing outages of those systems.
18. Meter maintenance is an important concern for the VA: where feasible, specify meters with no moving parts, so minimizing maintenance of mechanical components over the life of the meter.

PART 1 - ENERAL

1.1 DESCRIPTION

A. This Section includes the following for the advanced metering of the systems of the facility. The metered systems include the electrical power, natural gas distribution, fuel gas and fuel oil, steam, steam condensate, chilled water, heating water, domestic water, recovered water and makeup water systems. The metering systems in each facility are part of a 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. PC-based workstation(s) or server(s) and software.
2. Communication network and interface modules for //RS-232, RS-485, Modbus TCP/IP, IEEE 802.3// data transmission protocols.
3. Electric meters.
4. Volumetric flowmeters, temperature sensors and pressure transducers.
5. Mass flowmeters.

1.2 RELATED WORK

A. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of nonstructural components. //

B. Section 22 05 19 METERS AND GAGES FOR PLUMBING PIPING: meters and gages.

C. Section 22 33 00 ELECTRIC DOMESTIC WATER HEATERS: references meters.

D. Section 22 34 00 FUEL-FIRED DOMESTIC WATER HEATERS: references meters.

E. Section 22 35 00 DOMESTIC WATER HEATER EXCHANGERS: references meters.

F. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements, common to more than one section in mechanical.

G. Section 23 09 11, INSTRUMENTATION AND CONTROL FOR BOILER PLANT: Flowmeters

H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Flowmeters and communications

I. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

J. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage cable.

K. 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.

L. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

M. Section 26 11 16, SECONDARY UNIT SUBSTATIONS: Unit secondary substation.

N. Section 26 13 00, MEDIUM-VOLTAGE SWITCHGEAR: High voltage switchgear.

O. Section 26 18 41, MEDIUM-VOLTAGE SWITCHES: High voltage switches.

p. Section 26 23 00, LOW-VOLTAGE SWITCHGEAR: Secondary distribution switchgear.

Q. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Secondary distribution switchboards.

R. Section 26 24 19, MOTOR-CONTROL CENTERS: Motor control assemblies.

S. Section 32 84 00 PLANTING IRRIGATION: references meters.

T. Section 33 10 00 WATER UTILITIES: references meters.

U. Section 33 51 00 NATURAL GAS DISTRIBUTION: references meters.

V. Section 33 63 00 STEAM ENERGY DISTRIBUTION: references meters.

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 that 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
Natural Gas	l/s (CFH)	10:1	±2%
Liquefied Petroleum Gas	l/s (CFH)	10:1	±2%
Steam	kW (MBH)	20:1	±2%
Condensate	kW (MBH)	20:1	±2%
Domestic Water flow	l/s (GPH)	20:1	±2%
Reclaimed Water flow	l/s (GPH)	20:1	±2%
Make-up Water to Boilers flow	l/s (GPH)	10:1	±2%
Make-up Water to Cooling Towers flow	l/s (GPH)	10:1	±2%
No. 2 Heating Oil	l/s (GPH)	10:1	±2%
No. 6 Heating Oil	l/s (GPH)	10:1	±2%
Heating Water	kW (MBH)	20:1	±2%

Chilled Water	kW (MBH)	20:1	±2%
Outside Air Temperature	°C (°F)	n/a	±2%
Outside Air Relative Humidity	% rh	n/a	±2.5%

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. l/s: liter per second
   CFH: cubic feet per hour
   kW: kilowatt
   MBH: 1000's British Thermal Units per hour
   GPH: gallons per hour

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 (such as flowmeters, temperature sensors and pressure transmitters, 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 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 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.
6. "Quick-Start" guide to describe a simple, three-step commissioning process for setting the equipment’s Ethernet address, and ensuring trouble-free data access from any PC on the network, using a standard web browser.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future utility metering system revisions.

E. Firmware Upgrade Kit: For Owner to use in modifying firmware to suit future power system revisions or advanced utility metering system revisions. Firmware updates, and necessary software tools for firmware updates, shall be downloadable from the internet. VA shall be able to update firmware, in equipment, without removing device from the equipment. VA shall be capable of updating firmware over the utility

metering communication network or through local communication ports on the device.

F. Software licenses and upgrades required by and installed for operating and programming digital and analog devices.

G. Qualification Data: For installer and manufacturer

H. Other Informational Submittals:

1. System installation and setup guides, with data forms to plan and record options and setup decisions.

I. 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. Operating and applications software documentation.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot compact disks, and drivers for all installed hardware. Provide separately for each PC.
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.
6. In addition to the copies required by 01 00 00, provide 5 bound paper copies of the Operation and Maintenance Data and two compact disks (CD), with all Instructions as Acrobat PDF files. The pdf files shall identical to the paper copies and shall Acrobat navigation tools including Bookmarks for each Chapter.

7. The advanced utility metering system Operation and Maintenance Instructions shall include:
   a. Procedures for the AUMS system start-up, operation and shut-down.
   b. Final As-Built drawings, including actual LAN cabling routing shown on architectural backgrounds.
      1) IP address(es) as applicable for each piece of network hardware.
      2) IP address for each computer server, workstation and networked printer.
      3) Network identifier (name) for each printer, computer server and computer workstation.
      4) CEA-709.1B address (domain, subnet, node address) for each CEA-709.1B TP/FT-10 to IP Router.
   c. Routine maintenance checklist, rendered in a Microsoft Excel format. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall list each device’s node identifier/address, the third column shall describe each device’s physical location, the fourth column shall state the maintenance activity or state no maintenance required, the fifth column shall state the frequency of the maintenance activity, frequency of calibration and the sixth column for additional comments or reference.
   d. Qualified service organization list.
   e. In addition to the requirements in Section 01 33 23, the submittal shall include manufacturer Installation Requirements.
   f. Include complete instructions for calibration of each meter type and model.
   g. Start-Up and Start-Up Testing Report.
   h. Performance verification test procedures and reports.
   i. Preventive Maintenance Work Plan.
   j. In addition to factory-trained manufacturers' representatives requirements in 01 00 00, provide signed letter by factory-trained manufacturers' representatives stating that the system and components are installed in strict accordance with the manufacturers’ recommendations.

