SECTION 260573

POWER SYSTEM STUDIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Short-circuit analysis.

B. Protective device time-current coordination analysis.

1.2 ABBREVIATIONS AND ACRONYMS

A. PSSS: Power system study supplier.

B. TCC: Time-current curves.

C. DER: Distributed energy resources.

1.3 REFERENCE STANDARDS

A. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011 (Reaffirmed 2017).

B. ISO 9001 - Quality Management Systems — Requirements; 2015.

C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70E - Standard for Electrical Safety in the Workplace; 2021.

E. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work with power system study supplier to provide complete, accurate studies and associated application of study results to equipment and systems.
   2. Coordinate with Owner to gather input data required for power system studies.

B. Preinstallation Meeting: Review installation procedures with Owner, Engineer, power system study supplier's representative, and affected installers.

C. Sequencing:
   1. Submit initial studies prior to receiving release to furnish electrical distribution equipment.
   2. After sufficient data is available to ensure proper selection of devices, submit completed studies.
   3. If completion of studies may cause delays in equipment shipments, request exception for preliminary submittal of data to ensure selection of device ratings and characteristics are satisfactory to carefully select distribution equipment.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Provide sufficient information to determine compliance with contract documents. Identify submittal data with specific equipment tags and/or service descriptions to which they pertain.

C. Indicate deviations from contract documents with reference to corresponding drawing or specification number and written justification for deviation.

D. Product Data: Application software including modules or software plug-ins used to perform studies.

E. Power System Study Reports:
   1. Summarize results of studies in final report signed and sealed by registered professional engineer.
   2. In addition to hard copies required by Contract Documents, provide electronic PDF files of report on digital media acceptable to the Owner.
   3. Report Contents:
      a. Executive summary including introduction, scope of work, results, and recommendations.
      b. Power System One-Line Diagram: Computer generated; identify individual equipment buses and cable/bus connections between equipment.
      c. Identify calculation methods, missing/incomplete data, and assumptions with justifications.
      d. Short-Circuit Analysis:
         1) Short-circuit methodology, analysis, results, and recommendations.
         2) Short-circuit device evaluation table.
         3) Identify bus number used in short-circuit analysis and calculate maximum short-circuit current at each bus location on power system one-line diagram.
      e. Protective Device Time-Current Coordination Analysis:
         1) Protective device coordination methodology, analysis, results, and recommendations.
         2) Protective device settings table.
         3) Time-current coordination graphs and recommendations.
         4) Identify device numbers used in time-current coordination on power system one-line diagram.

1.6 QUALITY ASSURANCE

A. Electrical Power System Software for Studies: Developed under established quality assurance program certified in accordance with ISO 9001 and regularly reviewed and audited by third-party registrar.

B. Power System Study Supplier (PSSS) Qualifications:
   1. Minimum 25 years of experience in performing power system studies.
   2. Conduct studies under responsible charge and approval of registered professional engineer with minimum of five years of experience in performing and interpreting electrical power system studies.

PART 2 PRODUCTS

2.1 POWER SYSTEM STUDY SUPPLIERS (PSSS)

A. Source Limitations: Provide power system studies by same supplier as electrical distribution equipment for project.

2.2 POWER SYSTEM STUDIES

A. Software for Study Preparation: Perform power system studies using robust electrical power system design and analysis software package; manual calculations are not acceptable.
   1. Products:
      a. ETAP by Operation Technology, Inc: www.etap.com.
      b. SKM.
      c. Substitutions: See Section 016000 - Product Requirements.

B. Scope of Studies: Provide modeling from first overcurrent protective device upstream of furnished equipment from utility sources to overcurrent protective devices of furnished equipment.

C. Data:
   1. Gather input data required for power system studies, including existing equipment and equipment furnished by others.
   2. PSSS to furnish list of required data to Contractor immediately after award of contract; Contractor to expedite collection of data to assure completion of studies as required for final approval of distribution equipment shop drawings and prior to release of equipment for manufacturing.
   3. Source Combination: Include current and identified future motors, generators, and DER systems.
   4. Load Data: Include existing and proposed loads obtained from Contract Documents.

