PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. The requirements of the General Conditions, Supplementary Conditions and the following Specification sections apply to all Work herein:
1. Section 26 00 10 - General Requirements
2. Section 26 00 20 - Scope of Work
3. Section 26 05 11 - Electrical Service
4. Section 26 05 19 - Electrical Conductors – 600 Volts
5. Section 26 05 33 - Raceways and Boxes
6. Section 26 09 26 - Lighting Control Relay Panels
7. Section 26 22 13 - Low -Voltage Dry-Type Distribution Transformers
8. Section 26 22 14 - Harmonic Mitigating Transformers (HMT)
9. Section 26 24 13 - Switchboards – 600 Volts
10. Section 26 24 16 - Panelboards
11. Section 26 25 00 - Busways
12. Section 26 28 13 - Fuses
13. Section 26 28 16 - Enclosed Switches and Circuit Breakers
14. Section 26 29 13 - Enclosed Controllers
15. Section 26 32 13 - Engine Generators
16. Section 26 36 23 - Automatic Transfer Switches
17. Section 26 43 13 - Surge Protective Devices for Low-Voltage Electrical Power Circuits

1.2 SUMMARY

A. Furnish an Electrical Power System Study for the electrical distribution system as defined herein.

B. The study shall begin at the point of electrical service for the facility and include all downstream distribution and branch panelboards, motor control centers and significant motor locations (50HP and larger). In addition, all equipment that is required to be rated for the available fault current shall be evaluated in the study including but not limited to, transformers, enclosed switches, individual motor controllers, contactors, variable speed drives, and enclosed circuit breakers. The project shall include any new generators and any associated emergency power distribution equipment, including automatic transfer switches.

C. Where any part of the electrical system is served by multiple power sources the system configuration that delivers the highest level of fault current shall be used for the evaluation.

1.3 SUBMITTALS

A. The following submittal data shall be furnished according to the General Conditions and Section 26 00 10 and shall include, but not be limited to:
1. The final report shall be indexed and contain individual, tabbed sections. The tabbed section shall contain the information as outlined in Part 2 of this document including the following:
   a. Firm Name, Address, Phone Number and Professional Engineer's signature and seal of the registered professional Engineer that performed the study,
   b. Method used to perform the study and analysis,
   c. Short-circuit analysis with protective device evaluation,
   d. Protective device coordination study,
   e. Arc Flash Analysis,
   f. Input Data,
   g. One-line diagram.

B. All items or equipment listed above with asterisks (*) shall be certified by the manufacturer using Manufacturer Certification "MCA" as set forth in Section 26 00 10. See Section 26 00 10 for certification requirements.

1.4 RELATED STANDARDS

A. All studies shall be performed in accordance with the latest applicable industry standards including the following:
   1. IEEE/ANSI Std 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
   2. NEMA AB 3 - AB 3 Molded Case Circuit Breakers and their Application
   3. NFPA 70 - National Electrical Code
   4. NFPA 70E - Standard for Electrical Safety in the Workplace

1.5 QUALITY ASSURANCE

A. Short-Circuit Analysis, Arc Flash Analysis and Coordination Study shall be performed by a registered Professional Engineer. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years experience in the analysis, evaluation, and coordination of electrical distribution systems.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. If it complies with the specifications, the engineering study specified herein shall be prepared by the following manufacturer providing the electrical switchboards for this project as specified in Section 26 14 13 or manufacturer's authorized engineer:
   1. Eaton/Cutler Hammer
   2. General Electric
   3. Siemens
   4. Square D

2.2 SHORT-CIRCUIT ANALYSIS WITH PROTECTIVE DEVICE EVALUATION

A. Systematically calculate fault currents based on the available fault current at the facility service entrance. Study preparer shall obtain the maximum available fault current and power factor or X/R ratio of the fault current at the service entrance from the local utility.

