SECTION 26 09 13 - POWER MONITOR FOR ELECTRICAL, STEAM CONDENSATE, AND WATER

PART I - GENERAL

1.1 SUMMARY
A. This section describes the requirements for the installation of Power Monitors and associated hardware within a separate metering compartment of new or existing switchgear or switchboard.
B. For new switchgear or switchboard installation, the Power Monitor, CT’s, PT’s, shorting block, fusing, and wiring shall be provided by and installed by the switchgear or switchboard manufacturer within a separate metering section of the gear.
C. For existing switchgear or switchboard installation, the Power Monitor, CT’s, PT’s, shorting block, fusing, and wiring shall be provided and installed by the Electrical Contractor.
D. [Note to AE: For special circumstances and with prior approval by the Owner, Power Monitor and accessories can be mounted within a 20-inch by 20-inch by 10-inch Hoffman enclosure with the display mounted on front hinged cover.]
E. Standard utility metering shall be required for pole mounted or outdoor installations. See Section 26 27 13 - Electrical Metering.
F. The Power Monitor CT’s and PT’s shall be different that the CT’s and PT’s used for electrical metering in the same unit substation.

1.2 SECTION INCLUDES
A. Power monitoring devices
B. Enclosures, including
   1. Equipment requirements
   2. Wiring requirements
   3. Grounding requirements
   4. Labeling requirements
C. Electrical apparatus, including but not limited to:
   1. Switchgear and switchboard components in support of the power monitoring devices.
D. Current transformers
E. Potential transformers
F. Communications networks such as:
   1. Ethernet
   2. ControlNet
   3. Data Highway Plus
   4. Remote I/O
   5. DeviceNet

1.3 DEFINITIONS
A. PM – Power Monitor
B. CT – Current Transformer
C. PT – Potential Transformer

1.4 INSTALLATION DESCRIPTION

A. The full installation shall consist of digital power monitors, support and/or supply hardware and appropriate communication networks. The equipment shall be fully installed and tested.

B. A 1-inch conduit for dedicated Ethernet connection (with unique IP address) shall be installed for communication. This should be coordinated with the U of I Campus Information Technologies and Educational Services (CITES) department.

C. The steam condensate meter shall have pulsed output capability. A separate 3/4-inch conduit with a twisted pair signal cable shall be installed by the electrical Contractor from the steam condensate meter to the electric meter within the switchgear or switchboard metering section so that the pulse output from the steam condensate meter can be monitored by the Power Monitors Status Input “S1”.

D. The water meter shall have pulse output capability. A separate 3/4-inch conduit and signal cable shall be installed by the electrical Contractor from the water meter to the electric meter within the switchgear or switchboard metering section so that the pulse output from the water meter can be monitored by the Power Monitors Status Input “S2”.

1.5 TESTS, INSPECTION AND DOCUMENTATION

A. The fully installed and configured system shall be tested. It is important that PM’s be installed according to the instructions listed on instruction sheet. PM’s which are not installed correctly will produce erroneous readings, which can result in unfair energy allocations, injury or death.

B. One power monitoring checklist, available from the Energy Service Division within F&S, shall be completed for each power monitor installed.

C. Only qualified personnel shall execute this procedure. Installation personnel shall be properly trained in working with electrical circuits. Carefully follow all health and safety procedures.

D. Record the name or number of the switchboard and breaker to which the PM is connected. If a breaker has a name, record the name. If a breaker is a spare or space, record the breaker number.

E. Current transformers
   1. Write down the CT ratio.
   2. Write down all CT nameplate data including manufacturer, part number, accuracy class, etc.
   3. Verify that CT’s are adequately mounted and secured.
   4. Verify the polarity of the CT’s. The “dotted” or “H1” side of the CT opening shall always face the source of power. In the case of tie breakers, the “dotted” or “H1” side of the CT opening shall always face the lower numbered or lettered switchboard or bus. Neutral CT’s shall match the polarity of the phase CT’s on the same PM.
   5. Verify that the CT secondary wiring is correct. When CT’s are properly installed, a “positive” current flowing into the “dotted” or “H1” side of the CT opening will produce a “positive” current flowing out of the “dotted” or “X1” terminal of the CT. The “dotted” or “X1” terminal of the CT shall be connected to the appropriate “I+” current input terminal on the PM.
   6. Verify that CT shorting blocks are correctly installed.
   7. Verify that the CT’s are connected to the correct phase inputs. Proper CT phasing is important.

F. Voltage transformers / connections (PT’s are required when the Line-to-Ground voltage is greater than 120 volts.)
1. Write down the PT ratio. If the PM is connected directly to the line, note the nominal line-to-line voltage for PM’s.

