SECTION 26 05 73

ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, professional services, and incidentals required to perform electrical power distribution system studies.
   2. Motor starting and transformer information used in electrical power distribution system studies shall be based on equipment provided by CONTRACTOR and, where applicable, existing equipment ratings and settings.
   3. Electrical power distribution system studies shall include the following, as specified in this Section:
      a. Short-circuit study.
      b. Protective device evaluation study.
      c. Protective device coordination study.
      d. Arc flash analysis.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/IEEE C37.91, Guide for Protective Relay Applications to Power Transformers
   2. ANSI/NCSL Z540.3 Requirements for the Calibration of Measuring and Test Equipment.
   3 IEEE 141, Recommended Practice for Electric Power Distribution in Industrial Plants (IEEE Red Book).
   4. IEEE 242, Recommended Practice for Protection and Coord. of Industrial and Commercial Power Systems (IEEE Buff Book).
   5. IEEE 399, Analysis (IEEE Brown Book), Recommended Practice for Power System Analysis.
   6. IEEE 1584, Guide for Performing Arc-Flash Hazard Calculations.
   7. NFPA 70E, Electrical Safety in the Workplace.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Professional Engineer for Delegated Design:

a. Engage a registered professional engineer legally qualified to practice in the jurisdiction where the Project is located and experienced in providing engineering services of the kind indicated. Professional engineer may be employed by independent consulting firm or manufacturer of power distribution equipment.
b. Professional engineer shall have not less than five years of experience performing electrical power distribution system studies similar in scope and size to the studies required for the Project.
c. Submit qualifications data.
d. Responsibilities include but are not necessarily limited to:
1) Performing or supervising the performance of electrical power distribution system studies and related field services.
2) Preparing or supervising the preparation of test plans and test reports, and interpretation and engineering analysis of test data. Test reports shall bear the seal and signature of the professional engineer. State of licensure, license number, and professional engineer's name shall be clearly legible on the seal.
3) Certifying that tests performed and results achieved conform to the Contract Documents.

2. Field Engineer:
a. Field engineer performing protective device testing shall be experienced in type of testing required and testing equipment used on the Project.
b. Field engineer may be an employee of the protective device equipment manufacturer.

B. Test equipment and instrument calibration shall comply with accuracy standards of NIST and ANSI/NCSL Z540.3.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Delegated Design - Studies:
a. Calculations and results of the short-circuit study, protective device evaluation, and coordination studies in report format. Report shall be sealed and signed by the professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
b. Time current curves for protective devices included within the power system studies.
c. Calculations and results of arc-flash analysis in report format sealed and signed by professional engineer retained for the studies. Submit preliminary reports (when specified) and final reports.
2. Testing Plan: Submit work plan for field testing. Submit and obtain ENGINEER's approval prior to performing tests. Plan shall indicate schedule of field testing, time frames for tests, and duration of equipment

outage for testing. Submit shutdown requests for each outage in accordance with Section 01 14 16, Coordination with Owner's Operations.

B. Informational Submittals: Submit the following:
   1. Test Reports:
      a. Results of field testing.
   2. Qualifications Statements:
      a. Professional engineer.
      b. Field engineer, when required by ENGINEER.

C. Closeout Submittals: Submit the following:
   1. Final settings of protective devices. Submit compilation of final settings for each equipment lineup within 10 days of programming the associated protective devices.
   2. Electronic Files:
      a. Protective Devices:
         1) Settings for all microprocessor-based protective devices.
         2) Software versions used to program the protective devices.
      b. Electrical Power Distribution System Studies:
         1) Upon ENGINEER's approval or acceptance, as applicable, of submittals required under this Section, submit for OWNER's use all electronic files developed for the Work under this Section associated with the approved or accepted, as applicable, submittal to ENGINEER.
         2) Electronic files submitted for OWNER's use shall become OWNER's property.
         3) Source files for power studies performed under this Section.

1.5 ELECTRICAL POWER DISTRIBUTION SYSTEM STUDIES

A. General:
   1. Perform a current and complete short-circuit study, protective device evaluation study, and protective device coordination study for the Site's electrical distribution system. Perform studies in accordance with IEEE 141, IEEE 242, and IEEE 399.
   2. Studies shall include all portions of high-, medium-, and low-voltage electrical power distribution systems, from the normal and alternate sources of power through low-voltage distribution system. Thoroughly cover in the study normal system operating method, alternate operation, and operations that could result in maximum fault conditions.
   3. Promptly bring to attention of ENGINEER and OWNER problem areas and inadequacies in equipment.
      a. Preliminary Short-circuit and Coordination Study: Base the evaluation on the worst case operating mode. Include the utility-confirmed contribution plus an additional ten percent. Base the evaluation on

estimated cable lengths, and proposed equipment and protective devices.

b. Final Short-circuit and Coordination Study: Base the evaluation on utility-confirmed contribution. Evaluate the distribution system under each of the various operating modes. Base the evaluation on actual confirmed cable lengths, and installed equipment and protective devices.

