

SECTION 260573 – POWER DISTRIBUTION SYSTEM ELECTRICAL STUDIES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. THE WORK UNDER THIS SECTION INCLUDES BUT IS NOT LIMITED TO THE FOLLOWING:
 - 1. Power Distribution System Electrical Studies.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Short Circuit Studies, Protective Devices Evaluation Studies, Protective Device Coordination Studies and Arc Flash Hazard Studies shall be performed by the same entity, which shall be a Professional Engineer registered in the state where the equipment will be installed. The studies shall be per the requirements set forth in the latest edition of NFPA 70E-Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E, Annex D.
- B. The studies shall be submitted to the Architect prior to shipment of any electrical distribution equipment.
- C. The studies shall include all portions of all electrical systems affected by the project (including any existing systems/equipment) from the utility service to any existing equipment at the facility (including all existing equipment fed from the same service point as any new equipment) and to all new equipment installed under this contract. All induction motors 50 HP or below and fed from the same bus may be grouped together. All induction motors greater than 50 HP shall be included individually with associated starters and feeder impedance. See individual study sections below for additional scope requirements.
- D. The studies shall be performed using the latest revision of the SKM Systems Analysis Power*Tools for Windows (PTW) or EasyPower software program.
- E. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- F. The contractor shall be responsible for collecting data on any existing or proposed electrical equipment, devices, conductors, etc. as required to prepare the study, and shall supply pertinent electrical system conductor, circuit breaker, generator, and other component and system information in a timely manner to allow the studies to be completed prior to shipment of equipment.
- G. The Power Distribution System Electrical Studies shall be performed by Square 'D', G.E., Siemens or Cutler Hammer; or a third-party vendor if specifically approved by the engineer prior to preparation of the studies.
- H. The proposed vendor shall have completed a minimum of five (5) equivalent Arc-Flash Hazard Studies in the past three (3) years.

2.2 SHORT CIRCUIT STUDY

- A. The Short Circuit Study shall be performed with aid of a computer program. The study input data shall include the power company's short circuit contribution, resistance and reactive components of the branch impedances, X/R ratios, base quantities selected, and other source impedances.
- B. Short circuit momentary duty values and interrupting duty shall be calculated on each individual basis with the assumption that there is a three-phase bolted short circuit at the respective switchgear bus, switchboard, low voltage motor control center, distribution panelboard, and other significant locations throughout the system.
- C. The short circuit tabulation shall include symmetrical and asymmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contributions from each connected branch, including motor back EMF current contributions shall be listed with its respective X/R ratio.

2.3 PROTECTIVE DEVICE EVALUATION STUDY

- A. The Protective Device Evaluation Study shall be performed to determine the adequacy of circuit breakers, switches, transfer switches, and fuses by tabulating and comparing the short circuit rating of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied.
- B. Any problem areas or inadequacies in the equipment due to short circuit currents shall be promptly brought to the Architect's attention.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. The Protective Device Coordination Study shall be performed to provide the necessary calculation and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices.
- B. The coordination study shall show the best coordination attainable for all breakers down through the largest breaker at each piece of distribution equipment. Coordination study shall demonstrate selective coordination where required by applicable codes or contract documents.
- C. Phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices. Where ground fault protection is used, coordination of the ground fault protection with the first downstream overcurrent phase protection device shall be demonstrated.
- D. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves be maintained.

2.5 ARC-FLASH HAZARD STUDY

- A. The Arc-Flash Hazard Study shall be performed with the aid of computer software intended for this purpose in order to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.
- B. The Arc-Flash Hazard Study shall be performed in conjunction with a short-circuit Study and a time-current coordination Study.
- C. The Arc-Flash Hazard Study shall be performed for the following equipment:

