

SECTION 260573 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

Latest Update 5-6-2017 See underlined text for Edits.

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all “Underlines”.)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 26.

1.2 SUMMARY

- A. This Section includes computer-based, fault-current, overcurrent protective device coordination studies, and arc flash analysis. Protective devices shall be set based on results of the protective device coordination study.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.
 - 4. Setting Report.
 - 5. Motor starting Study.
 - 6. Arc Flash Analysis.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.

- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 QUALITY ASSURANCE

- A. 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.
- B. 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.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

1.6 WARRANTY/GUARANTEE

- A. See Division 26 Specification Section “Basic Electrical Requirements” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide or a comparable product by one (1) of the following:
 - 1. CGI CYME.
 - 2. EDSA Micro Corporation.
 - 3. ESA Inc.
 - 4. Operation Technology, Inc.
 - 5. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.

- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. 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

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified 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.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

- d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
- a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
 - d. Generator thermal-damage curve.
 - e. Ratings, types, and settings of utility company's overcurrent protective devices.
 - f. Special overcurrent protective device settings or types stipulated by utility company.
 - g. Time-current-characteristic curves of devices indicated to be coordinated.
 - h. 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.
 - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
 - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. The study shall originate at the four incoming BGE feeder breakers (ratings determined by utility company) and shall include 50/51 relays for the main ties and outgoing Northeast 5 and Northwest 5 feeders as well as downstream devices. Feeder settings must be coordinated with other buildings on the feeder.
- B. The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the overcurrent protective devices supplied.
- C. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance.

- D. A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
- E. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
- F. The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable overcurrent protective devices, the equipment where the device is located, the device number corresponding to the device on the system one-line diagram, and the number of the time-current log-log graphs where they are illustrated.
- G. A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known. Calculated short circuit currents are available from Owner.
- H. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for increasing system protection or device coordination. Submit curves and study as a shop drawing for approval.
- I. Factory set all relays, breaker trips, and select proper HV fuses which coordinate with transformer in rush current and circuit breakers.
- J. Include in study the emergency generator main breaker and associated distribution system.
- K. Preliminary coordination study shall be made by vendor prior to submission of shop drawings.
- L. Sizes of fuses, breaker interrupting rating, and bus bracing shall be minimum, as shown on drawing. Exact sizing shall be according to coordination study.
- M. Any changes to engineering documents, as a result of coordination study, shall not result in any additional cost to the Owner.
- N. The Vendor shall contact the Engineer immediately if any delay occurs due to the lack of required information he needs to complete this study.
- O. If any delay occurs due to time required for manufacturing of the indoor switchgear submit shop drawings on this switchgear prior to coordination study shop drawings.

- P. Present organized time-current analysis of each protective device in series from main circuit breaker in branch circuit panelboard back to Utility Company devices protective service, including on-site service, main and federal circuit protective devices.
- Q. Provide two (2) bound copies of the completed protective device time-current coordination analysis to the Owner.
- R. All tests shall comply with IEEE standards.

3.4 COORDINATION STUDY

- A. Calculation of the maximum rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a professional computer software program.
- B. Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
- C. A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
- D. The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
- E. Include a bus-to-bus computer printout identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus-to-bus calculation.
- F. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
- G. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- H. The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.

- I. Any inadequacies shall be called to the attention of the UMB and recommendations made for improvements as soon as any they are identified.
- J. Provide bound copies of the completed short-circuit analysis to UMB.

3.5 SWITCHING TRANSIENT ANALYSIS STUDY

- A. A Switching Transient Analysis Study shall be made to determine the transient overvoltages for various switching conditions and their effect on the operation of the electrical system.
- B. Various system conditions (consistent with previously gathered data from the Harmonic Analysis Study) shall be evaluated so that the proper overvoltage protection specifications may be developed.
- C. Transient simulations shall be performed using a digital computer in order to determine transient voltage levels at the low voltage buses within the electrical system.
- D. The electrical system parameters shall be varied to in order to determine their effect on the transient voltages.
- E. Various solutions to excessive transient voltage levels shall be considered and additional computer simulations made to determine their validity.
- F. The evaluation must consider solutions to power factor and harmonic concerns with respect to transient overvoltage levels.
- G. Nuisance tripping of electronic power equipment (e.g. adjustable speed drives) shall be evaluated and corrective or preventive techniques suggested.
- H. Provide two (2) bound copies of the completed Transient Analysis Study to the UMB.

