SECTION 26 09 13

ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.1   SUMMARY

A.   Section includes equipment and systems used to monitor and control electrical consumption:

1.   Multifunction energy meters.
2.   Power meters.
3.   Circuit meters and monitors.
4.   Network configuration software.

B.   Related Requirements:

1.   Section 230951 "Basic Materials Interface Devices and Sensors" for metering requirements of HVAC equipment.

1.2   ACTION SUBMITTALS

A.   Product Data: For each type of product.

1.3   COORDINATION

A.   Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1.   Match components and interconnections for optimum performance of specified functions.

B.   Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1   SYSTEM DESCRIPTION

A.   Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

1.   Electrical meters that monitor, control, and connect to the data transmission network.
2.   LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.

3. Include PC-based workstation with web access, with its operating system and application software, connected to data transmission network.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with UL 61010-1 and marked for intended location and application.

2.2   PERFORMANCE REQUIREMENTS

A. Addressable Devices: Transmitters and receivers must communicate unique device identification and status reports to monitoring and control clients.

2.3   MULTIFUNCTION ENERGY METERS

A. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

1. Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power Factor: 1.0 percent.
4. Frequency: 0.1 percent.
5. THD: 1.0 percent.
6. Waveform Sampling: 64 per cycle.

E. Data Link:

1. MODBUS .

F. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values:
   a. One screen to show at least three user-selected values displayed at the same time. Selections available to display must include the following:
      1) Meters.
      2) Measurements.

3) THD.
4) Energy.
5) Demand.
6) Minimum and maximum values.
7) Power demand.

G. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on voltage and current channels of the meter.

H. Meters:

1. Instantaneous, RMS:
   a. Current: Each phase, neutral and three-phase average.
   b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
   c. Active Power (kW): Each phase and three-phase total.
   d. Reactive Power (kVAR): Each phase and three-phase total.
   e. Apparent Power (kVA): Each phase and three-phase total.
   f. Power Factor: Each phase and three-phase total.
2. Energy:
   a. Active Energy (kWh): Three-phase total.
3. Demand, Derived from Instantaneous RMS Meters:
   a. Current: Present and maximum.
   b. Active: Present and maximum.
   c. Reactive: Present and maximum.
   d. Apparent: Present and maximum.
4. Power Quality Measurements:
   a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

I. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics must be 150 mA at 200 V.

1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:
   a. User-defined pulse output, associated with kWh.
   b. User-defined pulse output, associated with kVARh.

J. Capacities and Characteristics:

1. Power Supply: 120 V(ac), 60 Hz .
2. Circuit Connections:
   a. Voltage: Measurement autoranging, 60 to 400 V(ac) L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Connect to instrument grade potential transformers secondary at 120 V. Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
   b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.

        c.   Frequency: 45 to 65 Hz.

        d.   Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4   POWER METERS

A.   Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

        1.   Capable of metering four-wire wye, three-wire wye, three-wire delta, and single-phase power systems.

        2.   Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B.   Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

C.   Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D.   Accuracy:

        1.   Comply with ANSI C12.20, Class 0.5.
        2.   Neutral Current Measurement: Not more than 0.65 percent.
        3.   Power: 0.6 percent.
        4.   Power Factor: 0.5 percent.
        5.   Active Energy: 0.6 percent.
        6.   Reactive Energy: 2.5 percent.
        7.   Frequency: 0.05 percent.
        8.   THD: 1.0 percent.
        9.   Waveform Sampling: 32 per cycle.

E.   Data Link:

        1.   Provide for firmware and software updates through the communications port.

F.   Meter Physical Characteristics:

        1.   Display: Backlit LCD with antiglare and scratch-resistant lens.
        2.   Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display must include the following:

            a.   Meters, including those listed under the following:
                1)   Measurements.
                2)   THD.
                3)   Energy.
                4)   Demand.
                5)   Minimum and maximum values.
                6)   Power demand.

G.   Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle , simultaneously on voltage and current channels of the meter.

H.   Meters:

1.   Measurements: Instantaneous, in real time, RMS to the 15th harmonic.
     a.   Voltage: L-L each phase, L-N each phase, and three-phase average.
     b.   Current: Each phase, three-phase average, and neutral.
     c.   Unbalanced current, L-L V(ac) and L-N V(ac).
     d.   Active Power (+/- kW): Each phase and three-phase total.
     e.   Reactive Power (+/- kVAR): Each phase and three-phase total.
     f.   Apparent Power (+/- kVA): Each phase and three-phase total.
     g.   Displacement Power Factor: Each phase and three-phase total.
     h.   Distortion Power Factor: Each phase and three-phase total.
     i.   Frequency.
2.   THD from measurements simultaneously from the same cycle, through 15th harmonic.
     a.   Voltage THD: L-L each phase, L-N each phase, and three-phase average.
     b.   Current THD: Each phase and three-phase average.
     c.   Total demand distortion.
3.   Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.
     a.   Active kWh.
     b.   Reactive kVARh.
     c.   Apparent kVAh.
4.   Demand: Present, last, predicted, peak.
     a.   Three-phase average current.
     b.   Three-phase total active power (kW).
     c.   Reactive power (kVAR).
     d.   Apparent power (kVA).
5.   Minimum and Maximum Values:
     a.   L-L and L-N voltages.
     b.   Current in each phase.
     c.   Power factor.
     d.   Active power total.
     e.   Reactive power total.
     f.   Apparent power total.
     g.   THD L-L and L-N voltages.
     h.   THD current in each phase.
     i.   Frequency.

I.   Power Demand, User Selectable:

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 must be configurable as either a block or rolling block calculation.

