SECTION 26 05 73

SHORT CIRCUIT AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes short circuit and protective device coordination study encompassing portions of electrical distribution system from normal and emergency power source or sources up to and including utility company overcurrent devices and available fault circuits, breakers in service entrance switchboard, fuses in service entrance switchboard, main breaker in sub-distribution panels, fuses in sub-distribution panels, main breaker and feeder breaker in each panelboard.

B. Related Sections:

1. Division 26 - Low-Voltage Electrical Power Conductors and Cables.
2. Division 26 - Transformers.
3. Division 26 - Transformer Load Centers.
4. Division 26 - Switchboards.
5. Division 26 - Panelboards.
6. Division 26 - Motor-Control Centers.
7. Division 26 - Enclosed Bus Assemblies.
8. Division 26 - Fuses.
9. Division 26 - Enclosed Switches.
10. Division 26 - Enclosed Circuit Breakers.
11. Division 26 - Enclosed Transfer Switches.
12. Division 26 - Enclosed Controllers.
13. Division 26 - Enclosed Contactors.
14. Division 26 – Emergency Engine Generators.

C. The Developer Design/Builder shall submit a short circuit and coordination and arc flash study prepared for the electrical over-current devices to be installed under this project to assure proper equipment and personnel protection. The study shall be for the new building and re-feed of existing building. The study shall be submitted prior to or at the same time with electrical distribution equipment submittal for review and comment.

D. It is the responsibility of the entity performing the Short Circuit and Coordination Study to collect all data from the Developer Design/Builder to fully perform the study, including but not limited to engine generator data, motor data, circuit breakers, utility company short circuit, available new and existing device ratings, conductor data, transformer ratings, etc.

E. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the source. The study shall reflect the operation of each device during all normal and abnormal current conditions when served from the utility and from the standby electrical system.

F. The short circuit and coordination study shall be submitted prior to or along with the switchgear submittal, and shall include all equipment which has an AIC rating. The short circuit study shall reflect that all equipment with an AIC rating is properly rated for its specific application. The submitted switchgear (including all equipment which has an AIC rating) shall reflect the findings of short circuit study (i.e., the AIC ratings of the equipment shall exceed the available short circuit current and any required derating factors at each point in the system.)

1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers:

1. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).

B. National Fire Protection Association:

1. NFPA 70 - National Electrical Code.

1.03 DESIGN REQUIREMENTS

A. Complete Short Circuit and Protective Device Coordination and Arc Flash Study to meet requirements of NFPA 70.

B. Report Preparation:

1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.
2. Perform study with aid of computer software program.
3. Obtain actual settings for all motors for equipment incorporated into Work.
4. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:

a. Utility supply bus.
b. Main service switchgear.
c. Secondary unit substations.
d. Automatic transfer switch.
e. Engine generator.
f. Engine generator control and distribution switchgear.
g. Switchboards.
h. Motor control centers.
i. Distribution panelboards.
j. Branch circuit panelboards.
k. Busway.
l. Each other significant equipment location throughout system.

C. Report Contents:

1. Include the following:

a. Calculation methods and assumptions.
b. Base per unit value selected.
c. One-line diagram.
d. Source impedance data including power company system available power and characteristics.
e. Typical calculations.

1) Fault impedance.
2) X to R ratios.
3) Asymmetry factors.
4) Motor fault contribution.
5) Short circuit kVA.
6) Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents.
7) Tabulations of calculation quantities and results.

f. One-line diagram revised by adding actual instantaneous short circuits available.
g. State conclusions and recommendations.

2. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
3. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
4. Prepare 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.
5. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following:

a. Power company relay characteristics.
b. Power company fuse characteristics.
c. Low voltage (600 volt or below) equipment circuit breaker trip device characteristics.
d. Low voltage (600 volt or below) equipment fuse characteristics.
e. Cable damage point characteristics.
f. Pertinent transformer characteristics including:

1) Actual transformer full load current.
2) Actual transformer magnetizing inrush.
3) ANSI transformer withstand parameters.
4) Significant symmetrical fault current.
5) Note: Any increase in actual transformer spec to account for temperature rating or any other reason must be accounted for and noted in the study.

g. Pertinent motor characteristics.
h. Generator characteristics including:

1) Phase and ground coordination of generator protective devices.
2) Decrement curve and damage curve.
3) Operating characteristic of protective devices.
4) Actual impedance value.
5) Time constants.
6) Current boost data.
7) Do not use typical values for generator.

i. Transfer switch characteristics.
j. Other system load protective device characteristics.

1.04 SUBMITTALS

A. Division 01 - Submittal Procedures: Requirements for submittals.

B. Qualifications Data: Submit the following for review prior to starting study.

1. Submit qualifications and background of firm.
2. Submit qualifications of individual or individuals, Professional Engineer performing study or under whose direction the study is performed.
3. Certification: Two weeks prior to final inspection, deliver to the County's Representative four copies of the following certifications:

a. Certification by the Developer Design/Builder that the protective devices have been adjusted and set in accordance with the approved protective device study.