1. All Distribution Equipment – This includes but is not limited to the following:
 - a. Switchgear
 - b. Switchboards
 - c. Motor Control Center
 - d. All Lighting and Power Panelboards
 - e. Fused Disconnect Switches rated greater than 100A
 2. Separately enclosed devices fed from protection device rated greater than 100A - This includes but is not limited to the following:
 - a. Control Panels
 - b. VFD's
 - c. RVSS
- D. A generic Arc-Flash label shall be applied to other electrical equipment that has not been included in the study. This includes but is not limited to the following equipment:
1. Non-fused Disconnect Switches
 2. Fused Disconnect Switches rated 100A or less
 3. Transformers
 4. Control Panels, VFD's, RVSS, etc. rated 100A or less
- E. Where a main protective device is provided, the study shall be performed on the line side and load side of the main. The worst-case result shall be used for the study result and label.
- F. The Study shall be performed under worst-case Arc-Flash conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- G. Where incident energies are calculated to fall within the high marginal region of a given Hazard/Risk Category Level, the Hazard/Risk Category Level shall be increased one level.
- H. The Arc-Flash Hazard Study shall be performed in compliance with the latest IEEE Standard 1584, the IEEE Guide for Performing Arc-Flash Calculations. Where IEEE 1584 does not have a method for performing the required arc-flash calculations (such as for single phase equipment), calculations shall be performed and system shall be modeled using modules/methods as recommended by the arc flash software supplier (for example, using SKM Unbalanced/Single Phase Studies module for modeling single phase systems).
- I. Equipment labels to identify AFIE and appropriate Hazard/Risk Category in compliance with NFPA 70E and ANSI Z535.4 (latest version of these requirements) shall be provided to the Electrical Contractor. The Electrical Contractor shall affix the labels to the distribution equipment devices as directed by the equipment manufacturer. These labels shall, at a minimum, include the following:
1. WARNING label.
 2. Hazard/Risk Category.
 3. Arc Flash Boundary Distance.
 4. Incident Energy (in cal/cm²) at Working Distance.
 5. Shock Hazard Voltage.
 6. Limited Approach Boundary Distance.
 7. Restricted Approach Boundary Distance.
 8. Prohibited Approach Boundary Distance.
 9. Equipment Name.
 10. Name of Firm who prepared the Study.
 11. Project Number of the Firm who prepared the Study.
 12. Date that the Study was prepared.

13. Method for calculating analysis data.
14. Statement to read: "Any system modification, adjustment of protective device settings, or failure to properly maintain equipment will invalidate this label" (or equivalent).

PART 3 - EXECUTION

3.1 SUBMITTAL REQUIREMENTS

- A. The results of the studies shall be summarized in a final report. The report shall include the following sections:
 1. General:
 - a. Description, purpose, basis and scope of the studies
 - b. Single line diagram of the portion of the power system which is included within the scope of the work. The single line diagram shall fit on one sheet of paper (size as required) unless approved otherwise by engineer. The following information shall be shown on the single line diagram:
 - 1) Device Name
 - 2) Branch Fault Currents with directional indicators
 - 3) General Location (for busses only)
 - 4) Other basic component information such as cable type, cable length, breaker rating, buss short circuit rating, transformer voltages, transformer size, fuse size, etc..
 2. Short Circuit Study:
 - a. Tabulation of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.
 3. Protective Device Evaluation/Coordination Study:
 - a. Protective devices time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
 - b. Fault current calculations including definitions of terms and a guide for interpretation of computer printout.
 - c. Documentation from utility company on their letterhead showing their anticipated values of available short circuit currents X/R ratios and protective devices with which the power distribution system will coordinate.
 - d. Time-current characteristics of the respective protective devices shall be plotted on log-log paper. Plots shall be printed in color with a dedicated color and pattern for each curve for clear identification.
 - e. Plots shall include complete titles, respective single line diagrams and legends, and associated power company's relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of low voltage circuit breakers trip curves and fuses.
 - f. The coordination plots shall indicate the type of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, transformer magnetizing inrush and ANSI transformer withstand parameters, cable thermal overcurrent withstand limits and significant symmetrical and asymmetrical fault currents.
 - g. The coordination plots for phase and ground protective devices shall be provided on a system basis.
 - h. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

4. Arc-Flash Hazard Study:

- a. Tabulation of device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment classes and AFIE levels.
 - b. Recommendations for reducing AFIE levels and enhancing worker safety.
- B. Furnish all labor, materials, calculations, electrical equipment, technical data and incidentals required to provide a complete short circuit study, coordination study and arc flash hazard study of protective devices, busses, etc. from the utility service to any existing equipment at the facility and all new equipment installed under this contract.
- C. The study shall comply with the following applicable provisions and recommendations of the latest revisions of the following: ANSI C37.5, IEEE Standard No. 399, and IEEE Standard No. 141.
- D. Submit calculations and results of the short circuit, protective device evaluation and coordination and arc flash hazard studies prior to submitting shop drawings for new equipment. Contractor shall verify that all proposed equipment is properly rated per the short circuit and protective device evaluation portions of the study prior to releasing equipment for manufacturing.
- E. Submit a copy of a sample typical arc flash label layout (meeting requirements outlined above) that will be used for the project.
- F. Submit final electronic copies of all SKM program files/models/input data/etc. used to perform the study to the owner with final close-out documents. These files shall be complete as required to allow future users to recreate the study.

3.2 INSTALLATION

- A. Contractor shall adjust all breaker settings as recommended by the coordination study prior to energizing equipment.
- B. Contractor shall affix arc flash hazard notification labels (as determined by the results of this study) to each piece of distribution equipment prior to energization of equipment. A generic arc-flash warning label shall be affixed to any electrical equipment not included in the analysis as outlined above.
- C. Where short circuit rating of equipment is dependent on setting of upstream overcurrent device, provide and install label for equipment indicating the required settings of the associated device.

END OF SECTION 260573