2. Write down all PT nameplate data including manufacturer, part number, accuracy class, etc.

3. Verify that PT’s are adequately mounted and secured.

4. Verify that PT’s and PM inputs are properly fused.

5. Note the location of the voltage connection. Load-side of the breaker. Correct if necessary to the load-side.

6. Verify that the PT’s or voltage connections are terminated on the correct phase inputs. Proper PT phasing is important and must match the CT phasing.

G. PM display

1. Using an RMS reading digital multi-meter, measure the line-to-line and line-to-neutral voltages and verify that the readings observed on the DMM match those observed on the PM display module. Note that values shall agree to within the sum of the accuracy’s for the PM, DMM and PT’s.

2. Using an RMS reading clamp-on ammeter, measure the line and neutral currents and verify that the readings observed on the ammeter match those observed on the PM display module. Note that values shall agree to within the sum of the accuracies for the PM, clamp-on ammeter and CT’s.

3. Verify that the power (kW), reactive power (KVAR) and total apparent power (KVA) values are positive for loads.

4. Verify that the power factor is reasonable. Inductive load shall have a lagging or “negative” power factor. Capacitive loads shall have a leading or “positive” power factor.

5. Using the PM display module, verify that the phase rotation is correct (ABC).

6. As each test is completed, the Energy Service Division within F&S representative shall initial the checklist signifying that the test has been successfully completed.

PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

2.2 MATERIALS

A. Unless otherwise noted, all materials and equipment supplied shall be new, of the type, capacity and quality specified and free from defect.

2.3 WIRING CONVENTIONS

1. AC power shall be provided by the 120 v. or 208 volt service or by the fused secondary side of the PT’s.
   a. 120VAC, 240VAC and 480VAC “hot” conductors shall be black.
   b. All grounded, neutral conductors shall be white or natural gray.

2. AC control. Control wiring originates from where AC power has been switched by relay contacts or is connected to the secondary side of a transformer.
   a. All “hot” control conductors up to 120VAC shall be red.
   b. All grounded, neutral conductors shall be white or natural gray.

3. Externally powered interlock circuits, where control power is supplied from an external power source.
   a. All “hot” control conductors shall be yellow.
   b. All grounded, neutral conductors shall be white or natural gray.
4. DC control and power
   a. All “+” conductors shall be blue.
   b. All “-” conductors shall be blue with a white trace.
5. All ground conductors shall be green.
6. Potential transformer and/or voltage tap conductors shall be black.
7. Current transformer wiring shall be red.

B. All wiring shall be of the following minimum size:
   1. Power wiring shall be #12 AWG SIS wire.
   2. Ground terminals shall be connected to the enclosure ground bus with #8 AWG SIS wire.
   3. Current transformer secondary wiring shall be #10 AWG SIS wire.

C. Cabling:
   1. All communications wiring shall cross AC conductors at a 90-degree angle. Where
      communication wiring must run parallel to AC conductors, a minimum of 2” separation
      shall be maintained.
   2. Data Highway Plus (DH+) and Remote I/O (R I/O) communications circuits shall be
      wired with Belden 9463 or equivalent, twin-axial, shielded cable.
   3. DeviceNet communications shall be wired with flat media Dnet cable A-B type 1485C-
      P1E or equal.
   4. ControlNet communications shall be wired with quad-shielded coax type RG-6, A-B type
      1786-RG6F or equal.
   5. Ethernet communications shall be wired with screened twisted pair cable, (ScTP).

D. Termination:
   1. Conductors connected to terminal blocks without pressure-plates shall be terminated
      with insulated, fork-tongue type crimp lugs.
   2. Conductors connected to studs, grounding screws and meters shall be terminated with
      insulated, ring-type crimp lugs.
   3. Conductors for the current transformers shall be terminated with insulated, ring-type
      crimp lugs.

2.4 LABELING REQUIREMENTS

A. An engraved device tag showing the name of each device, as shown on the electrical and
   mechanical Drawings shall be placed on the sub-panel as near as practicable to each
   physical device. Engraved device tags shall have a white face with black lettering.

B. Engraved device tags shall be no smaller than 1/2 inch high by 1-1/2 inches long with 1/4
   inch high text and shall be affixed to the sub-panel with adhesive.

C. Incoming AC power conductors shall be labeled as follows:
   1. Single-phase 120VAC circuits: L1 and N.
   3. All three phase circuits: L1, L2 and L3.
   4. Current transformer secondary leads to Ix+ and Ix-: where x = phase representation, (1,
      2, 3 etc.)

