**SECTION 26 05 73**

**OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY**

1. **GENERAL**
   1. SCOPE
      1. The contractor shall provide an engineering analysis and coordination study for the ***[entire electrical system including existing equipment] [new portions of electrical distribution system]***. The basic analysis shall include a short-circuit analysis with protective device evaluation, a protective device coordination study. ***[In addition the study shall include [a motor starting study,] [load flow/voltage drop study,] [a harmonics analysis] and [an Arc Flash study].* Coordinate the choices in the previous sentence with the optional sections you select in the PRODUCT sections.**
      2. The project shall begin at the point of utility service for the facility and continue down through the system, to all downstream distribution and branch panelboards, motor control centers and significant motor locations.
      3. The project shall include any new generators and any associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.
   2. RELATED DOCUMENTS
      1. Single line diagrams
      2. Specifications
   3. SUBMITTALS
      1. General. Submit the following according to Conditions of the Contract and Division 1 Specification Sections:
      2. Submit for review a report of the protection coordination study.
      3. Shop drawings for equipment effected by the coordination study will not be reviewed until the coordination study has been submitted and approved.
      4. Qualification data for firms and persons specified in the “Quality Assurance” Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Engineer and Owner, and other information specified.
      5. A one-line diagram of the system shall be included.
      6. The final report shall be bound in a three-ring binder.
      7. The final report shall contain individual, tabbed sections for each section.
   4. RELATED STANDARDS
      1. All studies shall be performed in accordance with the latest applicable IEEE and ANSI standards.
      2. IEEE Std 141, IEEE Recommended Practices for Electric Power Distribution for Industrial Plants (IEEE Red Book)
      3. IEEE Std 399, IEEE Recommended Practices for Industrial and Commercial Power Systems Analysis (IEEE Brown Book)
      4. IEEE Std 242, IEEE Recommended Practices for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book)
      5. IEEE Std 1584, Guide for Performing Arc-Flash Hazard Calculations.
      6. ***[Add additional standards as needed]***
   5. QUALITY ASSURANCE
      1. Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems and similar to the system for this project. Firm must have at a minimum a 4 year record of successful in-service performance.
      2. Short-Circuit Analysis and Coordination Study shall be performed by a registered Professional Engineer in the state that the project is located in.
      3. The firm conducting the study shall have one million worth of Professional Liability Insurance in addition to standard general insurance.
   6. DELIVERY, STORAGE AND HANDLING
      1. The report shall be submitted for review and approval to:
         1. ***[\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_].***
      2. The report is due no later than ***[\_\_\_\_\_\_\_\_\_\_\_\_\_]*** and are required prior to the review of the shop drawings.
2. **PRODUCTS**
   1. MANUFACTURER
      1. ***[Engineering analysis and coordination study shall be performed by SIEMENS or an approved, acceptable and qualified equal by:***
         1. ***SIEMENS***
         2. ***.]***
   2. SHORT-CIRCUIT ANALYSIS WITH PROTECTIVE DEVICE EVALUATION
      1. Systematically calculate fault currents based on the available fault current at the facility service entrance. Study preparer shall obtain the available fault current from the local utility.
      2. Short-circuit calculations shall be prepared by means of a digital computer utilizing a commercially available software package. Motor contribution shall be incorporated in determining fault levels. Results of short-circuit calculations shall be presented in tabular form and shall include momentary and interrupting fault values for three-phase and phase-to-ground faults.
      3. Analyze the short-circuit currents by preparing a tabulation comparing the fault levels to the device interrupting ratings. Indicate areas in which integrated/series ratings are utilized. The following information shall be included in the tabulation:
         1. Bus identification number.
         2. Location identification.
         3. Voltage
         4. Manufacturer and type of equipment.
         5. Device rating.
         6. Calculated short-circuit current.
   3. PROTECTIVE DEVICE COORDINATION STUDY
      1. Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at the location.
      2. A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for the coordination issues. System coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer.
      3. The following information shall be provided on all curve sheets.
         1. Device identification and associated settings/size.
         2. Voltage at which curves are plotted.
         3. Current multiplier.
         4. ANSI frequent fault damage curve.
         5. Cable insulation damage curves.
         6. Transformer inrush point.
         7. Single-line for the portion of the system.
         8. Motor starting profiles (where applicable).
   4. ***[LOAD-FLOW/VOLTAGE DROP STUDY (OPTIONAL)***
      1. ***A load-flow and voltage drop study will be performed to determine the steady-state loading profile of the system. From the results of the load-flow/voltage drop calculations, an analysis will be prepared, based on the NEC, to indicate areas of overloaded conductors/loadcenters and areas of excessive voltage drop in the conductors. The load-flow/voltage drop study calculations must be performed using a digital computer utilizing commercially available software.]***
   5. ***[MOTOR STARTING STUDY (OPTIONAL)***
      1. ***A motor starting study shall be prepared in order to analyze the transient effect of the system’s voltage profile during motor starting. Significant motor starting voltage profiles must be calculated in order to analyze the effects of the motor starting on a system basis. The voltage profile as a result of motor starting will be analyzed based on ANSI/EEE requirements. The system loading for the motor starting study shall be in accordance with the Load-Flow/Voltage Drop Study as detailed above. The motor starting study calculations shall be performed using a digital computer utilizing commercially available software.]***
   6. ***[ARC FLASH ANALYSIS (OPTIONAL)***
      1. ***An arc flash analysis shall be performed based on existing short circuit values provided by the customer or in conjunction with a short circuit study. The results from the short circuit study shall be used to determine arc energy levels at each defined location in the facility for a specified working distance. Based on the arc energy at each defined point, the proper PPE level will be determined and if the arc energy level exceeds available PPE ratings, the locations shall be noted. Labels shall be provided for each evaluated location that lists the hazard levels along with the required PPE level while working in that area. Analysis shall be provided to determine if any changes can be made in protection system to reduce arc energy levels.]***
   7. ***[HARMONICS ANALYSIS (OPTIONAL)***
      1. ***The harmonic analysis shall be performed by a computer aided circuit simulation of the distribution system specific to this project. These calculations shall show that the total harmonic voltage distortion shall be less than 5 percent due to the contribution of all VFD’s supplied.]***
   8. SINGLE-LINE DIAGRAM
      1. The final report shall include a multi-color single-line diagram of the electrical distribution system within the scope of the project. The single-line shall include:
         1. Transformer rating, voltage ratio, impedance, and winding connection.
         2. Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
         3. Switchgear, switchboards, panelboards, MCC’s, fuses, circuit breakers, ATS’s and switches continuous current ratings.
         4. Protective relays with appropriate device numbers and CT’s and PT’s with associated ratios.
         5. Detailed legend indicating device type identification and other significant details.
3. **EXECUTION**
   1. Summary
      1. The results of the system studies shall be summarized in a final report.
      2. Where required, copies of the final report shall be submitted to the power company for their review and approval. Approved copies or the report shall be submitted to the Design Engineer.
   2. FIELD SETTINGS
      1. The contractor shall engage the manufacturer’s service group or alternately a qualified independent testing firm to perform field adjustments of the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.
      2. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination study, shall be carried out by manufacturer’s service group.

**END OF SECTION**