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 //two// //Insert number// years.

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 with attached procedures indicated by meter and component manufacturers. 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.

2. Semiannual Maintenance: perform the following Semiannual Maintenance as specified:

a. Perform data backups on all Server Hardware.

b. Run system diagnostics and correct diagnosed problems.

c. Perform fan checks and filter changes for AUMS hardware.

d. Perform all necessary adjustments on printers.

e. Resolve all outstanding problems.

f. Install new ribbons, ink cartridges and toner cartridges into printers, and ensure that there is at least one spare ribbon or cartridge located at each printer.

3. Maintenance Procedures

a. Maintenance Coordination: Any scheduled maintenance event by Contractor that will result in component downtime shall be coordinated with the VA as follows. Time periods shall be measured as actual elapsed time from beginning of equipment off-line period, including working and non-working hours.

1) For non-redundant computer server hardware, provide 14 days notice, components shall be off-line for no more than 8 hours.

2) For redundant computer server hardware, provide 7 days notice, components shall be off-line for no more than 36 hours.

3) For active (powered) network hardware, provide 14 days notice, components shall be off-line for no more than 6 hours.

4) For cabling and other passive network hardware, provide 21 days notice, components shall be off-line for no more than 12 hours.

b. Software/Firmware: Software/firmware maintenance shall include operating systems, application programs, and files required for the proper operation of the advanced utility metering system regardless of storage medium. User- (project site-) developed software is not covered by this contract, except that the advanced utility metering system software/firmware shall be maintained to allow user creation, modification, deletion, and proper execution of such user-developed software as specified. Perform diagnostics and corrective reprogramming as required to maintain total advanced utility metering system operations as specified. Back up software before performing any computer hardware and software maintenance. Do not modify any parameters without approval from the VA. Any approved changes and additions shall be properly documented, and the appropriate manuals shall be updated.

c. Network: Network maintenance shall include testing transmission media and equipment to verify signal levels, system data rates, errors and overall system performance.

B. Service Call Reception

1. A VA representative will advise the Contractor by phone or in person of all maintenance and service requests, as well as the classification of each based on the definitions specified. A description of the problem or requested work, date and time notified, location, classification, and other appropriate information will be placed on a Service Call Work Authorization Form by the VA.
2. The Contractor shall have procedures for receiving and responding to service calls during regular working hours. A single telephone number shall be provided for receipt of service calls during regular working hours. Service calls shall be considered received by the Contractor at the time and date the telephone call is placed by the VA.
3. Separately record each service call request, as received on the Service Call Work Authorization form.Complete the Service Call Work Authorization form for each service call. The completed form shall include the serial number identifying the component involved, its location, date and time the call was received, nature of trouble, names of the service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the materials to be used, the time and date work started, and the time and date of completion.
4. Respond to each service call request within two working hours. The status of any item of work must be provided within four hours of the inquiry during regular working hours, and within sixteen hours after regular working hours or as needed to repair equipment.

1.11 SPARE PARTS

A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Addressable Relays: One for every ten installed. Furnish at least one of each type.
   2. Data Line Surge Suppressors: One for every ten of each type installed. Furnish at least one of each type.
B. Furnish spare parts shall not be used for any warranty-required remediation.

1.12 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.

SPEC WRITER NOTES:
Following (within these Notes) are documents which are not referenced by this specification, but which provide contextual information to the specifying engineer.

AMI System Security Requirements, by the Advanced Metering Infrastructure System Security Task Force(AMI-SEC): this is a wok in progress by a utility industry consensus group.
National Infrastructure Protection Plan (2009), by the Department of Homeland Security: this si a management-level perspective on protection of federal information systems.
IEC 7498-1-1994 Open Systems Interconnection – Basic Reference Model: The Basic Method (ISO OSI), by the International Electrotechnical Commission: the antecedent layer reference for standardized digital communications; since superseded by other more specific standards.
SNVT List-2002 LonMark SNVT Master List; Version 11 Revision 2, by Lonmark International: many existing VA digital control systems use Lonmark networks.
XIF Guide (2001) LonMark External Interface File Reference Guide; Revision 4.0B: many existing VA digital control systems use Lonmark networks.
ITU-T, v.34 (94), by the International Telecommunications Union: a superseded draft standard for the old Hayes modem (28.8 kbit/sec).
ITU-T, V42), by the International Telecommunications Union: an error control protocol, generally used with dial-up modems.

B. American Society of Mechanical Engineers (ASME):

B16.1-1998.....Cast Iron Pipe Flanges and Flanged Fittings

B31.1-2007.....Power Piping

B31.8-2007.....Gas Transmission and Distribution Piping Systems

B31.9-2008.....Building Services Piping
B40.100-1998.....Pressure Gauges and Gauge Attachments

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASHRAE 135-2008.....A Data Communication Protocol for Building Automation and Control Networks (ANSI)

D. American Society for Testing and Materials (ASTM)
A53-2006.....Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106-2006.....Seamless Carbon Steel Pipe for High Temperature Service

E. 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

F. Federal Communications Commission (FCC)
EMC-2002.....FCC Electromagnetic Compliance Requirements

G. 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

H. International Electrotechnical Commission (IEC)

IEC 61000-2005.....Electromagnetic Compatibility (EMC)- Part 4-5: Testing and Measurement Techniques; Surge Immunity Test

I. National Electrical Contractors Association

NECA 1-2006.....Good Workmanship in Electrical Construction

J. 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

K. 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

L. National Fire Protection Association (NFPA)

30-08.....Flammable and Combustible Liquids Code

70-2008.....National Electrical Code (NEC)

54-06.....National Fuel Gas Code
85-07.....Boiler and Combustion Systems Hazard Code
101-06.....Life Safety Code
262-2007.....Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

M. NSF International
14-03.....Plastics Piping Components and Related Materials
61-02.....Drinking Water System Components-Health Effects (Sections 1-9)

N. 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

O. 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.

2) Steam and condensate

3) Domestic water.

4) Natural gas.

5) Oil.

6) Liquefied Petroleum Gas.

7) Used, Boiled/Evaporated, Reclaimed and Recovered water.

8) Chilled water

9) Heating water

c. Software: calculate allocation of utility costs.

