

## PART 1 - GENERAL

### 1.1 DESCRIPTION

#### A. Purpose

1. The purpose of these studies is to assure all electrical equipment is correctly applied within industry and manufacturer's ratings. This effort should minimize the damage and limit outages caused by any electrical failure and will assure proper personnel protection. These studies are required from the Contractor once the actual equipment being provided has been determined.

#### B. General

1. The Power System Protective Device Studies shall consist of one-line diagram(s), short circuit and coordination studies prepared for the specific electrical equipment, overcurrent devices, utilization equipment (NEC defined) and feeder lengths involved with this project. The study shall also include Arc Flash Analysis and Hazard/Risk categories for distribution points such as transformers, switchboards, panelboards, motor controllers, VFDs, disconnect switches, etc.
2. Furnish labor, material and Engineering to accomplish the studies as specified in this section.

### 1.2 QUALIFICATIONS

- A. The Contractor shall have the studies performed by or under the supervision, review, and approval of a professional Electrical Engineer holding a current license from the State of Washington.
- B. Preapproved, subject to the Licensed PE requirements and the software analysis products specified in this section:
  1. Powerstudies.com

### 1.3 RELATED SECTIONS

- A. The work under this section is subject to requirements of the Contract Documents including the General Conditions, Supplemental Conditions, and sections under Division 1 General Requirements.
- B. Maintenance Testing of Electrical Systems Section 26 01 26.

### 1.4 REFERENCES

- A. Applicable codes, standards, and references:
  1. National Electrical Code – NEC
  2. Institute of Electrical and Electronic Engineers – IEEE
  3. American National Standards Institute – ANSI
  4. State and local codes and ordinances

## 1.5 COORDINATION

- A. Coordinate with the electrical contractor and equipment vendors, as required, to determine the actual equipment to be furnished.

## 1.6 SUBMITTALS

- A. General
  - 1. Submittals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.
  - 2. The studies shall be submitted stamped by a professional Electrical Engineer holding a current license from the State of Washington.

## 1.7 OPERATIONS AND MAINTENANCE (O&M) MANUALS

- A. Operations and Maintenance Manuals shall be in accordance with Conditions of the Contract and Division 01 Specification Sections.

## 1.8 SCHEDULE

- A. One purpose of these studies is to verify equipment ratings. Submit preliminary Short Circuit and Coordination Studies with the submittals for the protective devices, panelboards, switchboards and other electrical equipment.

## 1.9 MEETINGS

- A. Attend meetings with the Owner and/or Owner's Representative as required to explain the results of the studies and to determine any corrective action that is required.

## PART 2 - PRODUCTS

### 2.1 APPROVED SOFTWARE ANALYSIS TOOLS

- A. The studies shall be performed using the following software packages, with no substitution:
  - 1. Short Circuit Study – SKM Dapper for Windows, or SKM A-Fault for medium voltage breakers
  - 2. Coordination Study – SKM Captor for Windows
- B. SKM software packages used shall be the latest available releases.

## PART 3 - EXECUTION

### 3.1 REQUIREMENTS

- A. Perform Power System Protective Device studies.
- B. The Contractor shall be responsible for gathering all field information and data needed for the protective device studies.

### 3.2 ONE-LINE DIAGRAM

- A. Provide a one-line diagram from Dapper that shows the schematic wiring of the electrical distribution system. Include all electrical equipment and wiring to be protected by the protective devices installed under this project.
1. Key nodes on the one line diagram shall be identified and referenced in the formal report. The one-line diagram shall include the following specific information:
    - a. X/R ratios, utility contribution, and short circuit values (asymmetric and symmetric) at the bus of the main switchboard, and all downstream equipment containing overcurrent devices
    - b. Breaker and fuse ratings
    - c. Transformer KVA and voltage ratings, percent impedance, X/R ratios, and wiring connections
    - d. Voltage at each bus
    - e. Identifications of each bus
    - f. Conduit material, feeder sizes, and length
    - g. Calculated short circuit current
    - h. Arch Flash hazard/risk categories

### 3.3 SHORT CIRCUIT STUDY

- A. Assumptions for Short Circuit Study calculations:

<b>At the West Receiving Station</b> <i>(Fault Current @ 13,800V)</i>		
<b>Fault Description</b>	<b>Amperes</b>	<b>X/R</b>
3-phase fault*	32.4kA	11
L-G fault	2kA (resistance limited)	

\* The three-phase fault level is a ½-cycle symmetrical value, which includes motor contribution and operation of all on-site generators. For purposes of calculating short circuits for devices with ½-cycle response, use this value as a steady-state quantity.

