

## SECTION [26 05 73.10][16050]

### ELECTRICAL POWER SYSTEM STUDIES - NEW OR UPGRADED CONSTRUCTION

#### COMPANY NAME Power System Consulting Services

##### ETAP Notes:

This guide specification is written in accordance with the Construction Specifications Institute (CSI) Master Format. This section must be carefully reviewed and edited by the architect or the engineer to meet the requirements of the project. Coordinate this section with other specification sections within the Contract Documents and Drawings.

To properly use / edit this document, show formatting and hidden text by selecting ¶ on the menu or by typing (Ctrl+\*) simultaneously. Except for these introductory and closing paragraphs, green hidden text will not print. Text in red is optional. Red text in [brackets] denotes multiple options where one or more should be chosen. All red text should be edited and changed to black for final project conformation. User-definable information highlighted in Yellow. In addition, these introductory paragraphs should be deleted or changed to hidden text.

#### PART 1 - INTRODUCTION

- A. Enter Company, background & power system information here

#### PART 2 - STUDY OBJECTIVE

- A. Company desires to conduct an arc flash hazard study to identify potential hazards supplement/enhance their existing electrical safety program; provide additional safety measures for their employees. After the study, Company will review the recommendations & proceed with implement as appropriate.

#### PART 3 - SCOPE OF WORK

- A. Company is soliciting proposals from the qualified consultant to perform Electrical Power System Studies. The successful consultant will assist Company with the following:
- B. Site visit
  1. Review of the safety procedure, and facility conditions to determine what steps need to be taken to perform power system study.
  2. Collection of additional data using etapAPP Mobile Field Data Collection tablet application.
  3. Verification of equipment nameplate ratings.
- C. Verification of the ETAP model & updated the as built study as required.
- D. Verify the protection relay setting & coordination study.
- E. Final recommendation of the Arc Flash Study to be implemented.
- F. NOTE: It is the consultant's responsibility to become familiar with all regulation(s) applicable to the work required in this Request for Proposal.
- G. The analysis shall consist of the following:
  1. Data Collection
  2. System Modeling

3. Model Verification & Validation
4. Fault & Device Duty Evaluation study
5. Protective Device Coordination study
6. Arc Flash Hazard Assessment
7. Project Deliverables including detailed report of findings & recommendations

#### PART 4 - INPUT DATA

- A. Overall key single line diagram (Attachment #)
- B. List of switchgears (Attachment #)
- C. Switchgear single line diagrams (Attachment #)
- D. Previous power system study (Attachment #)
- E. Load schedules (Attachment #)
- F. Protective relay setting sheets (Attachment #)

#### PART 5 - GENERAL

##### 5.1 SUMMARY

- A. Scope: Provide labor, engineering, supervision and related services, required for execution of short-circuit, protective device coordination and arc flash hazard analysis studies as required for the complete performance of the Work, as shown on the Drawings, as specified herein.
- B. Power system studies shall be provided by a qualified Power System Study Supplier (also identified as PSSS). The Contractor shall ultimately be responsible for providing the Power System Study and shall supplement the supplier's Work as necessary to provide a complete and accurate study along with associated WORK in applying the study's results using the latest version of the electrical design & analysis software tools. The Contractor shall coordinate the equipment and systems provided by others that are part of the scope of the study to ensure necessary data and Work are provided for the required functionality of the electrical power distribution system.
- C. The scope of the power system studies shall include modeling [from the first overcurrent protective device upstream of the furnished equipment][from utility source(s) to the overcurrent protective devices of the furnished equipment][from utility source(s) and Distributed Energy Resources (DER) to the overcurrent protective devices of the furnished equipment].
- D. Related Sections: Related sections include, but shall not be limited to, the following:
  1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
  2. Applicable general requirements for electrical Work specified within Division 26 Specification Sections apply to this Section.
  3. Refer to the applicable sections within Division 48 Electrical Power Generation. The Contractor shall coordinate data between the Distributed Energy Resources (DERs) provided outside of Division 26 and the PSSS.