SPEC WRITER NOTE:
The following paragraph is an unexercised capability of the AUMS, for possible future use by the VA. The VA does not presently bill departments.

1) Automatically import energy and water usage records to allocate energy and water costs for the following:

a) At least //XXX// departments.

b) At least //XXX// processes.

c) At least //XXX// buildings.

2) 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.

6) //XXX parameter.//

SPEC WRITER NOTE:
The following two paragraphs are unexercised capabilities of the AUMS, for possible future use by the VA. The AUMS is not a supervisory control and data acquisition system.

e. Emergency Load Shedding. Preserve critical loads or avoid total shutdown due to unforeseen loss of power sources according to the following logic:

1) Determine system topology.

2) Evaluate remaining loads and sources.

3) Shed loads in less than 100 ms.

4) //XXX activity related to load shedding.//

f. Demand Management:

1) Peaking or co-generator control.

2) Load interlocking.

3) Load shedding.

4) Load trimming.

5) //XXX management strategy.//

g. System: Report equipment status and power system control.

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. Hardware

SPEC WRITER NOTE:
Specify a workstation for larger facilities which have an energy engineer in residence. Specify a rack-mounted server for small facilities which have no resident energy engineer. Coordinate location with Users.

1. Workstation Hardware

a. Environmental Conditions: System components shall be capable of withstanding Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 140 deg F dry bulb temperature and 20 to 95% relative humidity, noncondensing environmental conditions without mechanical or electrical damage or degradation of operating capability.

b. Computer: Commercial standard with supporting 32- or 64-bit hardware (as limited by the advanced utility metering system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 4GB DDR3 SDRAM (minimum 1333 Mhz) memory, minimum 1 TB 7200 rpm SATA hard drive with 16 MB cache, 512 MB video card, and 16 speed high density DVD-RW+/- optical drive.

c. Real-Time Clock:

1) Accuracy: Plus or minus 1 minute per month.

2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.

3) Clock shall function for one year without power.

4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.

d. Serial Ports: Four USB ports and two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
e. Parallel Port: Enhanced.
f. Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
g. Color Monitor: PC compatible, not less than 22 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.
h. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
i. Mouse: Standard, compatible with installed software.
j. Removable Disk Storage: Include the following, each with appropriate controller:
   1) Minimum 1 TB removable hard disk, maximum average access time of 10 ms.
k. Network Interface Card (NIC): integrated 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector.

SPEC WRITER NOTE: Provide the cable modem and the Optical modem even if the infrastructure isn’t yet provided to the facility.

l. Cable Modem: 42.88 Mbps, DOCSIS 3.0 Certified, also backwards compatible with DCOSIS 2.0 and DOCSIS 1.1/1.0 standards. Provide Ethernet or USB connectivity.
m. Optical Modem: full duplex link, for use on 10 GBase-R single-mode and multi-mode fiber with a XENPAK module.
n. Modem: 56,600 bits per second, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
o. Audible Alarm: Manufacturer's standard.

2. Printers: provide a dedicated, minimum resolution 600 dpi, color laser printer, connected to the Site Data Aggregation Device through a USB interface.

a. If a network printer is used instead of this dedicated printer, it shall have a 100Base-T interface with an RJ45 connection and shall have a firmware print spooler compatible with the Operating System print spooler.
b. RAM: 512 MB, minimum.
c. Printing Speed: Minimum twenty six pages per minute (color); minimum 30 pages per minute (black/white).
d. Paper Handling: Automatic sheet feeder with 250-sheet x 8.5 inch x 11 inch paper cassette and with automatic feed.

3. RS-232 ASCII Interface
   a. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.
   b. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
   c. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
   d. Alarm System Interface: RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
   e. Cables: provide Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
      1) NFPA 70, Type CMP.
      2) Flame Resistance: NFPA 262, Flame Test.
4. Rack-Mounted Server Hardware
   a. Environmental Conditions: System components shall be capable of withstanding Indoor installation in spaces that have environmental controls to maintain ambient conditions of 36 to 140 deg F dry bulb temperature and 20 to 95% relative humidity,

noncondensing environmental conditions without mechanical or electrical damage or degradation of operating capability.

b. Computer: Commercial rack-mounted with supporting 32- or 64-bit hardware (as limited by the advanced utility metering system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 4GB DDR3 SDRAM (minimum 1333 Mhz) memory, minimum 1 TB 7200 rpm SATA hard drive with 16 MB cache, and 16 speed high density DVD-RW+/- optical drive.

c. Real-Time Clock:
   1) Accuracy: Plus or minus 1 minute per month.
   2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
   3) Clock shall function for one year without power.
   4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.

d. Serial Ports: Four USB ports and two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.

e. Parallel Port: Enhanced.

f. Removable Disk Storage: Include minimum 1 TB removable hard disk, maximum average access time of 10 ms, with appropriate controller:

g. Network Interface Card (NIC): integrated 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector.

SPEC WRITER NOTE: Provide the cable modem and the Optical modem even if the infrastructure isn’t yet provided to the facility.

h. Cable Modem: 42.88 Mbps, DOCSIS 2.0 Certified, also backwards compatible with DOCSIS 2.0 and DOCSIS 1.1/1.0 standards. Provide Ethernet or USB connectivity.

i. Optical Modem: full duplex link, for use on 10 GBase-R single-mode and multi-mode fiber with a XENPAK module.

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k. Audible Alarm: Manufacturer's standard.

5. RS-232 ASCII Interface

a. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.

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e. Cables: provide Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

1) NFPA 70, Type CMP.

2) Flame Resistance: NFPA 262, Flame Test.

B. Software

1. Operating System (OS)

a. For a Site Data Aggregation Device connected to multiple utility meters, software shall reside on the Workstation or Server PC connected to a network able to poll and support over 1000 utility metering devices; software shall be web-enabled with the option

to add custom graphics displays and additional web-enabled clients. BACNet, Ethernet, Modbus TCP/IP, RS-232, and RS-485 digital communications.

b. Operating System Software: Based on 32- or 64-bit, Microsoft Windows operating system, as required by the metering and database software. 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.

