

## **SECTION 26 05 73.19 – ARC-FLASH HAZARD ANALYSIS**

### **PART 1 – GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

#### **1.3 DEFINITIONS**

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. Field Adjusting Agency: Independent electrical testing agency with full-time employees and capability to adjust devices and conduct testing indicated and that is member company of NETA.
- C. One-Line Diagram: Diagram that shows, by means of single lines and graphic symbols, course of electric circuit or system of circuits and component devices or parts used therein.
- D. Power System Analysis Software Developer: Entity that commercially develops, maintains, and distributes computer software used for power system studies.
- E. Power Systems Analysis Specialist: Professional engineer in charge of performing study and documenting recommendations, licensed in state where Project is located.
- F. Protective Device: Device that senses when abnormal current flow exists and then removes affected portion from system.
- G. SCCR: Short-circuit current rating.
- H. Service: Conductors and equipment for delivering electric energy from serving utility to wiring system of premises served.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For computer software program to be used for studies.
- B. Study Submittals: Submit following submittals after approval of system protective devices submittals. Submittals shall be in digital form:

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. Submit study report for action before receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data:
  1. For Power Systems Analysis Software Developer.
  2. For Power System Analysis Specialist.
  3. For Field Adjusting Agency.
- B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data:
  1. Provide maintenance procedures in equipment manuals per requirements in NFPA 70E.
  2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

## **1.7 QUALITY ASSURANCE**

- A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms shall comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Power System Analysis Software Qualifications: Entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
  1. Computer program shall be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.
  2. Computer program shall be developed under charge of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.
- E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing arc-flash study, analyzing arc flash, and documenting recommendations, licensed in

state where Project is located. Elements of study shall be performed under direct supervision and control of this professional engineer.

- F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.
- G. Field Adjusting Agency Qualifications:
  - 1. Employer of NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for field adjusting of Work.
  - 2. A member company of NETA.
  - 3. Acceptable to authorities having jurisdiction.

## **PART 2 - PRODUCTS**

### **2.1 COMPUTER SOFTWARE DEVELOPERS**

- A. Computer software developer shall be SKM or approved equal.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

### **2.2 ARC-FLASH STUDY REPORT CONTENT**

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing following:
  - 1. Protective device designations and ampere ratings.
  - 2. Conductor types, sizes, and lengths.
  - 3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
  - 4. Motor and generator designations and kVA ratings.
  - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing following for each equipment location included in report:
  - a. Voltage.
  - b. Calculated symmetrical fault-current magnitude and angle.
  - c. Fault-point X/R ratio.
  - d. No AC Decrement (NACD) ratio.
  - e. Equivalent impedance.
  - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
  - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

## 2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification" for self-adhesive equipment labels. Produce 3.5-by-5-inch self-adhesive equipment label for each work location included in analysis.
- B. Label shall have orange header with wording, "WARNING, ARC-FLASH HAZARD," and shall include following information taken directly from arc-flash hazard analysis:
  1. Location designation.
  2. Nominal voltage.
  3. Protection boundaries.
    - a. Arc-flash boundary.
    - b. Restricted approach boundary.

- c. Limited approach boundary.
  - 4. Arc flash PPE category.
  - 5. Required minimum arc rating of PPE in Cal/cm squared.
  - 6. Available incident energy.
  - 7. Working distance.
  - 8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved before arc-flash study may not be used in study.

#### **3.2 ARC-FLASH HAZARD ANALYSIS**

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform Short-Circuit and Protective Device Coordination studies before starting Arc-Flash Hazard Analysis.
  - 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
  - 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- C. Calculate maximum and minimum contributions of fault-current size.
  - 1. Maximum calculation shall assume maximum contribution from utility and shall assume motors to be operating under full-load conditions.
  - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current per IEEE 1584 recommendations.
- D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except equipment rated 240V ac or less fed from transformers less than 125 kVA.
- F. Calculate limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations shall consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into

account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond 3 to 5 cycles.
  2. Fault contribution from synchronous motors and generators shall be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. Arc-flash energy shall generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of circuit breaker as follows:
1. When circuit breaker is in separate enclosure.
  2. When line terminals of circuit breaker are separate from work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at 2 seconds based on IEEE 1584, Section B.1.2.

### **3.3 POWER SYSTEM DATA**

- A. Obtain data necessary for conduct of arc-flash hazard analysis.
1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
  2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
  3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be acquired in field. Field data gathering shall be under direct supervision and control of engineer in charge of performing study, and shall be by engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, following:
1. Product Data for overcurrent protective devices specified in other Sections 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. Obtain electrical power utility impedance or available short circuit current at service.
  3. Power sources and ties.
  4. Short-circuit current at each system bus (3 phase and line to ground).
  5. Full-load current of loads.
  6. Voltage level at each bus.

7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

### **3.4 LABELING**

- A. Apply one arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below shall have arc-flash label applied to it:
  1. Low-voltage switchboard.
  2. Switchgear.
  3. Low voltage transformers.
  4. Panelboard and safety switch.
  5. Control panel.
- C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.
  1. Indicate accurate (not worst-case) arc-flash energy.
  2. Indicate protection level required.

### **3.5 APPLICATION OF WARNING LABELS**

- A. Install arc-flash warning labels under direct supervision and control of Power System Analysis Specialist.

### **3.6 DEMONSTRATION**

- A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and significance of arc-flash warning labels.

### **END OF SECTION**