SECTION 25 10 10
ADVANCED UTILITY METERING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes the following for the advanced metering of the systems of the facility. The metered systems include the, natural gas distribution, steam, chilled water, heating water, domestic water, recovered water and makeup water systems. The metering systems in each facility shall be part of a Corporate-Wide utility metering system, rendering the -- accurate and automated metering of its facilities' energy and water flows. Metering systems are comprised of but not limited to the following:

1. PC-based workstation(s) and software.
2. Communication network and interface modules.
3. Volumetric flowmeters, temperature sensors and pressure transducers.
4. 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 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

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

E. .

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

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

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

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

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, btu) and transferring that data to a central database for billing, troubleshooting, and analyzing.

B. 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.

C. 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

D. 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.

E. 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.
F. Ethernet: Local Area Network (LAN), based on IEEE 802.3 standards.
G. 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.
H. Gateway: Bi-directional protocol translator connecting control systems that use different communication protocols.
I. GB: Short for gigabyte. When used to describe data storage, "GB" represents 1024 megabytes.
J. HTML: Hypertext markup language.
K. I/O: Input/output.
L. KB: Short for kilobyte. When used to describe data storage, "KB" represents 1024 bytes.
M. 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. Sometimes plural as "LANs."
N. LAN: Local area network.
O. LCD: Liquid crystal display.
P. 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.
Q. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a “Neuron Chip” for communication.
R. LonWorks: Network technology developed by the Echelon Corporation.
S. 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.
T. MB: Short for megabyte. When used to describe data storage, "MB" represents 1024 kilobytes.
U. Modbus TCP/IP: An open protocol for exchange of process data.
V. 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.
W. 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
X. PC: Personal computer
Y. PICS, Protocol Implementation Conformance Statement: A written document that identifies the particular options specified by BACnet that are implemented in a device.
Z. Reported 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.
AA. 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.

BB. Router: A device that connects two or more networks at the network layer.
CC. RS-232: A TIA standard for asynchronous serial data communications between terminal devices.
DD. RS-485: A TIA standard for multipoint communications using two twisted-pairs.
EE. TB: Short for terrabyte. When used to describe data storage, "TB" represents 1024 gigabytes.
FF. TCP/IP: Transport Control Protocol/Internet Protocol.
GG. 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
HH. THD: Total harmonic distortion.
II. UPS: Uninterruptible power supply; used both in singular and plural context.
JJ. WAN: Wide area network.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 PERFORMANCE

A. The advanced utility metering system shall conform to the following:
1. 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.
2. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values reported by the meters:

Measured Variable	**Units Measured**	**Minimum Turn-Down of Meter**	**Reported Accuracy (Note 1)**
Natural 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 (e.g., Boiler flow and cooling tower flow)	l/s (GPH)	10:1	±2%
Heating Water	kW (MBH)	20:1	±2%
Chilled Water	kW (MBH)	20:1	±2%

Table 1.5: Meter Performance Criteria

Table Notes:
1. This table shows reported accuracy, not device accuracy. 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. At a minimum, 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 monitoring and control.

1. Provided to -- COTR for approval prior to contractor purchase
2. -- reserves the right to reject the salient characteristics.

B. Shop Drawings: include plans, elevations, sections, details, and attachments to other work.

1. Outline Drawings: Indicate arrangement of 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 magnetic media or compact disc, complete with Owner-selected options.
4. Device address list and the set point of each device and operator option, as set in applications software.
5. Graphic file and printout of graphic screens and related icons, with legend.
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. -- shall be able to update firmware, in equipment, without removing device from the equipment. -- shall be capable of updating firmware over the utility metering communication network or through local communication ports on the device.

F. Software licenses 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. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Software shall include system restore, emergency boot diskettes, and drivers for all installed hardware. Provide separately for each PC.
4. 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.
5. 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.
6. 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 state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, frequency of calibration and the fourth column for additional comments or reference.
(d) Qualified service organization list.
(e) In addition to the 01 00 00, 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 (PVT) Procedures and Reports.
(i) Preventive Maintenance Work Plan.

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 expiry and include updates during the life of the product.

1.10 MAINTENANCE AND SERVICE

A. Preventive Maintenance Requirements: provide a preventative maintenance plan with attached procedures indicated by meter and component manufacturers.
1. Preventive Maintenance Work Plan: prepare a Preventive Maintenance Work Plan to schedule all required preventive maintenance. The work plan shall detail the items to be services, type of maintenance, and schedule for each service (e.g., monthly) as well as a detailed description of the maintenance to be performed. -- approval of the Work Plan shall be obtained.
2. Calibration requirements, timelines, and procedures.
3. Provide recommended tools/meters for maintenance?