2. Office Automation Software shall consist of the e-mail, spreadsheet and word processing portions of the project site's standard office automation software.
3. Virus Protection Software shall consist of the project site's standard virus protection software complete with a virus definition update subscription.
4. Configuration server shall meet the requirements of CEA-852-A.
5. Network configuration tool shall meet the following minimum requirements:
   a. It shall allow configuration of the network while off-line such that an operator may set up changes to the network while disconnected from the network, and then execute all of them once connected.
   b. It shall have a graphics-based user interface, and be able to display and print a graphical representation of the control network.
   c. It shall be capable of generating and printing a table containing domain/subnet/node address and node identifier for the entire network or any subset thereof, selected by the User.
   d. It shall be capable of merging two existing standard databases into a single standard database.
6. Metering 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 on-line 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 the Site Data Aggregation Device 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. Workstation and Server Functions:
1) Support other client PCs on the LAN and WAN.
2) Maintain recorded data in databases accessible from other PCs on the LAN and WAN.

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.
5) Option to serve information to third-party applications via Object Linking and Embedding for Process Control using open standards.

d. Metered data: Display metered values in real time with a rigid time-stamp. Couple all metered data with measured outside air conditions at the relevant facility.

e. Metered Data alarms: Provide generic alarm modules to notify Users and highlight metered data gaps, data spikes outside of range, and data timestamp errors.

1) Customize the generic alarm modules to the application.
2) Modules shall allow for user adjustment of alarm criteria.
3) Alarm notices shall be shown via hyperlinks on the graphical User interface, and shall also be shown by flags within the data set.

f. Automatic Data Scrubbing: Provide tools for User-programming of rules to scrub the data of the followings errors: data gaps, data spikes outside of range, and data timestamp errors. Use these rules to scrub the raw metered data. Flag all data which has been so scrubbed.

SPEC WRITER NOTE:
Remote control (following is a latent capability of the AUMS: the AUMS is not a supervisory control and data acquisition system. It may be improved in the future to become one, however.

g. Remote control:
1) (for electrical load control) Display circuit-breaker status and allow breaker control.
2) User defined with load-shedding automatically initiated and executed schemes responding to programmed time schedules, set points of metered demands, utility contracted load shedding, or combinations of these.

h. Equipment Documentation: Database for recording of equipment ratings and characteristics; with capability for graphic display on monitors.

i. User-Defined 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, pickup, trip, and no-response events.

j. (for electrical power monitoring) Waveform Data: Display and record waveforms on demand or automatically on an alarm or programmed event; include the graphic displays of the following, based on user-specified criteria:
1) Phase voltages, phase currents, and residual current.
2) Overlay of three-phase currents, and overlay each phase voltage and current.

3) Waveforms ranging in length from //2//] //Insert number// cycles to //5// //Insert number// minutes.
4) Disturbance and steady-state waveforms up to 512 points per cycle.
5) Transient waveforms up to 83,333 points per cycle on 60-Hz base.
6) Calculated waveform on a minimum of four cycles of data of the following:
   a) THD.
   b) rms magnitudes.
   c) Peak values.
   d) Crest factors.
   e) Magnitude of individual harmonics.

k. Data Sharing: Allow export of recorded displays and tabular data to third-party applications software on the local server.
l. Activity Tracking Software:
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 electric utilities, including current vendor.
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.
m. Passwords
n. Protocol Drivers
o. System Graphic Displays: provide interactive color-graphics platform with pull-down menus and mouse-driven generation of power system graphics, in formats widely used for such drafting; to include the following:
1) Site plan.
2) Floor plans.
3) Equipment elevations.
4) Single-line diagrams.

5) Custom graphic screens configured, not programmed, using drag-and-drop tools available within the software.

p. 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.

q. Trending: display and record data acquired in real-time 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.

r. Report Generation: 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.
      a) Sort and report by device name and by function.
      b) Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.
      c) Differentiate alarm signals from other indications.
      d) When system is reset, report reset event with same information concerning device, location, date, and time.

7. BACnet: Site Data Aggregation Device shall have demonstrated interoperability during at least one BMA Interoperability Workshop and shall substantially conform to BACnet Operator Workstation (B-OWS) device profile as specified in ASHRAE/ANSI 135-2001, BACnet Annex L
8. Site Data Aggregation Device shall periodically upload metered data to the VA Corporate-wide server:
   a. The metering software shall provide periodic upload (adjustable interval, initially set on 15-minute intervals) of the scrubbed and collected data.

b. The VA’s Corporate wide server accepts the following data structures:
   1) Information structured using the 2005 and 2008 SQL server database engine.
   2) The following data stores are acceptable:
      a) Databases: SQL Server, DB2, Oracle, Access, Sybase, MySQL.
      b) Flat files: .CSV, .XLS, .TXT, .XML, .PQDIF
c. The minimum data to be uploaded (per meter) includes:
   1) A time stamp
   2) A device identifier
   3) A flow (power or water flow) value
   4) A flow order of magnitude
   5) Description of the flow’s units
   6) The outside air drybulb temperature at the time stamp
   7) The outside air wetbulb temperature at the time stamp
   8) A “scrubbed data” flag
   9) An irregular data alarm stamp

C. Self-contained uninterruptible power supply (UPS):
   1. Size: Provide a minimum of six hours of operation of workstation station equipment, including two hours of alarm printer operation.
   2. Batteries: Sealed, valve regulated, recombinant, lead calcium.
   3. Accessories:
      a. Transient voltage suppression.
      b. Input-harmonics reduction.
      c. Rectifier/charger.
      d. Battery disconnect device.
      e. Static bypass transfer switch.
      f. First six subparagraphs below are optional accessories.
      g. Internal maintenance bypass/isolation switch.
      h. External maintenance bypass/isolation switch.
      i. Output isolation transformer.
      j. Remote UPS monitoring.
      k. Battery monitoring.
      l. Remote battery monitoring.

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 throughout the Facility for all 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. LAN FIBER OPTICAL CABLES

1. Interior Fiber Optic Cable: Interior Fiber Optic Cable shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00 "Communications Horizontal

Cabling." The data communications equipment shall use the 850-nm range of multimode or 1310-nm range of singlemode fiber-optic cable. Fiber-optic cable shall be suitable for use with the 100Base-FX standard as defined in IEEE Std 802.3.

