



Division 260573

Power System Study

DESIGN GUIDE

1 General

1.1 Introduction

- A. This section applies to the following:
 - 1. Short circuit analysis
 - 2. Selective coordination analysis
 - 3. Overcurrent protective device settings
 - 4. Arc Flash Hazard Analysis

1.2 References

- A. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
- B. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- C. IEEE 399 - Recommended Practice for Industrial and Commercial Power Systems Analysis
- D. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

1.3 Scope

- A. The Contractor shall employ the services of a skilled specialist to perform the following studies:



1. Short Circuit Analysis including:
 - a. Primary side of pad mounted service transformers assuming an infinite bus.
 - b. Service entrance, main and distribution switchboards, dry-type transformers, distribution and branch circuit panels, and associated feeders.
 - c. Generator system if present.
 - d. Building motor contributions.
2. Relay, Fuse and Circuit Breaker Coordination Study including:
 - a. NEC 700, 701 and 702 distribution systems.
3. Load Flow Analysis including:
 - a. All electrical distribution systems.
4. Arc Flash Hazard Analysis and Labeling including:
 - a. Primary side of pad mounted transformers.
 - b. All electrical distribution system busses including normal and alternate power systems sources.

2 Materials

2.1 Computer Software

- A. Software shall plot and diagram time-current characteristic curves as part of its output.
- B. Software shall report device settings and ratings of all overcurrent protective devices.



2.2 Study Report

- A. The results of the power system studies shall be summarized in a compiled study report. Copies of the final report shall be furnished and included in the O&M Manuals.
- B. The report shall include the following sections:
 - 1. Project description, purpose, basis and scope of the study.
 - 2. Fault current calculations and indication that with the recommendations included in the study, the equipment will be properly rated and provided such that it will continue to operate properly following a maximum fault current episode.
 - 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding the same.
 - 4. Copies of manufacturer's time-current curves for the devices studied.
 - 5. Protective device time versus current coordination curves. Overlay curves to prove coordination.
 - 6. Tabulations of relay and circuit breaker trip settings, fuse selections, and commentary regarding the same.
 - 7. Coordination tabulation and report indicating that with the recommendations included in the study, the system will be coordinated.
 - 8. Calculations and placards required for posting relative to the Arc-Flash study. Provide all such placards and install at each item of equipment for the worst-case Operating Scenario.

3 Execution

3.1 Data Collection

- A. The Contractor shall be responsible to obtain all required data necessary for the required studies.



3.2 Short Circuit Analysis

- A. Perform computer aided short circuit analysis using suitable software.
- B. Source Impedance:
 - 1. Assume an infinite bus on the primary side of each pad mounted distribution transformer.
- C. Determine the available 3-phase short circuit and ground fault currents at each bus. Incorporate the motor contribution, applying motor contribution at the appropriate locations in the system.
- D. Provide a summary section evaluating the adequacy of the distribution equipment. Make recommendations as appropriate for improvements to the system.
- E. Contractor shall provide a preliminary study prior to submission of switchboard, panelboard, and circuit breaker product submittals.

3.3 Selective Coordination Analysis

- A. Perform computer aided selective coordination analysis using suitable software.
- B. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination. Display the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
- C. A table shall be included to summarize the settings selected for the protective devices.
- D. Provide a summary section evaluating the degree of system protection and service continuity with overcurrent devices, along with recommendations for increasing system protection or device coordination. Highlight areas lacking coordination.
- E. Contractor shall provide a preliminary study prior to submission of switchboard, panelboard, and circuit breaker product submittals.



3.4 Over-Current Protection Device Setting

- A. Model the entire electrical distribution system and run load flow analysis for all operating scenarios.
- B. Engage a factory-authorized service representative, to set overcurrent protective devices within equipment in accordance with the results of the study. Provide a written report which itemizes each setting applied to each device.

3.5 Arc-Flash Hazard Analysis

- A. Provide Arc-Flash labeling for all electrical equipment on the project in accordance with the requirements of NEC Article 110.
- B. Calculate the flash protection boundary and incident energy at all significant locations including switchgear, buses, switchboards, motor control centers, distribution panels, panelboards, and other locations that could require maintenance or service. Repeat calculations for each Operating Scenario.
- C. The analysis shall include all medium voltage equipment and locations plus all 480 & 208 volt locations within the limit of the study.
- D. Safe working distances shall be specified for all calculated fault locations based on the calculated arc flash boundary incident energy in accordance with IEEE 1584 ($>1.2 \text{ cal/cm}^2$)
- E. The analysis shall include calculations for maximum and minimum contributions of fault current magnitude originating from both line and load side.
- F. Calculations shall be based on actual overcurrent clearing protective device clearing time with a maximum clearing time as recommended in IEEE 1584 (<2 seconds).
- G. Include a list of all required placards with all the necessary information for each within the report.
- H. Placards shall be 3.5" x 5" and shall be provided for each work location analyzed. Each placard shall include an orange header with the wording "WARNING, ARC FLASH HAZARD" with all recommended information and in the configuration suggested in IEEE 1584.



4 Appendix

4.1 Reserved for future.