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

        c.   Provide for synchronizing the demand with the internal of this instrument.

J.   Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

    1.   Minimum and maximum of real-time RMS measurement.
    2.   Energy.
    3.   Demand values.
    4.   Alarms, store the last 40 events.

K.   Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm must be user configured, by using the following options:

    1.   Date and time stamp.
    2.   Enable-disable (default) or enable.
    3.   Pickup magnitude.
    4.   Pickup time delay.
    5.   Dropout magnitude.
    6.   Dropout time delay.
    7.   Alarm type.
    8.   Alarm label.

L.   Output Signals: Provide two mechanical relays, rated not less than 250 V(ac), 2 A resistive, and rated for 200-k cycles or more. The relays must be user configurable in one of the following listed modes:

    1.   Normal contact closure where the contacts change state for as long as the signal exists.
    2.   Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
    3.   Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

M.   Meter Face:

    1.   Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
    2.   Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
    3.   Provide for the reset of metered peak values.

N.   Capacities and Characteristics:

    1.   Power Supply: 120 V(ac), 60 Hz .

2. Circuit Connections:
    a. Voltage: Measurements autoranging, 60 to 400 V(ac) L-N. Connect directly to low-voltage (600 V and less) without using voltage transformers. Meter impedance must be 2 megohm L-L or greater. Overload Tolerance: 1500 V(ac), RMS, continuously.
    b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument must be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
    c. Frequency: 45 to 65 Hz.
    d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5   NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

    1. Add and remove devices in the power monitoring and control network.
    2. Application for naming devices based on a user-defined naming scheme.
    3. Add and remove I/O servers in the power monitoring and control network.
    4. Edit communication properties for devices including timeouts and delays.
    5. Display mandatory fields when adding a new device.
    6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
    7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
    8. Pool modem resources so that the software uses any available modem.
    9. Monitor the following diagnostics:
        a. Communication request/response and error rates, and timeouts.
        b. Log acquisition services.

B. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

    1. Features:
        a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
        b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
        c. Distribution of reports via email.
    2. Report on power and demand profiles.
    3. Power quality report with CBEMA evaluation.
    4. EN 50160 compliance report.
    5. 100-ms PQ report.
    6. Energy over Period Report:
        a. User-defined rollup interval by day, week, month, or year.
        b. Compare daily energy to the following:
            1) Previous day.
            2) Same day, previous week.

   3) Same day, previous month.
   4) User-defined specific day.
  c. Compare weekly energy to the following:
   1) Previous week.
   2) Same week from previous month.
   3) Same week from previous year.
   4) User-defined specific week.
  d. Compare monthly energy to the following:
   1) Previous month.
   2) Same month from previous year.
   3) User-defined specific month.
  e. Compare annual energy to the following:
   1) Previous year.
   2) User-defined specific year.
7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. System Configuration Report:
  a. Device name.
  b. Device type.
  c. Device address.
  d. Connection status.
  e. Device protocol.
  f. Device description.
10. Each default report must include the following:
  a. Summary aggregation of data from the selected devices.
  b. Individual device information.
  c. Raw data.
11. The reporting tool must provide a graphical interface to create and manage multiple Time of Use schedules:
  a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
  b. Off-peak and on-peak times.

PART 3 - EXECUTION

3.1 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

C. Wiring and Cabling Installation:

1. Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

D. Raceways Installation:

1. Comply with Section 26 05 33.13 "Conduits for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

E. Identification Installation:

1. Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

3.2 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.3 GROUNDING

A. For data communication wiring, comply with BICSI N1.

B. For control-voltage wiring and cabling, comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Architect and Engineer. .

B. Tests and Inspections:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Visually inspect balanced twisted-pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of components.
4. Test balanced twisted-pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
   a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

        b.   Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5.   Optical-Fiber Cable Tests:

        a.   Test instruments must meet or exceed applicable requirements in TIA-568-C.0. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

        b.   Link End-to-End Attenuation Tests:

            1)   Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.

            2)   Attenuation test results for links must be less than 2.0 dB that calculated according to equation in TIA-568-C.0.

        c.   Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

6.   Power Monitoring and Control System Tests.

        a.   Test Analog Signals:

            1)   Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.

            2)   Check analog current signals using a precision current meter at zero, 50, and 100 percent.

            3)   Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

        b.   Test Digital Signals:

            1)   Check digital signals using a jumper wire.

            2)   Check digital signals using an ohmmeter to test for contact making or breaking.

        c.   I/O Control Loop Tests:

            1)   Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.

            2)   Test every I/O point throughout its full operating range.

            3)   Test every control loop to verify that operation is stable and accurate.

            4)   Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.

            5)   Test and adjust every control loop for proper operation according to sequence of operation.

            6)   Test software and hardware interlocks for proper operation.

            7)   Operate each analog point at the following:

                a)   Upper quarter of range.

                b)   Lower quarter of range.

                c)   At midpoint of range.

            8)   Exercise each binary point.

            9)   For every I/O point in the system, read and record each value at operator workstation, at controller, and at field instrument simultaneously. Value displayed at operator workstation and at field instrument must match.

10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

C. Nonconforming Work:

1. Wiring and cabling will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when the power monitoring and control system is ready for final review. Written request must state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by Architect and Construction Manager will be made after receipt of written request. A field report must be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review must include a demonstration to parties participating in final review.

E. Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

3.6 TRAINING

A. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor must provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.

4.   On-site training must include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.

5.   The operator workstation provided with the system must be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

B.   Off-Site Training:

1.   Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.

2.   Provide capability to remotely access to Project monitoring and control system for use in training.

3.   Provide a workstation for use by each attendee.

END OF SECTION 26 09 13