2. Exterior Fiber Optic Cable: Exterior Fiber Optic Cable shall be Multimode or Singlemode Fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00 "Communications Horizontal Cabling.". The data communications equipment shall use the 850-nm range of multimode or 1310-nm range of singlemode fiber-optic cable. Fiber-optic cable shall be suitable for use with the 100Base-FX standard as defined in IEEE Std 802.3.
3. Fiber Optic Patch Panels shall be wall or rack mountable and designed to provide termination facilities for up to 24 fibers. Unit shall also have capability to be equipped with spliced trays, six packs (for adapters), and blank panels for easy termination of the fiber bundles and tube cables. Fiber-optic terminating equipment shall provide for mounting of ST or SC connectors on an optical patch panel. Provide fiber-cable management and cable-routing hardware to assure conformance to minimum fiber and cable bend radii. Connectors on the patch panel shall be ST or SC feed through. Provide access to both sides of the panel. The patch panel for the connectors shall be mounted to facilitate rearrangement and identification. Each apparatus shall have cabling and connection instructions associated with it.
4. Fiber Optic media converter shall provide media conversion between layer 1 copper and fiber media to support data rates equal to the greater of the physical layer or 100 Mbps as specified in IEEE Std 802.3.

D. 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.

E. WIRELESS MODEMS

SPEC WRITER NOTES:
RF shall not be used where proscribed by other standards, such as in or near critical-care spaces.

The AE shall design the RF antenna support, taking into account structural loads including wind loads and seismic loads.

The AE should conduct a signal survey to determine the usable frequency(ies), obstacles and other path loss factors. A structural engineer should be consulted to determine the impact of the antenna wind loading on the structure.

Provide wireless modems for high speed, point-to-point Ethernet communications between sites. Transceivers shall be single integral units and may be mounted within the building in a NEMA 1 enclosure or weatherproof with integral antenna and pole mounted. System shall have the following features as a minimum:

SPEC WRITER NOTES:
The AE shall specify the transmission frequency.

1. //4.9x GHz Licensed Frequency// //902-928Mhz Industrial/ Scientific/Medical (ISM)// //2.4GHz Industrial/Scientific/Medical (ISM)// //5.8GHz Industrial/Scientific/Medical (ISM)// band.
2. //Obtain FCC license on behalf of the VA for each licensed frequency.//
3. Security protocol shall utilize a minimum of 128-bit data encryption. //Provide Simple Network Management Protocol (SNMP) for network diagnostics and management.// Transceiver shall have status indicators for power, ethernet link status and RF link status.
4. Operating Conditions: 0 degrees C to 55 degrees C, 85% relative humidity (32 degrees F to 131 degrees F, 85% relative humidity).
5. Transmitter/Receiver/Antenna combination shall provide less than 0.005% frame error rate at 10Mbps data rate between sites.
6. Antennas may be omni-directional or directional as required for system gain. Antennas and supports shall withstand a combined load of ½" ice and 125mph wind loading.

7. Provide heavy-duty antenna masks and //wall// //roof// mask mount to support antennas. All hardware shall be stainless steel. Ground antenna mast per NFPA 780.
8. Coaxial cable shall be 0.200 diameter minimum for lengths below 50’ and 0.400 diameter or greater for length greater than 50’.
9. Surge suppressors for coaxial cables shall be rated for the frequency of operation, utilize gas tube technology and have a maximum let thru of 1mJ. Provide UL1449 listed, Type 1, 50kA, 120V, surge protective device for each power circuit.

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 each 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

SPEC WRITER NOTE:
The following paragraphs describe meters used in sub-metering roles as well as meters which may be used at the facility's service entrance. Verify with service utility their provisions and requirements: edit accordingly.

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 meters 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.

SPEC WRITER NOTE:
The following relates to real-time pricing electric price structures.

b. Demand calculations initiated by a Utility-furnished synchronization signal:

1) Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.

2) Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.

3) Demand can be synchronized with clock in the power meter.

c. 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.

d. 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.

2.7 WATER, OIL, GAS METER DEVICES

A. Water, oil and gas meter applications:

SPEC WRITER NOTE:
Utilize vortex meters for natural gas flow. Alternatively, turbine meters may be used for natural gas flow. See spec writer notes regarding use of turbine meters.

These meters may already be in place, or may already be specified in Sections 23 09 23 or 23 09 11. If the existing meters or if the meters specified elsewhere are sufficient to this Section's mission, those meters may be used for the Section's mission. Edit accordingly.

1. Steam Meters: provide vortex-shedding flowmeters, along with temperature sensors and pressure transducers to develop the energy flow.

SPEC WRITER NOTE:
The following paragraphs do not include turbine meters in recommendations for water applications, because of the maintenance issues described above. If first cost becomes an overriding factor, the AE may consider their use.

2. Steam Condensate Meters: provide a magnetic flowmeter in new installations; provide an ultrasonic or vortex-shedding flowmeter in existing installations which service interruption is not allowed. Provide temperature and pressure transducers to develop the energy flow.
3. Natural Gas Meters: provide vortex-shedding flowmeters with pressure sensors.
4. Liquefied Petroleum Gas Meters: provide vortex-shedding flowmeters with pressure sensors.
5. Potable (Domestic) Water: provide a magnetic flowmeter in new installations; provide an ultrasonic or vortex-shedding flowmeter with pressure sensor in existing installations which service interruption is not allowed.
6. Reclaimed (storm or gray): provide a magnetic flowmeter in new installations; provide a vortex-shedding flowmeter with pressure

sensor in existing installations which service interruption is not allowed.

7. Make-up Water Meters //to Cooling Towers, Evaporative Cooling Systems and Boiler Systems//: provide a magnetic flowmeter in new installations; provide a vortex-shedding flowmeter with pressure sensor in existing installations which service interruption is not allowed.
8. Oil Meters
   a. No. 2 Oils and other Light Oils (less than 60 SSU viscosity at 38 degrees C (100 degrees F)): use screw-type or positive-displacement (such as rotating piston or oscillating piston) flowmeters.