1.11 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
1. Advanced Metering Infrastructure System Security Task Force(AMI-SEC)
   2008 ..... AMI System Security Requirements
2. 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
3. American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE 135-2004 .. A Data Communication Protocol for Building Automation and Control Networks (ANSI)

4. 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
5. 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
6. Department of Homeland Security (DHS)
   2009 ..... National Infrastructure Protection Plan
7. Federal Communications Commission (FCC)
   EMC-2002 ..... FCC Electromagnetic Compliance Requirements
8. 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
9. International Electrotechnical Commission (IEC)
   IEC 61000-2005 ... Electromagnetic Compatibility (EMC)- Part 4-5: Testing and Measurement Techniques; Surge Immunity Test
   IEC 7498-1-1994 .. Open Systems Interconnection – Basic Reference Model: The Basic Method (ISO OSI)
10. National Electrical Contractors Association
   NECA 1-2006 ..... Good Workmanship in Electrical Construction
11. 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

12. 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

13. International Organization for Standardization (ISO)
ISO OSI ..... Model Open Systems Interconnection Reference Model

14. LonMark International (LonMark)
SNVT List-2002 ... LonMark SNVT Master List; Version 11 Revision 2
XIF Guide (2001 .. LonMark External Interface File Reference Guide; Revision 4.0B

15. 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

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

17. Telecommunications Industry Association, (TIA)
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

18. 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. Monitor and record load profiles. Chart energy consumption patterns.
   (a) Measure and record metering data for the following:
      (1) Steam and condensate
      (2) Domestic water.
      (3) Natural gas and other fuel gas.
      (4) Used, Boiled/Evaporated, Reclaimed and Recovered water.
   (b) Meter all data points relevant to the determination of energy and /or water usage and cost / bill auditing.
      (1) Verify utility bills and analyze alternate energy rates.
   (c) System: Report equipment status and power system control.
2. Advanced meters to be installed, according to this specification, shall in no way affect any existing utility meter or its components. This meter shall be used as supplemental information. It may be obvious, but the meters installed adjacent other utility meters will not read exactly the same. This error is due to the different turn-down ratios, calibrated to different CT's, and also due to different/ higher accuracy of the meter itself.

B. Communications Components and Networks

1. A Separate communication infrastructure shall be required to support the AUMS. The communications transmission shall not be run on the facility's IT network. If the meters are existing and part of the facility's 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.
2. The meter devices shall communicate with the facility or campus wireless access device through a wireless Ethernet / RF modem.
3. Meters shall communicate with the facility / wireless access point through Spread spectrum radios that satisfy and IC rules for unlicensed radio operation in the 902–928 MHz ISM band.
4. Meters shall communicate with the facility / wireless access point through using the spread spectrum Frequency Hopping technique for data communications. Frequency hopping has the advantage of transmitting with higher power over each single frequency for maximum range. In addition, robust interference rejection shall be insured by the use of traditional narrow band filtering techniques to reject noise and interference.
   (a)
5. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard LAN and WAN and Internetworked LAN.
6. Communication Security
   (a) All data transmitted shall be encrypted when being transferred from the site to the Pilot Metering System or to a collection point if wireless technology is used. The encryption shall use AES encryption cipher with a minimum encryption key size of 128 bits.

2.2 SITE DATA AGGREGATION DEVICE – PERSONAL COMPUTER WORKSTATION

A. Hardware

1. Laptop Hardware
   (a) The site aggregation device will be used to collect raw meter data for review. This device is not intended to be a local energy management system with long-term storage and analysis capabilities. These capabilities are part of the VA's corporate-wide utility metering system where meter data is transferred from the meter directly to a central storage and analysis location via the wireless access device and the Internet.
   (b) 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.
   (c) Computer: Commercial standard with supporting 32- or 64-bit hardware (as limited by the advanced utility metering system software) and software. 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 500 GB 7200 rpm SATA hard drive with 16 MB cache, 512 MB video card, and 16 speed high density DVD-RW+/- optical drive.
   (d) 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.
   (e) 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.
   (f) Parallel Port: Enhanced.
   (g) Sound Card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
   (h) Color Monitor: not less than 15.4 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.
   (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.