B. Motor contribution for motors 50HP and larger shall be incorporated in determining fault levels.

C. Evaluate the distribution device and equipment ratings compared to the calculated fault current and make recommendations where equipment is overdutied. Analyze the short-circuit currents by preparing a tabulation comparing the fault levels to the device interrupting ratings. Indicate equipment in which series ratings are utilized.

D. When the power factor or X/R ratio of the maximum symmetrical fault calculated at the device location is determined to be more inductive than that used to establish the device interrupting rating adjust the available short circuit current in accordance with ANSI/IEEE standard 242.

E. Calculations shall be presented in tabular form and shall include:
   1. Location identification
   2. Voltage
   3. Manufacturer and type of equipment
   4. Equipment short-circuit current rating
   5. Calculated short-circuit current (and adjustments due to high X/R ratio where required)
   6. Calculated X/R ratio of the fault
   7. Indicate if series ratings are used
   8. Recommendations where equipment is calculated to be overdutied

2.3 PROTECTIVE DEVICE COORDINATION STUDY

A. Prepare coordination time-current characteristic curves to determine the required settings of the protective devices to achieve selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves provided shall reflect actual protective devices (manufacturer and model number) to be installed. Adequate time-current curves shall be generated to depict coordination.

B. The coordination study shall include ground fault protection coordination and recommended device settings for the devices provided with ground fault protection.

C. Protective device characteristics shall be plotted to reflect calculated short-circuit levels at the location.

D. A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection. All curve sheets shall be multi-color or use hatching for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide recommendations to improve coordination.

E. The following information shall be provided on all curve sheets.
1. Device identification and associated settings/size.
2. Voltage at which curves are plotted.
3. Current multiplier.
4. ANSI frequent fault damage curve.
5. Cable insulation damage curves.
6. Transformer inrush point.
7. Single-line for the portion of the system.
8. Motor starting profiles (where applicable).

F. The recommended device settings shall be provided in tabular form and shall include:
1. Location Identification
2. Voltage
3. Device Manufacturer
4. Device catalog number/series
5. Adjustable long time pickup and delay
6. Adjustable short time pickup and delay
7. Adjustable ground fault pickup and delay
8. Adjustable instantaneous pickup

2.4 ARC FLASH ANALYSIS

A. An arc flash analysis shall be performed based on the short circuit values and device settings in conjunction with a short circuit and coordination study. The results from the short circuit and coordination study shall be used to determine arc energy levels at each power distribution location in the facility where work could be performed on energized parts.

B. Where any part of the electrical system is served by multiple power sources the system configuration that delivers the highest level of arc flash incident energy shall be used for the evaluation. Include significant motor contribution in the calculations.

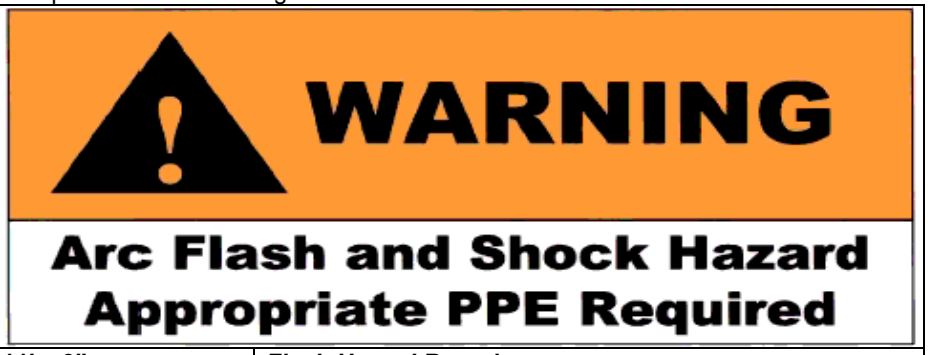
C. For each location with a main device, the line and load side fault contributions shall be included in the calculations.