      SPEC WRITER NOTE:
      These below oils are not prevalent, as they must be heated in order to handle them.

   b. No. 6 and Other Heavy Oils (more than 90 SSU viscosity at 38 degrees C (100 degrees F)): use positive-displacement flowmeters(such as rotating piston or oscillating piston).
9. HVAC Hydronic System Water Meters
   a. Chilled Water Systems: provide vortex-shedding flowmeters with pressure and temperature sensors to determine energy flow.
   b. Heating Water Systems: provide vortex-shedding flowmeters with pressure and temperature sensors to determine energy flow.

B. Associated Devices (to provide outside air conditions as well as energy metering, not merely flow metering):
   1. Temperature Sensors: Resistance Temperature Device (RTD) with an integral transmitter type.
      a. Immersion sensors shall be provided with a separable thermowell. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
      b. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
      c. Output Signal: 4-20 ma or digital.
   2. Humidity Sensors: Bulk polymer sensing element type.
      a. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
      b. Output Signal: 4-20 ma continuous output signal.

3. Pressure sensors.
   a. Gas Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   b. Water Pressure Transmitters: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
4. Thermowells.
   a. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting. Stepped shank unless straight or tapered shank is indicated. ASME B40.200. Bore diameter required to match thermometer bulb or stem. Insertion length required to match thermometer bulb or stem. Provide a lagging extension on thermowells for insulated piping and tubing. Provide bushings. Use a mixture of graphite and glycerin for the thermowell's heat transfer medium.
      1) Material for Use with Copper Tubing: copper nickel (90-10).
      2) Material for Use with Steel Piping: stainless steel.

C. Turbine flowmeters (natural gas duty).

SPEC WRITER NOTE:
Verify pressure requirements and revise as appropriate.

Meter maintenance is an important concern for the VA: where feasible, specify meters with no moving parts, so minimizing maintenance of mechanical components over the life of the meter. Turbine meters have moving parts.

Use the following paragraph if Section 23 09 11 is included in the technical specifications of the work. If that Section is not included, then delete the following paragraph, and use the paragraphs following it.

1. Flowmeter shall be as specified in Section 23 09 11, in the "Turbine-Type Natural Gas Flow Meters" paragraph. Provide data head on meter as specified in this section.
2. Meter shall be designed for // 125 // 250 // 300 psi. Meter's pipe connection flanges shall be ANSI Class // 125 or Class 150 // 250 or Class 300//. All meter bearings and gearing shall be in areas sealed from metered fluid and contaminants. Metering transducers shall be operated through magnetic coupling. The measuring devices

shall be contained within a module that can be removed from the meter body for service and calibration without breaking the system piping connections. Meter shall be constructed for measured fluid's chemical characteristics. Construct meter of corrosion-resistant materials, or provide a corrosion-resistant coating.

3. Provide a data head on the meter.
4. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.
5. Performance:
   a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 0.5% of flow rate.
   b. Flowmeter accuracy shall be no more than plus or minus 0.1%. Flowmeter repeatability shall be no more than 0.3% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.
   c. Minimum turndown capability shall be 10:1.
   d. Pressure drop shall not exceed 1.25 kPa (5 inches WC).
6. Calibration: Factory calibrated. Furnish three-point curve spanning required flow range on actual meter furnished.
   a. This meter requires //annual// semi-annual // // re-calibration.
7. Accessories:
   a. Filter: Shall have replaceable glass-fiber or cellulose cartridge with ten micron or smaller particle retention. Filter enclosure shall be the pipe size of the meter or larger as required by pressure drop considerations. Static pressure capability shall be at least twice lockup pressure of service supply regulators. Maximum pressure loss 1.25 kPa (5 inches WC) at maximum design flow rate of meter. Plug all drains or instrumentation outlets. Provide vent with cock for relieving pressure in filter.

D. Turbine flowmeters (water duty).

SPEC WRITER NOTE:
Verify pressure requirements and revise as appropriate.

Meter maintenance is an important concern for the VA: where feasible, specify meters with no moving parts, so minimizing maintenance of mechanical components over the life of the meter. Turbine meters have moving parts.

Use the following paragraph if Section 23 09 23 is included in the technical specifications of the work. If that Section is not included, then delete the following paragraph, and use the paragraphs following it.

1. Flowmeter shall be as specified in Section 23 09 23, in the “water flow sensors” paragraph. Provide data head on meter as specified in this section.
2. Sensor shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minute 0.05 inch; wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
   a. Ambient conditions: -40 to 60 degrees C (-40 to 140 degrees F), 5 to 100 percent humidity
   b. Operating conditions: 850 kPa (125 psig), 0 to 120 degrees C (30 to 250 degrees F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
3. Performance:
   a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 1% of actual flow rate.
   b. Flowmeter accuracy shall be no more than plus or minus 0.1% of actual flow rate. Flowmeter repeatability shall be no more than 0.3% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.
   c. Minimum turndown capability shall be 20:1.
   d. Pressure drop shall be as scheduled, maximum 1% of line pressure in lines sized 4 inches and larger.
   e. Ambient temperature effects, less than 0.005 percent calibrated span per degree C (degree F) temperature change.
   f. RFI effect - flow meter shall not be affected by RFI.
   g. Power supply effect less than 0.02 percent of actual flow rate for a variation of plus or minus 10 percent power supply.

4. Provide a data head on the meter.
   a. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet)..
5. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.

E. Screw type flowmeters (No. 2 oil duty)
1. Meters shall have cast iron cases, nitrided steel spindles, Viton seals, threaded pipe connections, designed for pressure exceeding set pressure, plus 25 percent, of nearest upstream relief valve. Meters shall be rated for 121 degrees C (250 degrees F) if utilized for heated oil.
2. Provide a meter data head.
   a. Meter Registers: Hermetically sealed flow computer with digital flow rate readout and digital register for totalizer with at least five digits located at meter, positioned for easy viewing. Provide a data head on the meter.
3. Performance:
   a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 1% of flow rate.
   b. Flowmeter accuracy shall be no more than plus or minus 0.1%, over the required flow range. Flowmeter repeatability shall be no more than 0.2% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.
   c. Minimum turndown capability shall be 10:1. Its maximum fluid pressure drop through meter shall be as scheduled.

