PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes PC-based workstation(s) and software for monitoring and control of electrical power system.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. 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, method of field assembly, components, and location and size of each field connection.

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.

G. Operation and Maintenance Data: For power monitoring and control units, to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," 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:

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

1.3 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.

1.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. Allen-Bradley; Rockwell Automation.
2. GE Industrial Systems.
3. Schneider Electric.
2.2 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:
   b. At least [five] <Insert number> processes.
   c. At least [five] <Insert number> buildings.
   d. <Insert entity.>

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.
4. Harmonics.
5. Voltage excursions.
6. <Insert parameter.>

2.3 SYSTEM REQUIREMENTS

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.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Division 16 Section "Transient Voltage Suppression."

2.4 OPERATING SYSTEM

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

A. Basic Requirements:

1. Fully compatible with and based on the approved operating system.
2. Password-protected operator login and access.
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] [selected workstation] 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.

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.

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

D. 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.

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

G. 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.

H. 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.

2.6 COMMUNICATION COMPONENTS AND NETWORKS


2.7 POWER MONITORS

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

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] [nontemperature-controlled] spaces that have environmental controls to maintain ambient conditions of [0 to 122 deg F] <Insert temperature range> 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 of \([128] \text{ samples per cycle on all voltage and current channels in the meter.}\)

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 \textless \textbf{Insert number} \textgreater 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: [\textbf{One} \textless \textbf{Insert number} \textgreater] 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] <Insert number> 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 receipt 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 [80] [800] <Insert number> 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] [Three] user-defined log(s) holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:
         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] <Insert number> severity levels to make it easier for user to respond to the most important events first.
   c. Allow for combining up to [four] <Insert value> 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. Display Monitor:

1. Backlighted LCD to display metered data with [touch-screen] [touch-pad] <Insert interface> selecting device.
2. Touch-screen display shall be a minimum 12-inch diagonal, resolution of 800 by 600 RGB pixels, 256 colors; NEMA 250, Type 1 display enclosure.
3. Display [four] <Insert number> values on one screen at same time.
   a. Current, per phase rms, three-phase average [and neutral].
   b. Voltage, phase to phase, phase to neutral, and three-phase averages of phase to phase and phase to neutral.
   c. Real power, per phase and three-phase total.
d. Reactive power, per phase and three-phase total.
e. Apparent power, per phase and three-phase total.
f. Power factor, per phase and three-phase total.
g. Frequency.
h. Demand current, per phase and three-phase average.
i. Demand real power, three-phase total.
j. Accumulated energy (MWh and MVARh).
k. THD, current and voltage, per phase.

4. Reset: Allow reset of the following parameters at the display:

  a. Peak demand current.
  b. Peak demand power (kW) and peak demand apparent power (kVA).
  c. Energy (MWh) and reactive energy (MVARh).

2.8 LOW-VOLTAGE WIRING

A. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 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.

PART 3 - EXECUTION

3.1 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Division 16 Section "Voice and Data Communication Cabling."

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

D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters 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.

E. Identify components and power and control wiring according to Division 16 Section "Electrical Identification."
F. Label each power monitoring and control module with a unique designation.


### 3.2 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. Test LANs according to requirements in Division 16 Section "Voice and Data Communication Cabling."
   c. 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.
   d. Verify accuracy of graphic screens and icons.
   e. 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.
   f. 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.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 1 Section "Demonstration and Training."

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 [12] <Insert number> hours' training.

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

END OF SECTION