(l) Wireless Networking: Integrated 802.11 a/b/g/n wireless Ethernet NIC card

(m) Modem: 56,600 bps, 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.

(n) Audible Alarm: Manufacturer's standard.

2. 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) Alarm System Interface: RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.

(c) 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) Software Configured to run on a portable laptop computer, a single PC, or a hand-held device, with capability for accessing a single meter at a time. System is not connected to a LAN. Modbus TCP/IP, RS-232, and RS-485 digital communications.

(b) Operating System Software: Based on 32- or 64-bit, Microsoft Windows operating system. Software shall have the following features:

(1) Multiuser and multitasking to allow independent activities and monitoring to occur simultaneously at different workstations.

(2) Graphical user interface to show pull-down menus and a menu tree format.

(3) Capability for future additions within the indicated system size limits.

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.
   (a)
5. Metering Software
   (1)
   (b) 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 OPC.
   (c) 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.
   (d) Data Sharing: Allow export of recorded displays and tabular data to third-party applications software on the local server.
   (1)
   (e) 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.
   i.
6. 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
   (a)

2.3 Campus / Facility Communication

A. General

1. Installed System Capabilities
   (a) The installed wireless network has the capability of handling 255 remotes for any type of meter, whether they be electrical, gas, water or steam meters, per Access Point or Master Radio, however a campus can have multiple AP’s
   (b) All wireless devices have remote network analysis enabled and available for remote monitoring, testing, configuration, and troubleshooting.
2. Ethernet Radio System
   (a) Spread spectrum radios supplied under this contract shall meet FCC and IC rules for unlicensed radio operation in the 902–928 MHz ISM band.
   (b) The radio shall use the spread spectrum Frequency Hopping technique for data communications. Frequency hopping has the advantage of transmitting with higher power over each single frequency for maximum range. In addition, robust interference rejection shall be insured by the use of

traditional narrow band filtering techniques to reject noise and interference.

(c) All radios shall be manufactured in the United States of America and the radio manufacturer shall be certified as an ISO 9001 approved facility. A certificate of ISO 9001 registration shall be included with the bid documents.

(d) The radio shall have FCC and Industry Canada certification under FCC rules Part 15.247 and IC RSS-210. No license will be required to operate radios supplied under this contract.

(e) The radios shall be industrial rated, with an MTBF of 35 years or better, following Telcordia method 1, case 3.

(f) The radio shall be UL approved for operation in Class I, Division 2, Groups A, B, C, D hazardous locations when installed in an approved enclosure.

B. Data Interface Capabilities

1. The Ethernet communications capabilities of the radio shall meet the following general requirements:
   (a) The Ethernet interface shall be 10BaseT on RJ45 connector.
   (b) The radios shall be able to bridge all types Ethernet frames.
   (c) The Ethernet interface shall support VLAN tagging following the IEEE 802.1Q standard
      (1) The Ethernet port shall support VLAN trunk mode
      (2) The Ethernet port shall support VLAN access mode. In this mode untagged traffic is tagged with a specifiv VLAN ID
      (3) The Ethernet port shall support operation of untagged Native VLAN when configured as Trunk.
      (4) Management traffic shall be kept on a different VLAN than that of the data traffic. This VLAN may be the Native VLAN.
2. The radios shall have a built in serial device server to allow connection of serial devices without requiring external interface boxes such as terminal servers.
3. The Serial communications capabilities of the radio shall meet the following general requirements:
   (a) The radio shall have two serial ports capable of transporting data traffic.
   (b) The serial data interfaces shall be RS232 signaling on DB9 connectors.
   (c) The interface data rate shall be adjustable from 1,200 to 115,200 bps.
   (d) Serial interfaces shall be available at either the Acces Point or any of the remote radios.
   (e) Serial data shall be transportable by encapsulation over the IP protocol.
   (f) Serial encapsulation shall be configurable as TCP or UDP socket.
   (g) Remotes radios shall be configured to encapsulate serial data over UDP shall accept IP multicast addresses as a valid destination address for local processing of data.
   (h) The radio shall be configurable to transport the users serial protocol without any kind of modifications required to the protocol.
   (i) The radio shall be capable of transporting data without introducing data gaps at the receiving end.

(j) It shall not acceptable to require a front-end controller to convert protocols or reorder data packets.
(k) It shall not acceptable to transmit data in a non-deterministic manner such that data would be received longer than 100 ms after transmission.

