**SECTION 26 05 71**
**ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. This section specifies the requirements of the Electrical System Protective Device Study and arc flash analysis study for all new electrical system and equipment installed in this project.

B. A short circuit and coordination study shall be prepared for the electrical over current devices to be installed under this project to assure proper equipment and personnel protection.

C. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the utility. The study shall reflect the operation of each device during normal and abnormal current conditions.

**1.2 RELATED WORK**

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.

B. Section 26 13 00, MEDIUM-VOLTAGE SWITCHGEAR: Primary distribution switchgear.

**1.3 SUBMITTALS**

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Complete short circuit and coordination study as described herein.

C. Protective equipment shop drawings shall be submitted simultaneously with or after the protective device study. Protective equipment shop drawings will not be accepted prior to protective device study.

D. Certification: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:

1. Certification by the Contractor that the protective devices have been adjusted and set in accordance with the approved protective device study.

**1.4 QUALIFICATIONS**

The protective device study shall be prepared by qualified engineers of the high voltage switchgear manufacturer or an approved consultant. The Contractor is responsible for providing all pertinent information required by the preparers to complete the study.

**1.5 REQUIREMENTS**

A. The complete study shall include a system one line diagram, short circuit and ground fault analysis, and protective coordination plots.

B. One Line Diagram:

1. Show, on the one line diagram, all electrical equipment and wiring to be protected by the overcurrent devices installed under this project. Clearly show, on the one line, the schematic wiring of the electrical distribution system.
2. Also show on the one line diagram the following specific information:
   a. Calculated fault impedance, X/R ratios, and short circuit values at each bus.
   b. Breaker and fuse ratings.
   c. Generator kW and Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
   d. Voltage at each bus.
   e. Identification of each bus.
   f. Conduit material, feeder sizes, length, and X/R ratios.

C. Short Circuit Study:

1. Systematically calculate the fault impedance to determine the available short circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
2. The study shall be calculated by means of a computer program. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
3. Present the data determined by the short circuit study in a table format. Include the following:
   a. Device identification.
   b. Operating voltage.
   c. Protective device.
   d. Device rating.
   e. Calculated short circuit current.

D. Coordination Curves:

1. Prepare the coordination curves to determine the required settings of protective devices to assure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists

between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices will be clearly depicted on one sheet.

2. The following specific information shall also be shown on the coordination curves:
   a. Device identification.
   b. Voltage and current ratio for curves.
   c. 3-phase and 1-phase ANSI damage points for each transformer.
   d. No-damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum short circuit cutoff point.
3. Develop a table to summarize the settings selected for the protective devices. Include the following in the table:
   a. Device identification.
   b. Relay CT ratios, tap, time dial, and instantaneous pickup.
   c. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
   d. Fuse rating and type.
   e. Ground fault pickup and time delay.

**1.6 ANALYSIS**

A. Analyze the short circuit calculations, and highlight any equipment that is determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Provide modifications to conform with the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, C.T. ranges, etc.).

B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

**1.7 ADJUSTMENTS, SETTINGS AND MODIFICATIONS**

A. Necessary final field adjustments, settings and minor modifications shall be made to conform with the protective device study without additional cost to the Government.

B. All final circuit breaker and relay settings and fuse sizes shall be made in accordance with the recommendations of the protective device study.

**1.8 ARC FLASH CALCULATIONS AND STUDY**

A. Contractor to perform an arc flash analysis for all electrical equipment installed in this project in accordance with IEEE Std 1584a. For each bus analyzed, determine the following: Flash Hazard Protection Boundary, Incident Energy Level, Required Personal Protective Equipment Category, Type of fire Rated Clothing, Limited Approach Boundary, Restricted Approach Boundary, and Prohibited Approach Boundary. Present the data from the arc flash analysis in tabular format, and submit the preparation of arc flash warning labels for each piece of new electrical equipment listed in this project.

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