F. Vortex-shedding flowmeters.
1. Meter shall have an all-welded flanged 316 stainless steel meter body with no seals. No sensor parts shall be exposed to the flow stream. Provide a 316 stainless steel trapezoidal shedder bar, sensing by detecting stresses in the shedder bar caused by vortices, and dual piezoelectric crystals located outside the process flow sense the shed vortices (dual crystal alignment cancels effects of noise and vibration). Design meter for Schedule 40 piping.
   a. Meter shall be suitable for 25% warmer than the fluid operating temperature and for 25% higher than either the fluid’s operating

pressure or 25% higher than the piping system’s safety valve set pressure, whichever is higher.

b. Meter flanges shall be Class 300 or higher, if required by the piping system’s temperature and pressure Class.

c. Meter shall be suitable for installation in ambient conditions ranging from -29 to 60 degrees C (-20 to 140 degrees F).

2. Provide meter data head.

a. Meters shall have digital readout of pressure-compensated flow rate and totalization located at transmitter and transmit flow rate and totalization digital signals to the Site Data Aggregation Device // and recorders //. As an option, pressure compensation and the compensated flow rate may be performed and displayed by the Site Data Aggregation Device receiving signals from the flow meter and from a pressure transmitter.

b. Provide programmable microprocessor electronics with on-board programming. Output signals shall be immune to ambient temperature swings. Processor shall include continuous self-diagnostic routines that identify electronics problems and provide a warning. Electronics shall be replaceable in the field without affecting metering accuracy. Provide power supply as recommended by meter manufacturer. Mount electronics in a NEMA 4 enclosure separate from meter body in position accessible from platform or floor without the use of a portable ladder.

1) Power supply to meter and transmitter shall be 120V/60hz. Provide a Class 2 control voltage transformer for 24VDC power to meter as needed.

2) Provide an internal battery, provided for 24-month retention of RAM contents when all other power sources are removed.

3. Performance:

a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 1.5% of flow rate.

b. Flowmeter accuracy shall be no more than plus or minus 1% of span for gasses and plus or minus 0.7% of span for liquids. Flowmeter repeatability shall be no more than 0.2% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.

c. Minimum turndown ratio shall be 20:1 for gasses and liquids. Maximum fluid pressure drop shall be as scheduled.

G. Ultrasonic (Doppler and time of travel) flowmeters.

1. Provide a clamp-on flowmeter precluding the requirement of penetrating into the process pipe. The flowmeter shall be completely microprocessor based utilizing the transit-time flow measurement technique. The flowmeter shall employ the phase detection multiple pulse transmit principle in conjunction with multiple frequency axial beam transducer technology to insure operation on liquids with solids and or bubbles. In addition, the flowmeter shall incorporate an alternate Doppler method measurement mode for highly aerated or heavy solid bearing liquids.
2. Provide a meter data head.
   a. The flowmeter shall provide automatic transducer spacing for clamp-on transducers utilizing a prefabricated mounting frame or mounting track (ruler scales shall not be acceptable), the meter shall also support in-line transducers. The meter shall also provide automatic Reynolds Number and liquid sonic velocity variation compensation and live zero flow measurement.
      1) By use of either transit-time or Doppler modes of operation, the flowmeter shall be capable of measuring all liquids in full sonically conductive pipes.
   b. The flowmeter shall have the ability to indicate flow rate, flow velocity, total flow, signal strength, liquid sonic velocity, Reynolds Number and liquid aeration level.
   c. The flowmeter shall be equipped with an integral front panel keypad and multifunction 240 X 128 pixel LCD display. In addition, the flowmeter shall provide self and application diagnostics to isolate any fault conditions to either equipment failure or abnormal process conditions.
   d. The flowmeter shall have full HELP menu routines corresponding to all levels of programming and operation.
   e. The flowmeter electronics shall be housed in a NEMA 4X enclosure and powered by 90-240VAC, 50-60Hz. Two isolated 4 to 20 maDC and two 0 to 5000 Hz pulse outputs proportional to flow shall be provided. The current outputs must be capable of driving a 1000-ohm resistive load. In addition, the unit shall provide two 0 to 10 volt outputs and four SPDT alarm relays assignable to flow velocity, liquid sonic velocity, signal strength or liquid aeration.

f. Provide an internal 1 MB data logger shall be provided to allow storage of all measured and calculated variables and alarms in intervals of 10 minutes.

g. Two each bi-directional communications ports shall be provided.
1) One each RS-485 with Modbus RTU or BACnet protocol.

3. Performance:

a. The flowmeter shall have an accuracy of plus or minus 1% of flow over span. Repeatability shall be 0.25% of flow.

b. Meter shall have a flow sensitivity of 0.001 fps at any flow rate including no flow conditions.

H. Magnetic flowmeters.

1. Meter shall have an all-welded flanged 316 stainless steel engineered flow tube with no seals. No sensor parts shall be exposed to the flow stream. Design meter for mating with Schedule 40 piping.

a. Meter shall be suitable for 25% warmer than the fluid operating temperature and for 25% higher than either the fluid’s operating pressure or 25% higher than the piping system’s safety valve set pressure, whichever is higher.

b. Meter flanges shall be Class 150 // Class 300 // or higher, if required by the piping system’s temperature and pressure Class.

c. Meter shall be suitable for installation in ambient conditions ranging from -29 to 60 degrees C (-20 to 140 degrees F).

2. Provide meter data head.

a. Meters shall have digital readout of pressure-compensated flow rate and totalization located at transmitter and transmit flow rate and totalization digital signals to the Site Data Aggregation Device // and recorders //. As an option, pressure compensation and the compensated flow rate may be performed and displayed by the Site Data Aggregation Device receiving signals from the flow meter and from a pressure transmitter.

b. Provide programmable microprocessor electronics with on-board programming. Output signals shall be immune to ambient temperature swings. Processor shall include continuous self-diagnostic routines that identify electronics problems and provide a warning. Electronics shall be replaceable in the field without affecting metering accuracy. Provide power supply as recommended by meter manufacturer. Mount electronics in a NEMA 4

enclosure separate from meter body in position accessible from platform or floor without the use of a portable ladder.

1) Power supply to meter and transmitter shall be 120V/60hz. Provide a Class 2 control voltage transformer for 24VDC power to meter as needed.

