SECTION 26 09 13
ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1   DESCRIPTION:

A.   This section specifies the furnishing, installation and connection for a complete operational Power Monitoring and Control System. It shall include, but not be limited to, remote devices for monitoring, control and protection, device communication interface hardware, intercommunication wiring, master control unit, software, printer, ancillary equipment and startup and training services.

B.   The power monitoring and control system shall be installed on the main electrical equipment such as the high voltage switchgear and low voltage switchgear or switchboards including the essential electrical systems as shown on the drawings or otherwise indicated herein.

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

C.   Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

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

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

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

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

1.3   SUBMITTALS

A.   In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

    1.   Product Data: For each type of product indicated.

    2.   Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B.   Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

1.   Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components.

2.   Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, components, and location and size of each field connection.

3.   Detail shop drawings showing locations of devices and device address, connections, conduit runs, wiring type, etc…shall be submitted by the manufacturers.

4.   Installations of devices, wirings, connections, programming, testing, troubleshooting, etc…shall be performed by factory certified technicians.

5.   Certifications of the technicians shall be submitted.

C.   Software and Firmware Operational Documentation:

1.   Software operating and upgrade manuals.

2.   Software Backup: On a magnetic media or compact disc, complete with Owner-selected options.

3.   Device address list and the set point of each device and operator option, as set in applications software.

D.   Software Upgrade Kit: For Owner to use in modifying software to suit future power system revisions or power monitoring and control revisions.

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

F.   Field quality-control test reports. Contractor shall perform complete programming of the system to show all functions, data, graphics, etc…

G.   Maintenance and Operation Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 00 00, GENERAL REQUIREMENTS include the following:

1.   Operating and applications software documentation.

2.   Software licenses.

3.   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.

H.   Other Informational Submittals: System installation and setup guides, with data forms to plan and record options and setup decisions.

I.   Qualifications: The manufacturer of the equipment shall have been regularly engaged in the manufacture of the specified remote devices for a period of at least five (5) years and demonstrate that these products have been utilized in satisfactory use in functioning systems for similar applications. The manufacturer shall have at least five (5) years demonstrated capability in PMS design, installation and start-up.

1.4   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 basic designation only.

B.   Institute of Electrical and Electronic Engineers (IEEE):

802.3-02……… CSMA/CD Access Method and Physical Layer Specification

37.90-89……… Standard for Relays and Relay Systems Associated with Electric Power Apparatus

C.   FCC Emission Standards (FCC):

15, Part J………Radio Frequency Devices

D.   National Fire Protection Association (NFPA):

70-05…National Electrical Code (NEC)

1.5   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.

1.6   SOFTWARE SERVICE AGREEMENT

A.   Technical Support: Beginning with Substantial Completion, provide hardware and software support for two years by factory certified technicians. VA personnel shall be trained for a period of a week for operation and maintenance by certified technicians.

B.   Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include the operating systems. Upgrade shall include new or revised licenses for use of software:

1.   Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.7   WARRANTY

A.   The manufacturer shall warrant the equipment supplied hereunder. The warranty shall include:

1.   One (1) year free telephone technical support

2.   Warranty on all hardware supplied under this system shall be for one (1) year from start- up or 18 months from shipment, whichever is less.

3.   When the Manufacturer provides start-up service on the hardware supplied under this system, the standard warranty shall be for two (2) years from start-up or 30 months from shipment, whichever is less.

4.   During the guarantee period, emergency service and routine maintenance calls shall be responded to within a 4-hour period during the hours of 7am-7pm. Between the hours of 7pm-7am, calls shall be responded within an 8-hour period.

PART 2 - PRODUCTS

2.1   FUNCTIONAL DESCRIPTION:

A.   Instrumentation and Recording Devices: Monitor and record load profiles and chart energy consumption patterns.

1.   Calculate and Record the following:

a.   Load factor.

b.   Peak demand periods.

c.   Consumption correlated with facility activities.

B.   Software: Calculate allocation of utility costs.

1.   Automatically Import Energy Usage Records to Allocate Energy Costs for the following:

a.   At least five buildings.