C. Cyber Security
1. The radios shall encrypt wireless control information that identifies the network, such as the SSID or equivalent information.
2. The radios shall encrypt wireless data using the AES encryption cipher with a minimum encryption key size of 128 bits.
3. The radios shall rotate the encryption key automatically without requiring operator intervention.
4. The radios shall support the 802.1x standard and interface with a RADIUS server for authentication purposes.
5. The radios shall support the EAP/TLS authentication standard, which includes two-way authentication mechanism.
6. The Access Point radios shall require that remote radios authenticate to the RADIUS server before allowing them to associate and pass data traffic.
7. The radios shall require a user/password to be provided before allowing access to the management interface. Verification of the user/password shall reside at a central RADIUS server.
8. The radios shall support Secure Shell (SSH) as a secure method of remote access to the management interface.
9. The radios shall support HTTPS as a secure web browser method of remote access to the management interface.
10. The radios shall provide a way to disable either mode of remote management access.
11. The radios shall provide a method to temporarily disable local or remote access to the management interface after a pre-defined number of failed login attempts is exceeded.

D. Management
1. The radio system shall provide integral diagnostic capability to allow the user to verify communications reliability between the master and remote radios.
2. All system configuration parameters shall be capable of being set by the user via a PC connected directly to the radio either through the Ethernet port or through a serial port. It will not be acceptable to require an external interface box to adapt a hand held terminal or PC to the radio, nor will it be acceptable to have any internal adjustments or switch settings of any type.
3. A diagnostic port shall be available to enable the remote RTU/PLC/Terminal to access all radio diagnostics directly from the radio and enable radio diagnostic data to be incorporated into the SCADA system database.
4. Radio performance statistics shall be maintained by each radio. This information shall include as a minimum, a) the total number of transmitted packets, b) the total number of received packet and c) the total number of packet with errors.
5. Basic diagnostic information shall be available from each radio via external LED’s including as a minimum: Power, link status, alarm state, Ethernet connection status, radio data activity, Ethernet data activity and serial data activity.
6. Remote management for each radio shall be accessible via a standard Web browser interface such as Microsoft Internet

Explorer, or via a Telnet session. It is preferred to have both methods available.

7. Network-wide remote management shall be an integral part of the radio and shall be compatible with SNMP based network managers.
8. SNMP management in the radios shall support v1/v2/v3 versions of SNMP.

E. Radio Transceiver Performance

1. The radios shall provide high performance, long distance communications. System gain shall be no less than 141 dB.
2. The radios shall be capable of over-the-air transmission rate of 1 Mbps or higher.
3. Communications between the central master site and all remote sites shall provide a Collision Avoidance mechanism.
4. The system shall allow communications between remote radios in an indirect form through the Access Point.
5. Transmit power shall be adjustable from 20 to 30 dBm.
6. The radio shall be capable of hopping over at least 37 different frequencies or channels.
7. Channel configuration shall be initiated at the AP radio and then broadcasted to all remote radios in the system.
8. The radio shall have a minimum of 15-byte network name or network ID. Assignment of a unique network name (which sets the hop pattern) insures that multiple radio systems can operate in the same area with minimal interference.
9. The radio system shall utilize internal components that automatically optimize communication performance and eliminate the requirements for internal tuning adjustments. A radio that requires internal adjustments shall be considered non-compliant.
10. Radio overhead or latency for Ethernet traffic shall average 10 ms but cannot exceed 50 ms (typical) for communications from master to remote or from remote to master when using a 100-byte ping test.
11. Software/Firmware configurable operating parameters shall be available to insure maximum radio system performance and that throughput is available for a wide variety of system conditions and configurations.
12. The radio shall be capable of operation on DC voltages from 10.5 to 30 VDC.
13. An optional “packaged” system shall be available that provides a Nema 4 enclosure with power supplies for 48, 120 VDC or 120/240 VAC at 50 or 60 Hz. Battery back-up with charger shall be available for radios with AC power supplies.
14. The radio shall have a diode protection to prevent problems caused by inverted power lead connections.

F. Radio System Specifications

1. The radio system shall meet the following specifications. If any specification is not met in its entirety, the supplier shall clearly identify the specific area of non-conformance as an exception to the specification.
2. GENERAL

(a)	Frequency Range	902–928 MHz ISM Band
(b)	Signaling rate	1 Mbps or 512 Kbps
(c)	MTBF	>306,000 hrs. (35 yrs.)