3. Performance:

a. Transmitted signal from flowmeter and its transmitter shall have a total (rms) accuracy plus or minus 1.5% of flow rate.

b. Flowmeter accuracy shall be no more than plus or minus 1.5% of actual flow rate for gasses and plus or minus 1% of actual flow rate for liquids. Flowmeter repeatability shall be no more than 0.2% of actual flow rate. Meter shall be designed to minimize vibration effect and to provide elimination of this effect.

c. Minimum turndown ratio shall be 20:1 for gasses and liquids. Maximum fluid pressure drop shall be as scheduled.

I. Positive-displacement oil flowmeters.

1. Meter shall be a rotating- or oscillating-piston meter with a and aluminum piston, cast bronze body, safety filter, viton o-rings and Class 150 flanges mating with Schedule 40 piping. Meter shall transmit pulse signals to meter’s data head.

2. Provide meter data head.

a. Meters shall have digital readout flow rate and totalization located at transmitter and transmit flow rate and totalization digital signals to the Site Data Aggregation Device // and recorders //. As an option,

b. Provide programmable microprocessor electronics with on-board programming. Output signals shall be immune to ambient temperature swings. Processor shall include continuous self-diagnostic routines that identify electronics problems and provide a warning. Electronics shall be replaceable in the field without affecting metering accuracy. Provide power supply as recommended by meter manufacturer. Mount electronics in a NEMA 4 enclosure separate from meter body in position accessible from platform or floor without the use of a portable ladder.

1) Power supply to meter and transmitter shall be 120V/60hz. Provide a Class 2 control voltage transformer for 24VDC power to meter as needed.

3. Performance:

a. Flowmeter accuracy shall be no more than plus or minus 1.5% of actual flow rate.

b. Minimum turndown ratio shall be 10:1.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Cabling

1. Install Category 5e UTP, Category 6 UTP, and optical fiber cabling 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 5e, 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 and optical fiber 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. Comply with VA 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS and with VA 26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

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 and as shown. 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 Hardware
   1. Provide the server(s) or personal computer workstation(s) where shown on the plans or indicated diagrammatically.

G. Computer Software
   1. User friendly software shall be suitable for operation on computer workstations which serve as site data aggregation devices by monitoring the meters in the system, recording events, indicating alarm conditions, and logging and displaying system reports.
   2. The software shall be developed by the manufacturer of the monitoring devices, and shall be designed specifically for energy, power monitoring and control. Additional utilities, i.e. water, air gas, electric and steam shall also be easily integrated.
   3. The software shall be configured, not programmed. All software shall be configured by the vendor and delivered ready to use. This configuration shall include preparation of all graphics, displays, and interactive one-line diagrams required as a part of this project.
      a. Configuration shall be to the point that when monitoring devices are required to be added, the user shall only convey to the software the communications address and type of device.

4. The software shall be a standard product offering with no customization required and clients shall interface with the server or computer workstation via Internet Explorer browser.
   a. The web-enabled interactive graphics client shall only reside on the server PC, client PC not required to host any application software other than Internet Explorer 6.0 SP1 or higher browser to become a fully functional system.

H. 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.

I. Water, Oil and Gas Meters
1. Thermowells
   a. Install thermowells with socket extending a minimum of 2 inches into fluid or one-third of pipe diameter and in vertical position in piping tees.
   b. Install thermowells of sizes required to match temperature sensor connectors. Include bushings if required to match sizes.
   c. Install thermowells with extension on insulated piping.
   d. Fill thermowells with heat-transfer medium.
2. Provide a test plug beside each temperature sensor.
3. Flow meters, general
   a. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
   b. Connect flowmeter-system elements to meters, connect flowmeter transmitters to meters, and connect thermal-energy meter transmitters to meters.

c. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
d. Install flowmeter elements in accessible positions in piping systems.
e. Install flowmeter, with minimum 20 x pipe diameter straight lengths of pipe upstream and minimum 10 x pipe diameter straight lengths of pipe downstream from flowmeter unless otherwise indicated by manufacturer’s written instructions.
f. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

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.

F. Optical Fiber cables: Contractor shall provide all necessary testing equipment to test all optical fiber cables.
   1. Attenuation Testing:
      a. Singlemode testing shall conform to TIA/EIA 526-7 Method A.1 single jumper reference and TIA/EIA 568-B-1 requirements for link segment testing.
      b. Multimode testing shall conform to TIA/EIA 526-14-A Method B single jumper reference and TIA/EIA 568-B-1 requirements for link segment testing.
      c. Attenuation testing shall be performed in one direction at each operating wavelength.
      d. Testing of backbone fiber optic cabling shall be performed from main telecommunications room to each telecommunications room.
      e. Testing of horizontal fiber optic cabling shall be performed from telecommunications room to station outlet location.
      f. Tester shall be capable of recording and reporting test reading in an electronic format.
   2. OTDR Testing:
      a. OTDR testing is required on all backbone fiber optic cables
      b. The test shall be preformed as per the EIA/TIA 455-61.
      c. Multimode testing shall be performed with a minimum 80 meter launch cable.
      d. Singlemode testing shall be performed with a minimum of 500 meter launch cable.
      e. Tests shall be performed on each fiber in each direction at both operating wavelengths.
   3. Test report data shall reference cables by cable labeling standards. Tests shall be submitted on a 1.5mb, 3.5" DOS formatted floppy disk. Contractor shall provide tests in the native file format of the tester. Contractor shall provide all software needed to view, print, and edit tests.
   4. Replace or repair and defective cables, connectors, terminations, etc.
   5. Mated connector pairs shall have no more than 0.5dB loss. Fusion splices shall have no more than .15dB loss per splice. Cable attenuation shall be no more than 2% more than the attenuation of

the cable on the reel as certified at the factory. Repair, replace, and/or rework any or all defective components to achieve specified test results prior to acceptance of the installation or payment for services.

G. Wireless Modems: Test system by sending 100,000 commands. Frame error rate shall not be greater than 5 out 100,000 commands.

3.5 DEMONSTRATION AND INSTRUCTION

A. Furnish the services of a factory-trained engineer or technician for a total of two four-hour classes 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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