- B. The study shall show fault currents available at key points in the system down to a fault current of 7,000A at 480V and 208V.
- C. Determine the available 3-phase short circuit and ground fault currents at each bus and piece of equipment. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
- D. Incorporate pertinent data and the rationale employed in developing the calculations into the introductory remarks of the study.
- E. Present the data determined by the short circuit study in a table or report format. Include:
1. Device identification
  2. Operating voltage

3. Protective device
4. Device rating
5. Calculated 3-phase short circuit current (asymmetrical and symmetrical), and ground fault current

### 3.4 COORDINATION STUDY

- A. Prepare coordination curves to determine the required settings of protective devices to assure selective coordination down to 0.1 seconds per the City of Seattle Electrical Code for life safety, critical and essential equipment branches of the emergency system.
  1. Graphically illustrate, on log-log scale, that adequate time separation is provided between existing and supplied series devices.
  2. 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.
  3. Utilize original SKM 8½" x 11" #8511 paper for curve plotting.
  4. Derive settings for new protective devices in consideration of existing upstream protective device settings, and optimize system coordination in light of this constraint.
  5. Where the upstream device characteristics do not allow reasonable coordination with new equipment, identify the problem and the recommended resolution in a letter to the Project Manager prior to submitting the coordination study.
- B. The following specific information shall also be shown on the coordination curves:
  1. Device identifications
  2. Settings and current transformer ratios for curves
  3. ANSI damage curves for each transformer
  4. Melting and clearing fuse curves
  5. Cable damage curves
  6. Transformer inrush points
  7. Maximum short-circuit cutoff point
  8. Simple one-line diagram for the portion of the distribution system that the coordination curves are depicting
- C. Provide the SKM TCC report for each curve, labeled with the applicable curve number.
- D. 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
  6. Provide 2 test points for each protective device at levels that are compatible with commonly available test equipment, and the ratings of the protective device. Provide the input level and expected response time for each test point.
- E. For substations with spot or distributed network protection provide calculations and settings to configure the network protection relays and prepare a report showing the engineered calculations.

### 3.5 ARC FLASH ANALYSIS AND HAZARD/RISK CATEGORY CALCULATION PER NFPA 70E

- A. Perform Arc Flash Analysis and determine Hazard/Risk categories at distribution points per NFPA 70E and show them on one-line diagrams. Analysis shall include all equipment that is being provided in this contract using IEEE 1584 calculation method for all switchgear, switchboards, panelboards, etc. being provided in this contract. Study and label to indicate incident energy, flash hazard boundary, equipment name, study date, and recommended category of personnel protective equipment (PPE).

### 3.6 COORDINATION, SHORT CIRCUIT STUDY AND ARC FLASH ANALYSIS

- A. Analyze the short circuit calculations, and highlight any equipment that is determined to be underrated as specified or not coordinated. Propose approaches to effectively protect the underrated equipment. The Engineer will take major corrective modifications under advisement and the Contractor will be given further instructions.
- B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.
- C. Provide labels showing Arc Flash Hazard/Risk Categories to be affixed on all distribution points such as switchgear, transformers, switchboards, motor controllers, VFDs, disconnect switches, etc.
- D. In addition to the O&M requirements, provide 1 hardcopy and 2 electronic copies on CD to University of Washington Campus Engineering. Provide the following immediately upon final completion of the Power Systems Protective Device Studies:
  - 1. Copy of the Project One-line Diagram(s)
  - 2. Coordination Study
  - 3. Short Circuit Study
  - 4. Arc Flash Analysis
  - 5. A cross-reference index of the electronic file names on these disks or CDs to the specific pieces of equipment or systems

**END OF SECTION**