## 5.2 REFERENCES

- A. General, Publications: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.
1. American National Standards Institute (ANSI):
    - a. ANSI C37.010, "Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis"
    - b. ANSI C37.13, "Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures"
    - c. ANSI C 37.41, "Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories."
    - d. ANSI C57.12.00, "Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers"
  2. Canadian Standards Association (CSA):
    - a. Z462, Workplace Electrical Safety
  3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - a. IEEE 3002.2, "Recommended Practice for Conducting Load-Flow Studies and Analysis of Industrial and Commercial Power Systems"
    - b. IEEE 3002.3, "Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems"
    - c. IEEE 3002.7, "Recommended Practice for Conducting Harmonic Studies and Analysis of Industrial and Commercial Power Systems"
    - d. IEEE 3002.8, "Recommended Practice for Conducting Motor-Starting Studies and Analysis of Industrial and Commercial Power Systems"
    - e. IEEE 141, "Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems"
    - f. IEEE 241, "Recommended Practice for Electric Power Systems in Commercial Buildings"
    - g. IEEE 242, "Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems"
    - h. IEEE 399, "Recommended Practice for Industrial and Commercial Power System Analysis"
    - i. IEEE 1015, "Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems."
    - j. IEEE 1584, "Guide for Performing Arc-Flash Hazard Calculations"
  4. International Organization for Standardization (ISO)
    - a. ISO 9001, "Quality Management Systems - Requirements"
  5. The National Fire Protection Association (NFPA)
    - a. NFPA 70, "National Electrical Code, latest edition"
    - b. NFPA 70E, "Standard for Electrical Safety in the Workplace"

## 5.3 DEFINITIONS

- A. Unless specifically defined within the Contract Documents, the words or acronyms contained within this specification shall be as defined within, or by the references listed within this specification, the Contract Documents, or, if not listed by either, by common industry practice.

1. PSSS: Power System Studies Supplier

2. TCC: Time-Current Curves
3. DER: Distributed Energy Resources (e.g. engine generators, energy storage, solar, turbines, etc.)

#### 5.4 SUBMITTALS

- A. General: Submittals shall be in accordance with the requirements of Section [01 33 00][01300] Submittals and Section [26 00 10][16010] Electrical Requirements, in addition to those specified herein.
1. Submit sufficient information to determine compliance with the Contract Documents. Identify submittal data with the specific equipment tags and/or service descriptions to which they pertain. Submittal data shall be clearly marked to identify the specific model numbers, options, and features of equipment and work proposed.
  2. Deviations from the Contract Documents shall be indicated within the submittal. Each deviation shall reference the corresponding drawing or specification number, show the Contract Document requirement text and/or illustration, and shall be accompanied by a detailed written justification for the deviation.
  3. Submit product data on the application software, including any modules or software plug-ins used to perform the studies.
  4. Submit the name and qualifications of the Power System Studies Supplier and registered engineer(s) in charge of the studies for this Project.
  5. Submit qualification data for the qualified technician performing parameter adjustments to existing equipment as a result of the studies.
  6. Initial studies shall be submitted to the Engineer prior to receiving release to furnish the electrical distribution equipment. After sufficient data is available to ensure proper selection of devices proceed with completion of the power system studies and submit. If completion of the studies may cause delays in equipment shipments, request an exception from the Engineer for a preliminary submittal of data to ensure that the selection of device ratings and characteristics shall be satisfactory to properly select the distribution equipment.
  7. For large system studies with more than 100 bus locations, the contractor is required to provide the study project files to the Owner in electronic format. In addition, a copy of the computer analysis software program is required to accompany the electronic project files, to allow the Owner to review all aspects of the project and print arc flash labels, one-line diagrams, and make minor modifications, as necessary.
- B. Operation & Maintenance (O&M) manuals shall be provided in accordance with the minimum requirements specified in Section [01 78 23][01780] Operation and Maintenance Data, Section [26 00 10][16010] Electrical Requirements and additional requirements specified herein.
1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report including study result analyzer summary tables. In addition to the hardcopies required by the Contract Documents provide electronic PDF files of the report on digital media acceptable to the Owner. The report shall include the following:
    - a. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
    - b. Short-Circuit Methodology, Analysis, Results and Recommendations
    - c. Short-Circuit Device Evaluation Table and Multi-Scenario Result Analyzer Table
    - d. Protective Device Coordination Methodology, Analysis, Results and Recommendations
    - e. Protective Device Settings Table & Automatic Evaluation Summary Tables
    - f. Time-Current Coordination Graphs with Sequence of Events Normalized TCC Graphs (as needed) and Recommendations
    - g. Arc Flash Hazard Methodology, Analysis, Results and Recommendations including the details of the incident energy and flash protection boundary calculations along with Arc Flash

boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.