3. RADIO INTERFACE (antenna port)

(a)	Modulation Type	Binary CPFSK
(b)	Connector Type	TNC
(c)	Output Impedance	50 Ohms

4. TRANSMITTER

(a)	Power Output	0.1 to 1.0 watt (+20 to +30 dBm)
(b)	Duty Cycle	Continuous
(c)	Spurious Emissions	-67 dBc
(d)	Transmitter Keying	Data activated
(e)	Channel Bandwidth	600 kHz

5. RECEIVER

(a)	Type	Double conversion superheterodyne
(b)	Sensitivity	-99 dBm @ 512Kbps < 1x10-6 BER -92 dBm @ 1Mbps < 1x10-6 BER
(c)	Intermodulation	59 dB minimum (EIA)
(d)	Desensitization	70 dB

6. DATA INTERFACE (Ethernet)

(a)	User Interface	10BaseT
(b)	Interface Connector	RJ-45

7. DATA INTERFACE (Serial)

(a)	User Interface	RS-232
(b)	Interface Connectors	DB-9
(c)	Byte Lengths	10/11 bits
(d)	Data Transmission Rates	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps

8. PRIMARY POWER

(a)	Voltage	10.5–30.0 Vdc (13.8 Vdc nominal)
(b)	TX Supply Current	580 mA @ 13.8 Vdc
(c)	RX Supply Current	203 mA @ 13.8 Vdc
(d)	Connector	Power/Interface connector

9. ENVIRONMENTAL

(a)	Humidity	95% at 40°C (104°F); non-condensing
(b)	Temperature Range	–30° to + 60°C (–22° to 140°F) minimum
(c)	Size	2.0" x 5.625" x 7.25" H/D/W maximum
(d)	Weight	2.2 pounds (1.0 kg) maximum
(e)	Case	Die-cast aluminum preferred

10. AGENCY CERTIFICATIONS (US)

(a)	FCC	Part 15. 247
(b)	FM (for Hazardous Locations)	Class 1, Division 2, Groups A, B, C and D

(c)

G. Wireless Access Point

1. The AE shall 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.
2. Provide wireless access point for high speed, point-to-point Ethernet communications between sites and the Internet for transfer of data to VA central storage and analysis center. 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:
3. Wireless access points are required for all NCA locations and all VBA locations not collocated with a VHA site that already contains a wireless access point.

4. Wireless access point shall conform to those requirements defined in Section 2.3 of this specification.
5. Wireless access points shall be provided for all NCA sites and for all non collocated VBA sites.

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).

(1)

2.6 WATER, GAS METER DEVICES

A. Water, oil and gas meter applications:

1. General Requirements
   (a) Utilize turbine meters for natural gas flow (turbine meter has high turndown capability). Alternatively, vortex meters may be used for natural gas flow.
   (b) Ultrasonic meters shall be used in cases where a facility cannot support any outage (either during normal working hours or after hour/weekend) and where an in-line or hot tapped meter cannot be installed.
2. Steam Meters: provide vortex-shedding flowmeters, along with temperature sensors and pressure transducers to develop the energy flow.
3. 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.

4. Natural Gas Meters: provide vortex-shedding flowmeters.
5. Potable (Domestic) Water: provide a magnetic flowmeter in new installations; provide an ultrasonic or vortex-shedding flowmeter in existing installations which service interruption is not allowed.
6. Reclaimed Water (storm or gray): provide a magnetic flowmeter in new installations; provide a vortex-shedding flowmeter 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 in existing installations which service interruption is not allowed.
   (a)
8. HVAC Hydronic System Water Meters
   (a) Chilled Water Systems: provide vortex-shedding flowmeters with temperature sensors to determine energy flow.
   (b) Heating Water Systems: provide vortex-shedding flowmeters with temperature sensors to determine energy flow.

B. Associated Devices (to provide energy metering, and 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.
   (c) Steam Pressure Transmitter
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).

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, or 300 psi as appropriate. Meter's pipe connection flanges shall be ANSI Class 125, Class 150, Class 250, or Class 300 as appropriate. 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.
   (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. 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) 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).
   (c) Provide an internal 1 MB data logger shall be provided to allow storage of all measured and calculated variables and alarms in intervals of at most 15 minutes.
   (d) The flowmeter shall have full HELP menu routines corresponding to all levels of programming and operation.
   (e)
   (f)
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 1.5% 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 20:1.
   (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.
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).