B. Short-circuit Study:
   1. Perform short-circuit evaluation using computer software specifically designed for such use. Acceptable software includes SKM, ETAP or EasyPower.
   2. Input data shall include electric utility company's short-circuit, single-, and three-phase contributions, with reactance/resistance (X/R) ratio, resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other applicable circuit parameters.
   3. Calculate short-circuit momentary duties and interrupting duties on the basis of maximum available fault current at each switchgear bus, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboards, and other significant locations through the system.
   4. Short-circuit tabulations shall include symmetrical fault currents and X/R ratios. For each fault location, total duty on the bus and individual contribution from each connected branch, including motor back electro-motive force (EMF) current contributions, shall be listed with its associated X/R ratio.

C. Protective Device Evaluation Study:
   1. Determine adequacy of circuit breakers, controllers, surge arresters, busways, switches, and fuses by tabulating and comparing short-circuit ratings of these devices with the available fault currents.
   2. Apply appropriate multiplying factors based upon system X/R ratios and protective device rating standards.

D. Protective Device Coordination Study:
   1. Perform study to select or to check selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and setting.
   2. Overcurrent device settings estimated in the protective device coordination study shall provide complete, 100 percent selectivity. Selectively coordinate system such that only the device nearest a fault will operate to remove the faulted circuit. System selectively shall be based on both the magnitude and duration of a fault current.
   3. Study shall include all voltage classes of equipment starting at electric utility's incoming line protective device, down to and including medium-

and low-voltage equipment. Phase and ground overcurrent and phase and ground fault protection shall be included, and settings for other adjustable protective devices.

4. Plot time-current characteristics of installed protective devices on appropriate log-log paper. Maintain reasonable coordination intervals and separation of characteristic curves. Provide coordination plots for phase and ground protective devices for complete system. Use sufficient curves to clearly indicate selective coordination achieved through electric utility's main breaker, power distribution feeder breakers, and overcurrent devices at each major load center.
5. Show maximum of eight protective devices per plot. Appropriately title each plot and include the following information as required for the circuits shown:
    a. Representative one-line diagram, legends, and types of protective devices selected.
    b. Power company's relays or fuse characteristics.
    c. Significant motor starting characteristics.
    d. Parameters of transformers, magnetizing inrush and withstand curves in accordance with ANSI C37.91.
    e. Operating bands of low-voltage circuit breaker trip curves, and fuse curves.
    f. Relay taps, time dial and instantaneous trip settings.
    g. Cable damage curves.
    h. Symmetrical and asymmetrical fault currents.
6. Provide selection and settings of protective devices separately in tabular format listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings. Provide a tabulation of recommended power fuse selection for all fuses in system.

E. Arc-Flash Analysis:
    1. Conduct arc flash analysis after acceptance by ENGINEER of short-circuit study and coordination study. Perform arc flash analysis for each operating mode of the system, in accordance with IEEE 1584 and NFPA 70E.
    2. Document the protection and calculation procedures and coordination review in testing report. Present analysis results in tabular format showing the following:
        a. Bus and protection device name.
        b. Bolted and arcing fault values.
        c. Protective device trip times.
        d. Arc flash boundary, working distance, and incident energy.
        e. Required protective flame-resistant (FR) clothing class.

1.6 STUDY REPORT

A. Summarize results of electrical power distribution system studies in a typed or computer-printed report that includes the following:
   1. Description, purpose, basis, written scope, and single-line diagram of power distribution systems evaluated.
   2. Tabulations of circuit breaker, fuses, and other equipment ratings versus calculated short-circuit duties. Evaluation of short-circuit calculations and identification of underrated equipment.
   3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, and fuse selection. Include an evaluation and discussion of logical compromises for proposed protection.
   4. Fault current tabulation including definition of terms and guide for interpretation.
   5. Tabulation of appropriate tap settings for relay seal-in units.
   6. Tabulation of equipment survey information.

B. Electrical power distribution system studies report shall include a separate section addressing arc flash analysis. In addition to protection and calculation procedures, and coordination review and analysis results, report shall include protective device evaluation for each high-incident energy case to determine if adjustments can improve system performance relative to arc flash hazard level.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. General:
   1. Coordinate with professional engineer performing the studies and assist professional engineer with collecting information necessary to complete the specified studies.
   2. Prior to performing studies, obtain information pertaining to existing system necessary for performing studies.

3.2 INSTALLATION

A. Provide personnel protective equipment labels in accordance with Section 26 05 53, Identification for Electrical Systems.
   1. Supplier Services: Provide training for OWNER's operation and maintenance personnel in personnel protection equipment. Provide at least eight hours of training, in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   2. Print and install the arc flash labels produced by the study.

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