- h. Arc Flash result analyzer reports shall indicate worst case scenario conditions and associated results.
- i. Arc Flash risk analysis summary based on multiple operating conditions and current variations. Arc flash energy evaluation based on Constant Energy Boundary Area (C-area plots). Time-Current Coordination Graphs showing Incident energy area plots to be provided.
- j. Arc Flash Labeling section showing types of labels to be provided. Section shall contain descriptive information as well as typical label images.
- k. Power system one-line diagram shall be computer generated and 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, device numbers used in the time-current coordination analysis and other information pertinent to the computer analysis. One-line diagram shall also clearly identify voltage levels and graphically indicate locked equipment, i.e., equipment for which data has been field verified and validated.

## 5.5 QUALITY ASSURANCE

- A. Electrical power system software used for the studies shall be developed under an established quality assurance program, comply with ISO 9000 with accredited certification agency such as UL. Compliance with U.S. Code of Federal Regulations as well as other quality assurance standards is preferred.
- B. Power System Study Supplier Qualifications:
  - 1. The PSSS shall have **25 years of experience** in performing power system studies.
  - 2. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a registered professional engineer skilled in performing and interpreting the electrical power system studies.
  - 3. **The approved power system study supplier shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.**
  - 4. The registered professional engineer shall have a **minimum of five (5) years** of experience in performing power system studies. The registered professional engineer shall sign and affix their seal to the completed power system study in accordance with state laws.

## 5.6 DELIVERY, STORAGE AND HANDLING [- NOT USED]

## 5.7 WARRANTY

- A. General: Refer to **[Section 01 77 00 - Closeout Procedures][Section 01770 - Closeout Procedures]**.
- B. **Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.**

## 5.8 SPECIAL TOOLS AND SPARE PARTS [- NOT USED]

### PART 6 - PRODUCTS

#### 6.1 POWER SYSTEM STUDIES

- A. The Power System Study Supplier shall be the same as the equipment supplier for the majority of the new electrical power system equipment of Division 26 Electrical.
- B. Power system studies specified herein shall be provided by a single Power System Study Supplier. Provide the specified studies and related work without exception, unless allowed as a substitute per the general provisions of the Contract.
  - 1. Arc flash hazard analysis, short-circuit and protective device coordination studies by Schneider Electric Engineering Services
  - 2. [2nd supplier]
  - 3. [3rd supplier]
- C. All power system studies shall use a robust electrical power system design and analysis software package which complies with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- D. The studies shall be performed using ETAP software by Operation Technology, Inc.
- E. Contractor shall use computer software to confirm the viability of the electrical design under various scenarios. ETAP software will be used for power system analysis since it offers an electrical digital twin platform for conceptual design, engineering, and system control. Once company power system network is modeled, designed, and analyzed with ETAP, the digitized network model can be upgraded to an operational digital twin for increased transparency & investment security. This is to facilitate an integrated and unified model from design and analysis to operation and maintenance for real-time operation, control, root-cause analysis, switch plan validation, predictive maintenance, operator training, asset management, cost optimization and 'model based validate before operate' actions.
- F. The Power System Study Supplier shall furnish an arc flash hazard analysis study in compliance with the requirements of the latest [NFPA 70E & IEEE-1584 Standard] / [CSA Z462] in conjunction with the short-circuit and protective device coordination studies furnished.

#### 6.2 DATA

- A. Contractor shall coordinate with Owner and gather all input data required for the power system studies. The power system study supplier performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a list of 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 the release of the equipment for manufacturing.
- B. Source combination shall include current and any identified future motors, generators or DER systems.
- C. Load data utilized shall include existing and proposed loads obtained from Contract Documents or provided by [Engineer][Owner][an audit provided by the Contractor].
- D. If applicable, fault contribution of existing motors shall be included in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
- E. Contractor can take advantage of mobile field data collection applications to expedite data collection and synchronize the changes directly into the "as revised" power system model. Should this method be used,

ensure that equipment nameplate photos are collected and tagged with each equipment in the power system model.