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 minus 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 1.5% of flow rate.
   (b) Flowmeter accuracy shall be no more than plus or minus 0.1% of span. 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 span 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).
   (b) Provide an internal 1 MB data logger shall be provided to allow storage of all measured and calculated variables and alarms in intervals of at most 15 minutes.
   (c) The flowmeter shall have full HELP menu routines corresponding to all levels of programming and operation.
   (d)

(e)

5. Straightening Vanes: Provide as recommended by the meter manufacturer for the actual installation arrangement.

(a)

E. 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. 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.
   (c) Provide an internal 1 MB data logger shall be provided to allow storage of all measured and calculated variables and alarms in intervals of at most 15 minutes.
   (d) The flowmeter shall have full HELP menu routines corresponding to all levels of programming and operation.

   (e)
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.

F. 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. Ultrasonic Flowmeters shall only be installed in cases where a facility cannot support any outage (either during normal working hours or after hour/weekend) and where an in-line or hot tapped meter cannot be installed.
3. 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 shall 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 at most 15 minutes.
   (g) Two each bi-directional communications ports shall be provided.

(1) One each RS-485 with Modbus RTU protocol.

4. Performance:
   (a) The flowmeter shall have an accuracy of plus or minus 1.5 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.

G. 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 ANSI Class 125, Class 150, Class 250, or Class 300 as appropriate, 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. 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.
   (c) Provide an internal 1 MB data logger shall be provided to allow storage of all measured and calculated variables and alarms in intervals of at most 15 minutes.
   (d) The flowmeter shall have full HELP menu routines corresponding to all levels of programming and operation.
   (e)
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.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Meters, Data Communication and acquisition equipment shall be located and installed in a manner which allows safe and easy access for maintenance and operation. Remote local indication shall be provided for meters located such that the meter cannot be easily read.

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.
3. Install a permanent wire marker on each wire at each termination.
4. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
5. Wire markers shall retain their markings after cleaning.
6.

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.
2.

F. Water, 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. Temperature sensors

(a) Install temperature sensors and thermometers in the following locations:
(1) Inlet and outlet of each hydronic boiler.
(2) Each of two inlets and two outlets of each chiller.
(3) Two inlets and two outlets of each hydronic heat exchanger.
(4) Inlet and outlet of each thermal-storage tank.
(b) Provide a test plug beside each temperature sensor.

3. Pressure gages
(a) Install pressure gages in the following locations:
(1) Discharge of each pressure-reducing valve.
(2) Inlet and outlet of each chiller chilled-water and condenser-water connection.
(3) Suction and discharge of each pump.

4. Flow meters, general
(a) Install meters and guages 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 wafer-orifice flowmeter elements between pipe flanges.
(f) 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.
(g) Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

3.2 FIELD QUALITY CONTROL

A. The power monitoring and control system vendor shall be able to provide development, integration and installation services required to complete and turn over a fully functional system including:
1. Project management shall 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. 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.
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.

3.3 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 manufacturer's recommendation and the Contract Documents.

C. Before testing, the following prerequisite items shall 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.
6.

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

F. All meters shall be tested to ensure that all required interval data is collected by the meter and archived to a local site aggregation device and communicated to the wireless access device for transfer to the VA central metering system.

3.4 Commissioning and Verification

A. Intent

1. Shall verify that the intended design as reflected in the contract documents has been achieved.

B. Shall be the responsibility of the VA.

C. Commissioning and Verification shall be conducted in a manner to include the full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems function in accordance with the design intent, as identified in the contract documents. In this context, "function" includes all modes of operations, and all specified responses to abnormal emergency conditions.

D. Although not desirable, it may sometimes be necessary and acceptable to postpone testing, pending the appropriate climatic condition provided all parties understand the contractual implications.

E. The Contractor shall be on site to assist during the commissioning and verification process.

3.5 DEMONSTRATION AND INSTRUCTION

A. Furnish the services 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. This training shall also include training on all aspects of:

1. Comprehensive software and hardware setup, configuration, and operation.
2. Advanced monitoring and data reporting.
3. Advanced power quality and disturbance monitoring.

B. Before the System can be accepted by the VA, this training shall be provided and executed. Training will be scheduled at the convenience of the Facilities Contracting Officer and Chief of Engineering Service. Training schedule shall be defined by the VA COTR.

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 and shall be scheduled and coordinated by the VA COTR.

E. 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.

F. The contractor shall provide the following material for all training and demonstration courses:

1. Student manual/training materials
2. Videotape of one typical system administrator and one typical user training session for in-house instruction of personnel at a later date.
3. Two (2) DVD copies of typical system administrator and one typical user training session for in-house instruction of personnel at a later date.

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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