C. Software: Submit for review information on software proposed to be used in performing study.

D. Product Data: Submit summarized results of study in report format including the following:

1. Single Diagram:

a. Show on the single 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.
b. Also show on the single line diagram the following specific information:

1) Calculated fault impedance, X/R ratios, and short circuit values at each bus.
2) Breaker and fuse ratings.
3) Transformer KVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
4) Voltage at each bus.
5) Identification of each bus.
6) Conduit material, feeder sizes, length, and X/R ratios.

2. Short Circuit Study:

a. 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.
b. Entire system shall be modeled under both normal and emergency power. If any closed transition transfer switches are used, normal and emergency power shall be combined.
c. The short circuit study shall incorporate the actual feeder types, sizes and lengths proposed to be used by the Developer Design/Builder.
d. The calculations may be prepared by means of a digital computer. All pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
e. Present the data determined by the short circuit study in a table format. Include the following:

1) Device identification.
2) Operating voltage.
3) Protective device.
4) Device rating.
5) Calculated short circuit current, indicating worst-case fault current incorporating all system models as outlined above.

3. Coordination Curves:

a. 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 (where possible) 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. Where a switchboard or panelboard has multiple devices of different sizes, it is not necessary to plot curves for each device when coordination for one device is demonstrated graphically and it is intuitively obvious that the other devices coordinate as well.
b. The following specific information shall also be shown on the coordination curves:

1) Device identification.
2) Voltage and current ratio for curves.
3) 3-phase and 1-phase ANSI damage points for each transformer.
4) No-damage, melting, and clearing curves for fuses.
5) Cable damage curves.

6) Transformer inrush points.
7) Maximum short circuit cutoff point.
8) Short-time withstand capability of main 480V circuit breakers.
9) Coordination between the directional overcurrent relays and the main 480V breaker.

c. Develop a table to summarize the settings selected for the protective devices. Include in the table the following:

1) Device identification.
2) Relay CT ratios, tap, time dial, and instantaneous pickup.
3) Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
4) Fuse rating and type.
5) Ground fault pickup and time delay.

E. Submit copies of final report signed by professional engineer under whose direction the study was performed. Make any additions or changes required by review comments.

1.05 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

B. Use commercially available software, designed specifically for short circuit and protective device coordination studies approved by the County's Representative.

C. Perform study in accordance with IEEE 242.

1.06 QUALIFICATIONS

A. The short circuit and protective device coordination and arc flash study shall be signed and stamped by a Professional Engineer (Electrical) licensed in the State of California, under whose direction the study was performed.

B. The Developer Design/Builder shall have the coordination study prepared by qualified engineers who are employed by the switchboard manufacturer or an approved consultant. The Developer Design/Builder is responsible for providing all pertinent information (feeder lengths and existing equipment parameters) as well as utility information (i.e. transformers, impedances, and available short circuit currents), required to complete the study. The engineer(s) or consultant(s) shall meet all state and local requirements with regard to professional registration and standards of practice.

C. Demonstrate company performing study has capability and experience to provide assistance during system start up.

1.07 PRE-INSTALLATION MEETINGS

A. Division 01 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.08 SEQUENCING

A. Division 01 - Summary: Requirements for sequencing.

B. The short circuit portion of the study shall be submitted prior to or along with the switchboard submittal, and shall include all equipment which has an AIC rating. The short circuit study shall reflect that all equipment with an AIC rating is properly rated for its specific application. The submitted switchboard (including all equipment which has an AIC rating) shall reflect the findings of short circuit study (i.e., the AIC ratings of the equipment shall exceed the available short circuit current and any required derating factors at each point in the system.).

C. When formal completion of study will cause delay in equipment manufacturing, obtain approval from County's Representative for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

1.09 SCHEDULING

A. Division 01 - Administrative Requirements and Construction Progress Schedule: Requirements for scheduling.

B. Schedule work to expedite collection of data to ensure completion of study for final approval of distribution equipment shop drawings prior to release of equipment for manufacturing.

1.10 COORDINATION

A. Division 01 - Administrative Requirements: Requirements for coordination.

B. Coordinate work with local power company.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Division 01 - Quality Requirements and Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Provide assistance to electrical distribution system equipment manufacturer during start up of electrical system and equipment.

C. Select each primary protective device for delta-wye connected transformer so device’s characteristic or operating band is within transformer characteristics, including point equal to 58 percent of ANSI withstand point to provide secondary line-to-ground fault protection.

D. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by 16 percent current margin to provide proper coordination and protection in event of secondary line-to-line faults.

E. Separate high and medium-voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

F. 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. Proposed major corrective modifications will be taken under advisement by the County's Representative, and the Developer Design/Builder will be given further instructions. Provide minor modifications to conform with the study (Examples of minor modifications are trip sizes within the same frame, the time curve characteristics of induction relays, CT ranges, etc.).

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

3.02 ADJUSTING

A. Division 01 - Execution and Closeout Requirements: Requirements for starting and adjusting.

B. The Developer Design/Builder's electrical contractor shall be responsible for adjusting the trip settings of all breakers and other adjustable over-current devices per the approved coordination study.

C. The Developer Design/Builder Electrical Contractor shall provide the breaker testing agency with a copy of the final, approved coordination study and ensure all breaker testing is conducted with breaker settings adjusted per the study.

D. Accomplish necessary field settings, adjustments, and minor modifications to conform with the study without cost to the County.

END OF SECTION