D. Short-Circuit Analysis:
   1. Identify selected base per unit quantities.
   2. Provide a one-line diagram that identifies individual equipment buses, bus numbers, and cable/bus connections between equipment.
   3. Identify input circuit data pertinent to calculations including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, and motor contributions.
   4. Provide tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding adequacy or inadequacy of equipment rating.
   5. Summarize results, conclusions, and recommendations including discussion section evaluating adequacy or inadequacy of equipment with recommendations for improvements to system.
   6. Use transformer design impedances when test impedances are not available.
   7. For solidly grounded systems, provide bolted line-to-ground fault current study for applicable buses as determined by engineer performing study.
   8. Protective Device Evaluation:
      a. Include evaluation of equipment and protective devices with comparison to short-circuit ratings.
      b. Include evaluation of adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
      c. PSSS to notify Engineer in writing of circuit protective devices improperly rated for calculated available fault current.

E. Protective Device Time-Current Coordination Analysis:
   1. Display protective device coordination time-current curves (TCC) on log-log scale graphs.
   2. Provide complete title with descriptive device names on each TCC graph.
   3. Provide device termination characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
   4. Identify device associated with each curve by manufacturer type, function, and, where applicable, recommended tap, time delay, and instantaneous settings.

5. Plot the following characteristics on TCC graphs where applicable:
    a. Electric utility's overcurrent protective device.
    b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    c. Low-voltage equipment circuit breaker trip devices including manufacturer's tolerance bands.
    d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    e. Ground fault protective devices.
    f. Pertinent motor starting characteristics and motor damage points.
    g. Pertinent generator short-circuit decrement curve and generator damage point.
    h. Largest feeder circuit breaker in each motor control center and panelboard.
6. Provide adequate time margins between device characteristics for selective operation while providing proper protection.
7. Provide one-line diagram that identifies individual equipment buses, bus numbers, device identification numbers, and maximum available short-circuit current at each bus where known.
8. Provide enough log-log plots to indicate degree of system protection and coordination by displaying time-current characteristics of series-connected overcurrent devices.
9. Provide computer printouts that accompany log-log plots with descriptions for each device shown, settings of adjustable devices, and device identification numbers for locating devices on log-log plots and system one-line diagram.
10. Provide separate, tabular printout with recommended settings of adjustable overcurrent protective devices, equipment designation where device is located, and device number corresponding to device on system one-line diagram.
11. Summarize results, conclusions, and recommendations including discussion section that evaluates degree of system protection and service continuity with overcurrent devices, with recommendations for addressing system protection or device coordination deficiencies.
12. PSSS to notify Engineer/Contractor in writing of significant deficiencies in protection and/or coordination and provide recommendations for improvements.
13. The study shall be conducted in compliance with NEC 517 requirements.

2.3 RECURRING POWER SYSTEM STUDY SUPPORT SERVICES

A. Provide separate contract to Owner, as proposal in addition to base bid, for recurring system study support services for one year from date of Substantial Completion. Include proposal for yearly renewals.

B. Provide ongoing technical support services to keep current, analyze, consult on the digital one-line diagram provided during initial system study.
    1. Receive data from customer regarding changes to their electrical power system.
    2. Revise digital one-line diagram to reflect these modifications and document data related to change and revision history.
    3. Perform short circuit analysis, protective device coordination, and arc flash analysis on new and affected equipment in system. Present results in report addendum.

C. Services:
    1. For duration of specified contract period, provide recurring updates where Owner provides maximum of thirty changes and one batch per month:
        a. Ongoing maintenance of customer digital one-line diagram to reflect changes made by customer to their electrical power system.
        b. Ongoing power system support and analysis for existing system, modifications, expansions, feasibility, and system improvements.
        c. Ongoing reporting of results in accordance with industry codes and standards, including production of equipment labeling.

2. Updates including new utility service, changes in generation sources, or large motor additions that may impact system-wide arc flash analysis are excluded from scope and require contractual change orders to cover additional work.
3. Basic support via telephone and emails during regular business hours to provide technical guidance, recommendations on power systems design and operation, discussion of applicable codes and standards, and review results of power system analysis.
4. Support engineer as single point of contact for customer support.
5. Periodic reports with system optimization recommendations and actionable work orders.

D. Products:
1. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

3.2 CLOSEOUT ACTIVITIES

B. See Section 017800 - Closeout Submittals for additional submittals.

END OF SECTION