SECTION 26 05 73

**SHORT CIRCUIT/COORDINATION STUDY**

**AND**

**ARC FLASH RISK ASSESSMENT**

**BASED ON DFD MASTER SPECIFICATION DATED 07/01/21**

***This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.***

***This specification section shall be used when the project requires short circuit, coordination, or arc flash studies. Use this section when the project involves a significant amount of new electrical construction such as a new building, building addition, comprehensive building remodel or electrical infrastructure replacement, upgrade or modification. This section shall be edited to match the scope of the project. Discuss with the DFD electrical team as needed.***

***The requirements in this section do not relieve the A/E from determining and including short circuit ratings for equipment on the one-line diagram.***

# PART 1 - GENERAL

**SCOPE**

The electrical contractor shall retain the services of an independent third party firm, or the equipment manufacturer’s technical services group, to perform a short circuit/coordination study and arc flash risk assessment as described herein.

Preliminary studies shall be submitted to the A/E prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture to ensure the characteristics and ratings of the proposed overcurrent devices will be satisfactory. The final submittal shall capture any changes in circuit lengths, wire sizes, additional loads, etc. that may occur during the construction project.

***Edit this paragraph to coordinate with the scope of the project. Discuss with the DFD electrical section as needed.***

The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency/standby sources, down to and including the smallest OCPD in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.

The firm should be currently involved in medium- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Wisconsin. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the A/E for approval prior to start of the work. A minimum of five (5) years experience in power system analysis is required for the individual in charge of the project.

The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.

The study and assessment shall be performed on SKM Dapper, Captor and PowerTool software or EasyPower product suite software.

Included are the following topics:

PART 1 - GENERAL

Scope

Related Work

Reference Standards

Data Collection for the Study

Submittals

PART 2 - PRODUCTS

Not Used

PART 3 – EXECUTION

Short Circuit and Coordination Study

Field Settings

Arc Flash Risk Assessment

**RELATED WORK**

Applicable provisions of Division 1 govern work under this section.

Section 26 14 13 - Switchboards

Section 26 24 16 – Panelboards

Section 01 91 01 or 01 91 02 – Commissioning Process

**REFERENCE STANDARDS**

Standards listed in the IEEE “Buff Book”, latest edition

National Fire Protection Association (NFPA) 70E, latest addition

IEEE 1584 – Guide for Performing Arc Flash Calculations

**DATA COLLECTION FOR THE STUDY**

The contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the contractor with a listing of the required data immediately after award of the contract.

The contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

**SUBMITTALS**

THIRD PARTY QUALIFICATIONS

Submit qualifications of individual(s) who will perform the work to the A/E for approval prior to commencement of the studies.

PRELIMINARY REPORT

Submit a draft of the studies to the A/E for review prior to delivery of the final study to the Owner. Make all additions or changes as required by the reviewer.

For building construction projects, submit a draft of the studies to the A/E for review prior to A/E approval of project electrical switchgear, panelboard and generator shop drawings.

FINAL STUDY REPORT

Provide studies in conjunction with equipment submittals to verify equipment ratings required.

The results of the power system studies shall be summarized in a final report and provided in the following formats. Provide (2) bound hard copies of the final report. Provide (2) electronic copies (on CD) of the final report and one-line diagrams in PDF format. Provide (2) electronic copies (on CD) of the final report in MS Word format and the one-line diagrams in CAD format.

Also provide (2) electronic copies (on CD) of all files generated by the SKM or EasyPower software for all scenarios evaluated in the studies. The files shall permit the studies to be opened, reviewed or updated by any user of the analysis software used for the studies.

The report shall typically include the following sections:

1. Overview
2. Short Circuit Study

SC-1 Purpose

SC-2 Explanation of Data

SC-3 Assumptions

SC-4 Analysis of Results

SC-5 Recommendations

SC-6 Fault Analysis Input Report from Software Program

SC-7 Fault Contribution Report

1. Protective Device Coordination Study

PDC-1 Purpose

PDC-2 Explanation of Data

PDC-3 Assumptions

PDC-4 Analysis of Results

PDC-5 Recommendations (Including NEC 700-27 Requirement)

PDC-6 Results from Software Program

PDC-7 Example Drawings

1. Arc Flash Study

ARC-1 Purpose

ARC-2 Explanation of Data

ARC-3 Assumptions

ARC-4 Analysis of Results

ARC-5 Recommendations

ARC-6 Arc Flash Evaluation Report from Software Program

1. Prioritized Recommendations and Conclusions

VI. Appendices

APP-1 One-line Diagrams from Software Program

APP-2 AutoCAD One-line Diagrams

APP-3 Protective Device Summaries from Software Program

APP-4 Reference Data

APP-5 Sample Work Permit Form

APP-6 Copy of Warning Labels, including study date

The above sections shall include the following items in detail:

* Obtain available fault current from the local utility company.
* Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.
* Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
* Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
* Worst case Arc Flash values (highest incident energy) for project specific scenarios (low short circuit and high short circuit for each possible power supply source).
* Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.
* IEEE standard one-line diagram with equipment evaluation and circuit breaker settings that clearly define the system data and are easy to interpret. The diagrams should include the bus names and references used in the studies.
* Recommendations to reduce the arc flash incident energy in all areas that are subject to 8 calories per square centimeter or greater of available incident energy.
* Condition of Maintenance information for any existing equipment included in the study.
* Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
* The contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24” x 36” (minimum) Styrofoam backboard. This one-line diagram shall be mounted in each electrical room.

**PART 2 - PRODUCTS**

Not used.

**PART 3 - EXECUTION**

**SHORT CIRCUIT AND COORDINATION STUDY**

The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software or EasyPower product suite Windows based software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.

In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a 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.

Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage fuse characteristics, circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.

Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.

Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.

When Current Limiting fuses are utilized as part of the distribution system, the current limiting characteristics shall be accounted for when doing calculations downstream. Manufacturer’s data utilizing maximum fault current- Apparent RMS Symmetrical Current that the fuse will let through during fault conditions shall be used. If modeling software does not take this into account, values shall be manually entered prior to doing calculations.

Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.

Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not property rated for fault conditions.

Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.

When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.

Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.

For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

**FIELD SETTINGS**

The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash risk assessment.

Necessary field settings and adjustments of devices and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

**ARC FLASH RISK ASSESSMENT**

As part of the short circuit and coordination study, arc flash risk assessment shall be included. The study shall include the following:

1. Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
2. Calculations to conform to National Fire Protection Association (NFPA) 70E recognized means of calculation standards. All incident energy units shall be calculated in calories per square centimeter.
3. Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E for each piece of electrical gear.

Electrical Contractor shall provide warning labels as required by OSHA based upon the results of the arc flash risk assessment. At a minimum, the labeling shall contain the following information: nominal system voltage, arc flash boundary, limited approach boundary, restricted approach boundary, available incident energy and the corresponding working distance or the arc flash PPE category, minimum arc rating of clothing, and study date. Label shall also include the name or logo and the phone number of the company performing the study.

Arc flash warning labels shall be affixed to all electrical equipment that is likely to require examination, adjustment, servicing or maintenance while energized. This includes, but is not limited to, medium-voltage switchgear, transformers, switchboards, panel boards, three-phase disconnect switches, transfer switches, motor control centers, motor controllers, and three-phase motor disconnect switches.

END OF SECTION