POWERSYSTEM
ENGINEERING UPDATE
Short Circuit & Coordination * Power Quality * Energy Analysis

Why specify a Short Circuit and Coordination Study?

A Short Circuit and Coordination Study is critical for the safe, efficient, and economical operation of any electrical distribution system. A Short Circuit Study will help to ensure that personnel and equipment are protected by establishing proper interrupting ratings. When an electrical fault exceeds the interrupting rating of the protective device, the consequences can be devastating, including injury, damaged electrical equipment, and costly downtime. A Coordination Study maximizes power system selectivity by isolating faults to the nearest protective device, as well as helping to avoid nuisance operations that are due to transformer inrush or motor starting operations.

NFPA 70B maintains that a Short Circuit and Coordination Study is a very important, yet sometimes an overlooked step after the initial design and before the implementation of an electrical distribution system. The NEC addresses the importance of this type of study in articles 110-9, 110-10, 240, and 517.17. It is clear that a third-party, independent study performed during/after the equipment submittal process, can prove to be invaluable. A Short Circuit and Coordination Study serves to incorporate all the system changes that come about after the initial design. Some examples of factors that commonly change in the implementation of a system are: the utility available fault level, size and/or transformer impedance values, conductor size/type, addition of motors, and the system operating parameters.

The following is an example of a complete short circuit/coordination, motor starting, harmonics, and load flow study project specification. Please review this specification for possible use in your next electrical design project to protect and maximize the operating efficiency of your power system design. If you would like this specification on a disc formatted in Microsoft Office (Word), please call CPE at (401) 694-9494, fax your request to (410) 694-0085, or e-mail carl@cpeinc.net

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TECHNICAL SPECIFICATIONS
SHORT CIRCUIT ANALYSIS AND COORDINATION STUDY

PART 1 – GENERAL

1.1 SUMMARY

A. An Engineering Analysis and Coordination Study shall be performed on the electrical distribution system. The analysis shall include a short-circuit analysis with protective device evaluation, a protective device coordination study, a motor starting study, load flow/voltage drop study and a harmonics analysis. A one-line diagram of the system shall also be included. The final report shall be bound in a three-ring binder.

1.2 SCOPE OF PROJECT

A. The project shall begin at the 34.5kV utility service at the facility, continue through the corresponding 15kV system, down through the 480V unit substation to all downstream distribution and branch panelboards, motor control centers, and significant motor locations.

B. The project shall include the new generator and all associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.

1.3 PREPARER

A. Engineering Analysis and Coordination Study shall be performed by Coordinated Power Engineering, Inc. or an approved, acceptable and qualified equal.

Local Representative: Coordinated Power Engineering, Inc.
1340-G Charwood Road
Hanover, Maryland 21076
Voice: 410-694-9494
Fax: 410-694-0085
Attention: Carl Rager

1.4 SHORT-CIRCUIT ANALYSIS WITH PROTECTIVE DEVICE EVALUATION

A. 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.

B. 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.

C. 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.

1.5 PROTECTIVE DEVICE COORDINATION STUDY

A. 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.

B. 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 allowing condition to remain or provide solution to resolve situation. System coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of eight years of current experience in the coordination of electrical power systems.

C. 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).

1.6 LOAD-FLOW/VOLTAGE DROP STUDY

A. A load-flow and voltage drop study will be performed to determine the steady-state loading profile of the system. This analysis will be conducted under two modes of operation. The loading under the first mode of operation will be based on the instantaneous load values collected during the field effort. The loading under the second mode of operation will be based on a 80% design criteria of the loadcenters. 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.

1.7 MOTOR STARTING STUDY

A. A motor starting study will 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 will be in accordance with the Load-Flow/Voltage Drop Study as detailed above. The motor starting study calculations must be performed using a digital computer utilizing commercially available software.

1.8 SINGLE-LINE DIAGRAM

A. 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.

1.9 HARMONICS ANALYSIS

A. 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.

1.10 SUBMITTALS

A. General. Submit the following according to Conditions of the Contract and Division 1 Specification Sections:

1. Submit for review six copies of the protection coordination study.

B. Shop drawings for equipment effected by the coordination study will not be reviewed until the coordination study has been submitted and approved.

C. 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.

1.11 QUALITY ASSURANCE

A. 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.

B. The study shall be prepared in accordance with the latest edition of NETA Std. ATS, NFPA 70B, the "National Electrical Code", ANSI C2" National Electrical Safety Code", and ANSI/IEEE Guidelines, as well as manufacturer's recommendations.

C. Analysis and Coordination Study shall be performed by a registered Professional Engineer. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years experience in the analysis, evaluation, and coordination of electrical distribution systems.

D. The firm conducting the study shall have one million worth of Professional Liability Insurance in addition to standard general insurance.