D. Arc Flash Calculation results shall be presented in tabular form and shall include:
1. Location identification
2. Voltage
3. Arcing fault magnitude
4. Protective device clearing time
5. Duration of arc

6. Arc flash boundary
7. Working distance
8. Incident energy
9. Hazard Risk Category

E. Equipment Labeling shall be provided in accordance with NFPA 70E. Arc Flash Warning Labels shall be provided as part of the report. Labels shall be provide in accordance with ANSI Z535.4. The labels shall be 3.5 inch x 5 inch thermal transfer type labels of high adhesion polyester for each work location analyzed. Labels shall be machine printed with no field markings. The labels shall include the following information:
1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Highest Hazard/Risk category for the equipment
5. Incident energy
6. Working distance

F. Sample Arc Flash Warning Label:



11' – 3" **9** **#3**	**Flash Hazard Boundary** **Cal/cm2 Flash Hazard at 18 inches** **PPE Level** **Cotton underwear plus FR shirt & FR pants plus FR coverall**
2.4 **5' – 0"** **2' – 2"** **0' – 7"**	**kV Shock Hazard when cover is removed** **Limited Approach** **Restricted Approach – Class 1 voltage Gloves** **Prohibited Approach – Class 1 Voltage Gloves**
Equipment Name: MCC 10-24-1 **VALID FOR NORMAL SYSTEM CONFIGURATION ONLY.**	

2.5 INPUT DATA

A. The study shall be conducted based on the equipment and conductors being installed. Input data for the report shall be compiled from the contractor, manufacturers, and codes and standards as required providing the studies and conducting a proper evaluation.

B. Conductor lengths, sizes, material, and raceway information shall be provided by the Electrical Subcontractor to the engineer performing the study so that the study is performed based on the final installation.

C. Input data used for the studies shall be provided in the final report. The input data for the report shall include supporting data from the manufacturer used for the evaluation, lengths of all feeders provided by the contractor, transformer data, motor data, utility company and motor generator data and any other supporting data to the report.

2.6 SINGLE-LINE DIAGRAM

A. The final report shall include a single-line diagram of the electrical distribution system within the scope of the project. The single-line shall include:
   1. Transformer rating, voltage ratio, impedance, and winding connection.
   2. Feeder cables per phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
   3. Switchgear, switchboards, panelboards, individual motor controllers, variable speed drives, fuses, circuit breakers, ATS's and enclosed switches.
   4. Protective relays with appropriate device numbers and CT's and PT's with associated ratios.
   5. Motor identification and horsepower used in the evaluation.

PART 3 EXECUTION

3.1 INSTALLATION

A. The electrical equipment and protective devices shall not be installed prior to confirmation of adequate equipment fault ratings as specified herein.

3.2 FIELD SETTINGS

A. Adjustments shall be made to the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.

B. Arc Flash Labels shall be affixed to the equipment after the study is approved by the Engineer.
   1. One label shall be affixed at a height and location that is clearly visible on the front of panelboards, switchboards, switchgear, motor control centers and other electrical equipment that is less than 8 feet in length unless otherwise noted.
   2. Switchboards and switchgear that are longer than 6 feet shall have labels affixed at a height and location that is clearly visible on the front of the equipment at each end of the equipment.
   3. Transformers shall be labeled based on the high voltage side of the transformer.
   4. Labels shall be affixed at similar locations on each type of equipment. For example, multiple panelboards of similar size shall have labels located at the same location on the front of each panelboard cover.
   5. Where multiple labels are affixed to equipment, the labels shall be identical and identify the worse case information for that equipment.
   6. Where equipment is rear connected affix labels on both the front and rear of the equipment. Locate the labels on the rear at a similar height and location as on the front.
   7. Label each plug-in section of busway. Affixed at a height and location that is clearly visible. Labels shall be affixed on both sides of the busway.

C. Device settings and adjustments and affixing of Arc Flash Hazard Labels shall be by one of the following companies: General Electric Engineering Services, Cutler Hammer Engineering Services, Siemens Industrial Services, Square D Technical Services or a manufacturer authorized service and testing organization.

END OF SECTION