

SECTION 260573 - SHORT CIRCUIT/COORDINATION STUDY AND ARC FLASH HAZARD STUDY

PART 1 GENERAL

1.1 SCOPE

- A. The electrical contractor shall retain the services of an independent third party firm to perform a short circuit/coordination study and arc flash hazard study as described herein.
- B. The studies shall be submitted to the Design Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval from the Engineer may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.
- C. The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency / standby sources, down to and including the smallest circuit breaker in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- D. The firm should be currently involved in high- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Maryland. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the Design Engineer for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.
- E. The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- F. The study and assessment shall be performed based on SKM's Dapper, Captor and PowerTool software.
- G. The study can be included in the on-going Red Panda Project in the campus.

1.2 RELATED WORK

- A. Applicable provisions of Division 1 govern work under this section.
- B. Section 26 24 16 – Panelboards

1.3 QUALITY ASSURANCE

- A. One- Reference standards listed in the IEEE "Buff Book", latest edition.

1.4 DATA COLLECTION FOR THE STUDY

- A. The contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the contractor with a listing of the required data immediately after award of the contract.
- B. The contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

1.5 SUBMITTALS

A. THIRD PARTY QUALIFICATIONS

1. Submit qualifications of individual(s) who will perform the work to Design Engineer for approval prior to commencement of the studies.

B. DRAFT REPORT

1. Submit a draft of the study to Design Engineer for review prior to delivery of the study to the Owner. Make all additions or changes as required by the reviewer.

C. FINAL STUDY REPORT

1. Provide studies in conjunction with equipment submittals to verify equipment ratings required.
2. The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted. Provide two (2) copies in PDF format of the study, so that it can be more easily stored and shared. Also, provide 2 copies (on CD) of the report in MS word, and 2 copies (on CD) of the one-line diagram in CAD format.

D. The report shall include the following sections:

1. Overview
2. Short Circuit Study
 - a. SC-1 Purpose
 - b. SC-2 Explanation of Data
 - c. SC-3 Assumptions
 - d. SC-4 Analysis of Results
 - e. SC-5 Recommendations
 - f. SC-6 DAPPER Fault Analysis Input Report
3. Protective Device Coordination Study
 - a. PDC-1 Purpose
 - b. PDC-2 Explanation of Data
 - c. PDC-3 Assumptions
 - d. PDC-4 Analysis of Results
 - e. PDC-5 Recommendations (Including NEC 700-27 Requirement)
 - f. PDC-6 CAPTOR Results
 - g. PDC-7 Example Drawings

4. Arc Flash Study

- a. ARC-1 Purpose
- b. ARC-2 Explanation of Data
- c. ARC-3 Assumptions
- d. ARC-4 Analysis of Results
- e. ARC-5 Recommendations
- f. ARC-6 SKM Arc Flash Evaluation Report

5. Prioritized Recommendations and Conclusions

- a. Appendices
- b. APP-1 DAPPER One-line Diagrams
- c. APP-2 AutoCAD One-line Diagrams
- d. APP-3 SKM Protective Device Summaries
- e. APP-4 Reference Data
- f. APP-5 Sample Work Permit Form
- g. APP-6 Copy of Warning Labels, including study date
- h. The above sections shall include the following items in detail:
 - 1) Obtain available fault current from the local utility company.
 - 2) Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.
 - 3) Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
 - 4) Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
 - 5) Arc flash values for two normal cases to define the highest values (low short circuit and high short circuit).
 - 6) Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.
 - 7) IEEE standard one-line diagram with equipment evaluation and circuit breaker setting forms that clearly define the system data and are easy to interpret.

- 8) Recommendations to reduce the arc flash incident energy in all areas that require class2 and higher PPE.
- 9) Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
- 10) The contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24" x 36" (minimum) Styrofoam backboard. This one one-line diagram shall be mounted in each electrical room.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 SHORT CIRCUIT AND COORDINATION STUDY

- A. The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
- B. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
- C. Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- D. Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

- E. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- F. Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.
- G. Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- H. Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not properly rated for fault conditions.
- I. Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.
- J. When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- K. Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- L. For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

3.2 FIELD SETTINGS

- A. The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash hazard study.
- B. 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 the Contractor at no additional cost to the owner.

3.3 ARC FLASH HAZARD STUDY

- A. As part of the short circuit and coordination study, arc flash hazard study shall be included. The study shall include the following:

1. Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
 2. Calculations to conform to National Fire Protection Association (NFPA) 70E – 2003 calculation standards. All incident energy units shall be calculated in calories per square centimeter.
 3. Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E-2003 for each piece of electrical gear.
- B. Electrical Contractor shall provide labeling as required by OSHA based upon the results of the arc flash hazard study. At a minimum, the labeling shall contain the following information: PPE level, Flash Hazard Boundaries, Flash Protection Boundary, and Shock Hazard Boundaries such as Limited Approach Boundary, Restricted Approach Boundary, Prohibited Approach Boundary, and study date."

END OF SECTION 260573