3.6 LOAD FLOW AND VOLTAGE DROP ANALYSIS

- A. The Load Flow and Voltage Drop Analysis shall be made using a digital computer and include calculations of power flow in all three-phase branch and feeder circuits, calculated voltages at each bus and voltage drops of each feeder.
- B. The analysis shall provide the calculated maximum values of kVA, kW, kVAR, power factor, and amperes for each power circuit.
- C. The calculated power losses in each branch and total system losses shall be provided.
- D. A computer printout listing all cables, transformers, loads, and other circuit data shall be included.

- E. Provide tabular bus-to-bus computer printouts listing the calculated values.
- F. The analysis shall include a computer generated system one-line diagram clearly identifying individual equipment buses, bus numbers, cable and bus connections, power flow throughout the system, and other information related to the analysis.
- G. A discussion section evaluating the loading and voltage levels for the system shall be provided and recommendations included as appropriate to improve system operation.
- H. Significant deficiencies in loading or voltage levels shall be called to attention of UMB and recommendations made for improvements as soon as they are identified.
- I. Provide bound copies of the completed Load Flow and Voltage Drop Analysis to UMB.

3.7 HARMONIC ANALYSIS STUDY

- A. A Harmonic Analysis Study shall be made to determine the levels of harmonic voltages and currents in the system.
- B. The type and level of compensation needed to achieve the desired power factor and acceptable levels of harmonics shall be considered.
- C. Transient concerns shall be evaluated in order to determine the optimum equipment size, location in the system, and configuration.
- D. The study shall make appropriate recommendations in order to provide proper protection and operation of the electrical system.
- E. Harmonic source models will be developed for each nonlinear load (drive, etc.) type. The load characteristics shall be approximated based on the loads indicated on the project drawings.
- F. The application of harmonic filters will be evaluated to determine the optimum filter size and configurations.
- G. Computer simulations shall be performed to determine the system harmonic voltage and current levels and voltage distortion levels (and compared with measured values to determine the effect of various system conditions).
- H. If required, harmonic filter specifications shall be developed with consideration to cost, filtering options, and effectiveness of harmonic filters.
- I. Provide bound copies of the completed Harmonic Analysis Study to UMB.

3.8 ARC Flash Hazard Study

- A. Perform an arc flash hazard study after the short circuit and protective device coordination study has been completed based upon IEEE Std. 1584, "IEEE Guide For Performing Arc Flash Hazard Calculations."
- B. Pertinent data, rationale employed, and assumptions in developing the calculations shall be incorporated in the introductory remarks of the study.
- C. The study shall be in accordance with applicable NFPA 70E, OSHA 29-CFR, Part 1910 Sub Part S and IEEE 1584 Standards.
- D. Determine the following:
 1. Flash Hazard Protection Boundary
 2. Limited Approach Boundary
 3. Restricted Boundary
 4. Prohibited Boundary
 5. Incident Energy Level
 6. Required Personal Protective Equipment Class
 7. Type of Fire-Rated Clothing
- E. Produce an Arc Flash Warning label listing items 1-7 above. Also include the bus name, system operating voltage, and date of issue. Labels shall be printed in color and be printed on adhesive-backed Avery labels.
- F. Produce Bus Detail sheets that lists the items D 1-7 from above and the following additional items:
 1. Bus Name
 2. Upstream Protective Device Name, Type, and Settings
 3. Bus Line to Line Voltage
- G. Produce Arc Flash Evaluation Summary Sheet listing the following additional items:
 1. Bus Name
 2. Upstream Protective Device Name, Type, and Settings
 3. Bus Line to Line Voltage
 4. Bus Bolted Fault
 5. Protective Device Bolted Fault Current
 6. Arcing Fault Current
 7. Protective Device Trip/Delay Time
 8. Breaker Opening Time
 9. Solidly Grounded Column
 10. Equipment Type
 11. Gap

12. Arc Flash Boundary
13. Working Distance
14. Incident Energy
15. Required Protective Fire-Rated Clothing Type and Class

END OF SECTION 260573