2.   Verify utility bills and analyze alternate energy rates.

C.   Power Quality Monitoring: Identify power system anomalies and measure, display, and record trends and alarms of the following power quality parameters:

1.   Voltage regulation and unbalance.

2.   Continuous three-phase rms voltage.

3.   Periodic max./min./avg. samples of voltage, amperage and wattage.

4.   Harmonics.

5.   Voltage excursions.

2.2   MAIN NETWORK

A.   The main network shall be a dedicated Ethernet network, utilizing TCP/IP protocol communicating at 10/100 MegaBaud. The physical media used to form the network shall be fiber. Any devices connected to the main network shall be equipped with an Ethernet communication card and communicate at 10/100 MegaBaud. Provide network hubs, routers, switches, media converts, etc., as shown on drawings and as required for the installation.

B.   The main network shall be a shared Ethernet network, utilizing TCP/IP protocol communicating at 10/100 MegaBaud. The physical media used to form the network shall be fiber 10Base-T. All required network hubs, routers, switches, media converts, etc will be existing or provided under other sections of the specifications.

C.   The network shall have the capability of being connected to a higher-level network by a router or gateway provided by others.

D.   The system shall alarm on detected faults in communication servers or remote devices.

E.   The system shall have the capability of being programmed and modified online. It shall not be necessary to shut down any part of the system during programming operations.

2.3   SURGE PROTECTION

A.   Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

B.   Transient Voltage Surge Suppression and Electromagnetic-Interference Immunity: Include in solid-state equipment. Comply with IEEE C37.90.

C.   Signal wiring shall be integrated to the main Ethernet line.

2.4   2.4 APPLICATIONS SOFTWARE

A.   Software: Configured to run on a portable laptop computer, a single PC, or a palm computer, with capability for accessing a single meter at a time.

B.   Basic Requirements:

1.   Fully compatible with and based on the approved manufacturer's operating system.

2.   Password-protected operator login and access.

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.   Automatic and encrypted backups for database and history; automatically stored at central control PC and encrypted with a nine-character alphanumeric password, which must be used to restore or read data contained in backup.

7.   Operator audit trail for recording and reporting all changes made to user-defined system options.

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.

D.   Metered Data: Display metered values in real-time.

E.   Remote Control:

1.   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.

F.   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.   Waveforms ranging in length from 2 cycles to 5 minutes.

3.   Disturbance and steady-state waveforms up to 512 points per cycle.

4.   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.

G.   Data Sharing: Allow export of recorded displays and tabular data to third-party applications software.

H.   Tenant or Activity Billing 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 tenant's historical billing information.

5.   Prepare summary reports in user-defined formats and time intervals.

I.   Reporting: User commands initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

1.   Print a record of user-defined alarm, supervisory, and trouble events on workstation printer.

2.   Sort and report by device name and by function.

3. Report type of signal (alarm, supervisory, or trouble), description, date, and time of occurrence.

4. Differentiate alarm signals from other indications.

5. When system is reset, report reset event with same information concerning device, location, date, and time.

2.5 POWER MONITORS

A. Separately mounted, permanently installed instrument for power monitoring and control:

1. Enclosure: NEMA 250, Type 3.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in non-air-conditioned spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.

C. RMS Real-Time Measurements:

1. Current: Each phase, neutral, average of three phases, percent unbalance.

2. 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.

3. Power: Per phase and three-phase total.

4. Reactive Power: Per phase and three-phase total.

5. Power Factor: Per phase and three-phase total.

6. Frequency.

7. THD: Current and voltage.

8. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

9. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

10. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

D. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:

1. Present.

2. Running average.

   3. Last completed interval.

   4. Peak.

  E. Demand Real Power Calculations, Three-Phase Total:

   1. Present.

   2. Running average.

   3. Last completed interval.

   4. Predicted.

   5. Peak.

   6. Coincident with peak kVA demand.

   7. Coincident with kVAR demand.

  F. Demand Reactive Power Calculations, Three-Phase Total:

   1. Present.

   2. Running average.

   3. Last completed interval.

   4. Predicted.

   5. Peak.

   6. Coincident with peak kVA demand.

   7. Coincident with kVAR demand.

  G. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:

   1. Last completed interval.

   2. Coincident with kW peak.

   3. Coincident with kVAR peak.

   4. Coincident with kVA peak.

  H. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:

   1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.

2.   Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

   a.   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.

   b.   Fixed block that calculates demand at end of the interval.

   c.   Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3.   Demand Calculation Initiated by a Synchronization Signal:

   a.   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.

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

I.   Sampling:

1.   Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.

2.   Power monitor shall provide continuous sampling at a rate 128 of samples per cycle on all voltage and current channels in the meter.

J.   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.   THD voltage L-L.

11.   THD voltage L-N.

12.   THD current.

13.   Frequency.

K.   Harmonic Calculation: Display and record the following:

1.   Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. 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 user.

