

Section 16055

Overcurrent Protective Device Coordination

PART 1: General

- 1.1 *Summary* – This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. Coordination of series-rated devices is permitted where indicated on Drawings.
- 1.2 *Submittals* –
 - 1.2.1 *Product Certificates* – For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
 - 1.2.2 *Qualification Data* – For coordination-study specialist.
 - 1.2.3 *Submittals* – Submittals shall be in paper and electronic forms.
 - 1.2.3.1 Study input data, including completed computer program input data sheets.
 - 1.2.3.2 Study and Equipment Evaluation Reports.
 - 1.2.3.3 Study Report (breaker curves in color).
 - 1.2.3.4 Provide Electronic Study for Engineer and Owner Review.
- 1.3 *Quality Assurance* –
 - 1.3.1 Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
 - 1.3.2 *Coordination-Study Specialist Qualifications* - An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices. Professional Engineer, licensed in the state of Florida, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of the Engineer.
 - 1.3.3 *Standards* –
 - 1.3.3.1 Comply with IEEE 242 for short-circuit currents and coordination time intervals.
 - 1.3.3.2 Comply with IEEE 399 for general study procedures.

PART 2: Products

2.1 *Computer Software Developers* –

2.1.1 *Product* – Subject to compliance with requirements, provide by one of the following:

2.1.1.1 SKM Systems Analysis, Inc.

PART 3: Execution

3.1 *Examination* – Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.

Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 *Power System Data* – Gather and tabulate the following input data to support coordination study:

3.2.1 Product Data for overcurrent protective devices specified in Sections 16010 – 16950 and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

3.2.2 Impedance of utility service entrance.

3.2.3 Electrical Distribution System Diagram in hard-copy and electronic-copy formats, showing the following:

3.2.3.1 Circuit-breaker and fuse-current ratings and types.

3.2.3.2 Relays and associated power and current transformer ratings and ratios.

3.2.3.3 Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

3.2.3.4 Generator kilovolt amperes, size, voltage, and source impedance.

3.2.3.5 Indicate conduit material, sizes of conductors, conductor material, insulation, and length.

3.2.3.6 Motor horsepower and code letter designation according to NEMA MG 1.

3.2.4 Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

3.2.4.1 Special load considerations, including starting inrush currents and frequent starting and stopping.

- 3.2.4.2 Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
- 3.2.4.3 Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- 3.2.4.4 Generator thermal-damage curve.
- 3.2.4.5 Ratings, types, and settings of utility company's overcurrent protective devices.
- 3.2.4.6 Special overcurrent protective device settings or types stipulated by utility company.
- 3.2.4.7 Time-current-characteristic curves of devices indicated to be coordinated.
- 3.2.4.8 Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- 3.2.4.9 Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- 3.2.4.10 Control panel ampacity and interrupting rating in amperes rms symmetrical.

3.3 *Fault-Current Study –*

- 3.3.1 Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at the Control Panel.
- 3.3.2 Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- 3.3.3 Calculate momentary and interrupting duties on the basis of maximum available fault current.
- 3.3.4 Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
 - 3.3.4.1 Transformers:
 - 3.3.4.1.1 ANSI C57.12.10.
 - 3.3.4.1.2 ANSI C57.12.22.
 - 3.3.4.1.3 ANSI C57.12.40.
 - 3.3.4.1.4 IEEE C57.12.00.
 - 3.3.4.1.5 IEEE C57.96.

- 3.3.4.2 Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
- 3.3.4.3 Low-Voltage Fuses: IEEE C37.46.
- 3.4 *Study Report* – Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- 3.5 *Equipment Evaluation Report* –
 - 3.5.1 For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 3.5.2 For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3.5.3 Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- 3.6 *Coordination Study* – Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 3.6.1 *Calculations* –
 - 3.6.1.1 Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 3.6.1.2 Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 - 3.6.1.3 Calculate the maximum and minimum ground-fault currents.
 - 3.6.2 *Standards* – Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals.
 - 3.6.3 *Transformer Primary Overcurrent Protective Devices* –
 - 3.6.3.1 Device shall not operate in response to the following:
 - 3.6.3.1.1 Inrush current when first energized.
 - 3.6.3.1.2 Self-cooled, full-load current.
 - 3.6.3.2 Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- 3.7 *Conductor Protection* – Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

- 3.8 *Coordination-Study Report* – Prepare a written report indicating the following results of coordination study:
- 3.8.1 *Tabular Format of Settings Selected for Overcurrent Protective Devices* –
- 3.8.1.1 Device tag.
 - 3.8.1.2 Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - 3.8.1.3 Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - 3.8.1.4 Fuse-current rating and type.
 - 3.8.1.5 Ground-fault relay-pickup and time-delay settings.
- 3.8.2 *Coordination Curves* – Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
- 3.8.2.1 Device tag.
 - 3.8.2.2 Voltage and current ratio for curves.
 - 3.8.2.3 Three-phase and single-phase damage points for each transformer.
 - 3.8.2.4 No damage, melting, and clearing curves for fuses.
 - 3.8.2.5 Cable damage curves.
 - 3.8.2.6 Transformer inrush points.
 - 3.8.2.7 Maximum fault-current cutoff point.
- 3.8.3 *Data Sheets* – Completed data sheets for setting of overcurrent protective devices.