D. Wiring labels shall be printed on white shrink tubing and applied such that they are read
   from left to right on wires which terminate horizontally and from top to bottom on wires
   which terminate vertically. On wires where the numeral 0 appears, the numeral shall be
   printed with a slash in order to distinguish it from the letter O (example: Ø).
2.5 TRANSFORMER REQUIREMENTS

A. Current transformers shall be of Metering class and Revenue grade. There shall be 1 CT for each phase and the neutral conductor if present.
   1. Transformers shall be chosen for proper voltage and insulation class.
   2. Accuracy shall be 0.1%.
   3. Accuracy Class 0.3.
   4. CT’s shall be selected with a burden rating sufficient to supply the total/summation of the circuit wiring VA and the VA of the power monitor (0.5VA for PMII or PM3000). Total burden shall not exceed the rated burden of the CT.
   5. Ratio, primary current to secondary current, such that the primary is equal to that of the system current and the secondary current is 5 Amps.
   6. Neutral transformer (if required) ratings and ratio shall be equal to those of the phase CT’s.

B. Separate Potential (Voltage) transformers (required above 120 V. to ground) Number of PT’s supplied shall be as required for the system configuration to be monitored; i.e. two for single phase, two for 3 phase-3 wire Open-Delta, three for 3 phase-3 wire Wye and Delta and three for 3 phase-4 wire Wye.
   1. Power Monitor(s) shall have separate voltage transformers.
   2. Transformers shall be chosen for proper voltage and insulation class and BIL Rating.
   3. Accuracy shall be 0.1%.
      a. Accuracy Class 0.3.
   4. Burden shall be determined by summation of the VA of the circuit wiring and VA of connected power monitor.
   5. Ratio, primary voltage to secondary voltage, such that the primary is equal to that of the system voltage and secondary voltage is 120V.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Switchboard or Switchgear Manufacturer shall provide all labor, materials, and equipment to install the system in accordance with the Energy Service Division within F&S instructions as indicated and as specified herein.

B. Installation Contractor shall verify the following items:
   1. All power monitors shall be properly installed and wired in accordance with the manufacturer’s recommendations.
   2. All communications cables have been properly installed and all devices are connected.
   3. All hardware is free from damage, clean and ready for startup.
   4. All transformers are solidly mounted and secure.
   5. All transformer polarities are consistent and point to the supply of power.

C. Good workmanship shall be evidenced in the installation of all electrical materials equipment. All materials shall be firmly secured in place and adequately supported and permanent. The requirements of the codes are minimum standards. The recommendations of the National Electrical Contractors Association Standard of Installation shall be followed except where otherwise specifically directed.

3.2 TRANSFORMER INSTALLATION REQUIREMENTS

A. Current transformer secondary shall be wired to shorting terminal blocks.
   1. Shorting terminal block, rated 600V, 30A.
2. Block shall be one piece and shall be UL compliant.
3. Terminals shall accommodate #10 AWG with ring type crimp lugs.
4. Terminals shall have barrier separations and be at a minimum spacing of 13/32”.
5. Adjacent terminals shall be at a spacing of 5/8 inch.
6. Number of poles shall be based upon number of CT’s utilized. (2 poles per CT).
7. Shorting terminal blocks shall be located in the low – voltage compartment with the PM and shall be accessible from the front of the enclosure.
8. There shall be no intermediate connections made to the CT circuit between the CT and the shorting terminal block.
9. CT’s shall be grounded at the Shorting terminal block.
10. There shall be no additional terminations to allow for shipping splits. If CT circuit wiring is to cross a shipping split, the secondary leads shall be coiled back for shipment and connected to the shorting block at installation.
11. Current transformers shall be solidly mounted and secured.
12. Polarity markings shall be always point/face to the source of power.

B. Separate potential transformers connection requirements:
1. Primary protection shall consist of a 30 ampere 3-pole switch (or circuit breaker) and pull out fuse blocks, rated 600V, 30A. with Class J type fusing. Bussmann Fusing shall be sized per NEC for PT’s.
2. Number of poles shall be based upon the PT configuration of the system.
3. Switch and Fuse blocks shall be located in the low – voltage compartment with the PM and shall be accessible from the front of the enclosure.
4. Primary connections shall be made at the secondary, or load side of the circuit disconnecting means, i.e. circuit breaker.

C. Separate potential, (Voltage) tap connection requirements to Power Monitor line terminals L1 and L2 (208 - 240 Volts).
1. Power Monitor(s) shall have separate voltage taps.
2. Protection shall consist of pull out fuse blocks, rated 600V, 30A. with 1 Amp, Class J type Bussmann fusing.
3. One wire from each phase (Phase A & B) shall be from the tap point(s) to the PM (L1 & L2 Terminals)
4. Fuse blocks shall be located in the low – voltage compartment with the PM and shall be accessible from the front of the enclosure.
5. Tap connections shall be made at the secondary, or load, side of the circuit disconnect means, i.e. circuit breaker.

3.3 POWER MONITOR MODULE(S) INSTALLATION REQUIREMENTS
A. Power Monitor shall be installed in the low voltage compartment and shall be accessible from the front of the enclosure.