L.   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.   Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

M.   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 0.25 percent of reading, plus 0.025 percent of full scale.

b.   Voltage and Current: Accurate to 0.075 percent of reading, plus 0.025 percent of full scale.

c.   Power Factor: Plus or minus 0.002, from 0.5 leading to 0.5 lagging.

d.   Frequency: Plus or minus 0.01 Hz at 45 to 67 Hz.

N.   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.   Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

O.   Input: One digital input signal(s).

1.   Normal mode for on/off signal.

2.   Demand interval synchronization pulse, accepting a demand synchronization pulse from a utility demand meter.

3.   Conditional energy signal to control conditional energy accumulation.

P.   Outputs:

1.   Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.

2.   Closed in either a momentary or latched mode as defined by user.

3.   Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.

4.   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.

5.   One relay output module(s), 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.

6.   Output Relay Control:

a.   Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.

b.   Normally open and normally closed contacts, field configured to operate as follows:

1)   Normal contact closure where contacts change state for as long as signal exists.

2)   Latched mode when contacts change state on receipts of a pickup signal; changed state is held until a dropout signal is received.

3)   Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.

4)   End of power demand interval when relay operates as synchronization pulse for other devices.

5)   Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.

6)   Output controlled by multiple alarms using Boolean-type logic.

Q.   Onboard Data Logging:

1.   Store logged data, alarms, events, and waveforms in 800 KB of onboard nonvolatile memory.

2.   Stored Data:

a. 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.

b. Custom Data Logs: One user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:

    1) Schedule interval.

    2) Event definition.

    3) Configured as "fill-and-hold" or "circular, first-in first-out."

c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.

d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

R. Alarms:

1. User Options:

a. Define pickup, dropout, and delay.

b. Assign one of four severity levels to make it easier for user to respond to the most important events first.

c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:

a. Over/undercurrent.

b. Over/undervoltage.

c. Current imbalance.

d. Phase loss, current.

e. Phase loss, voltage.

f. Voltage imbalance.

g. Over kW demand.

h. Phase reversal.

i. Digital input off/on.

j.   End of incremental energy interval.

k.   End of demand interval.

S.   Control Power: 90- to 457-V ac or 100- to 300-V dc.

T.   Communications:

1.   Power monitor shall be permanently connected to communicate via Modbus TCP via a 100 Base-T Ethernet.

2.   Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

U.   Master Computer Station: Existing At San Francisco VA Medical Center

V.   Display Monitor: Existing At San Francisco VA Medical Center

2.6   LOW-VOLTAGE WIRING

A.   Low-Voltage Control Cable: Multiple conductor, color-coded, No. 16 AWG copper, minimum.

1.   Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.

2.   Ordinary Switching Circuits: Three conductors, unless otherwise indicated.

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

4.   Wires shall be all copper, stranded, unshielded twisted pairs. All wire shall be in conduit.

2.7   UPS

A.   Provide UPS units with appropriate KVA to supply power to the Master Computer Station with at least 30 minutes battery back-up power. UPS shall be backed up by the generator power.

PART 3 - EXECUTION

3.1   INSTALLATION:

A.   Comply with NECA 1.

B.   Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

C.   Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Use NRTL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

D.   Identify components and power and control wiring according to Section 26 05 11 REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

E.   Label each power monitoring and control module with a unique designation.

F.   Grounding: Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

G.   All cables shall be installed in conduits.

3.2   3.2 SPARE PARTS

A.   Spares shall be provided for each component in the PLC system as follows:

1.   One (1) power supply.

2.   One (1) CPU

3.   10% (minimum of one (1)) of each type of I/O module.

3.3   3.3 FIELD QUALITY CONTROL

A.   Perform tests and inspections and prepare test reports:

1.   Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B.   Tests and Inspections:

1.   Electrical Tests: Use caution when testing devices containing solid-state components.

2.   Continuity tests of circuits.

3.   Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.

a.   Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.

b.   System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.

c.   Verify accuracy of graphic screens and icons.

d.   Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.

e.   Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.

C.   Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

D.   Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E.   Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

F.   Remove and replace malfunctioning devices and circuits and retest as specified above.

3.4   3.4 DEMONSTRATION:

A.   Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Section 01 00 00,"GENERAL REQUIREMENTS.

    1.   Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 40 hours' training.

    2.   Training Aid: Use approved final versions of software and maintenance manuals as training aids.

    3.   Test and troubleshoot the system.

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