- F. Contractor can take advantage of importing CAD files in DWG format to create the power system model and reuse the existing drawings as the starting point.

### **6.3 LOAD FLOW STUDY**

- A. Load flow study shall be performed to evaluate the system's capability to adequately supply the connected load and prevent overloading of equipment.
- B. Compare equipment (transformers, cables, breakers, fuses) operating values against manufacturer's specified maximum capability ratings whenever available.
- C. Provide a computer-generated Alert View list/report which lists all equipment that is critically overloaded.
- D. Load Flow study should consider various operating conditions (scenarios) such as; maximum loading, minimum loading and normal loading.
- E. Provide a computer-generated load flow analysis report that provides a summarized comparison of power flow results between the different scenarios being evaluated.

### **6.4 SHORT CIRCUIT ANALYSIS**

- A. Software shall have the ability to generate a single Fault Current report that includes the Device Duty Evaluation as per **ANSI/IEEE C37** standards.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. Short Circuit Analysis shall include the following
  1. Calculation methods and assumptions
  2. Selected base per unit quantities
  3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, and other information pertinent to the computer analysis
  4. The study shall include input circuit data including electric utility system characteristics, source impedance data, 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.
  5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating. Comparison of Short Circuit results from different scenarios shall be provided in a single tabular report.
  6. Results, conclusions, and recommendations. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment shall be provided and include recommendations as appropriate for improvements to the system.
- D. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.
- E. Protective Device Evaluation shall include:
  1. Evaluation of equipment and protective devices and comparison to short circuit ratings

2. Evaluation of adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
  3. PSSS shall notify Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.
  4. Software shall have the ability to generate a single Fault Current report that includes the Device Duty Evaluation as per ANSI/IEEE C37 standards
- F. Software shall utilize data revisions to track system data changes such as “As Found” and “Recommended” settings.

## 6.5 PROTECTIVE DEVICE TIME CURRENT COORDINATION ANALYSIS

- A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs. 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.
- B. Protective device time current coordination analysis shall include on each TCC graph, a complete title with descriptive device names.
- C. Protective device time current coordination analysis shall include device termination characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Protective device time current coordination analysis shall identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Protective device time current coordination analysis shall plot the following characteristics on the TCC graphs, where applicable:
1. Electric utility’s overcurrent protective device
  2. Medium voltage equipment overcurrent relays
  3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
  4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
  5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
  6. Medium voltage conductor damage curves
  7. Ground fault protective devices, as applicable
  8. Pertinent motor starting characteristics and motor damage points, where applicable
  9. Pertinent generator short-circuit decrement curve and generator damage point
  10. The largest feeder circuit breaker in each motor control center and applicable panelboard.
- F. Protective device time current coordination analysis shall provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection. Comply with IEEE 241 recommendations for fault currents and time intervals.
- G. Protective device time current coordination analysis shall provide a Sequence of Operation that evaluates, verifies, and confirms the operation and selectivity of the protective devices for various types of faults directly from the one-line diagram and via normalized Time Current Characteristic Curve views.
- H. Protective device time current coordination analysis shall provide the following:
1. A 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.



2. Enough 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.
  3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
  4. The study shall include a separate, computer generated tabular printout containing the “as found” and “recommended” settings of all adjustable overcurrent protective devices, the equipment designation where the device is located, and the device number corresponding to the device on the system one-line diagram. Power system model shall utilize data revisions to track system data changes such as “As Found” and “Recommended” settings to ensure management of change with the field devices. Revised data shall be visible graphically on the single-line diagram.
  5. The study shall include report that highlights detected violations related to equipment protection and device coordination and provide equipment wise violation description in a tabular manner.
  6. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
  7. PSSS shall notify Engineer in writing of any significant deficiencies in protection and/or coordination and shall provide recommendations for improvements.
- I. Software shall utilize data revisions to track system data changes such as “As Found” and “Recommended” settings.

## **6.6 ARC FLASH HAZARD ANALYSIS**

- A. The arc flash hazard analysis shall be performed according to the latest IEEE 1584 equations that are presented in NFPA70E. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.3) and the protective device time-current coordination analysis (Section 2.4).
- B. The flash protection boundary and the incident energy shall be calculated at significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. Working distances shall be based on latest IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.
- D. Short circuit calculations (bolted and arcing fault) and the clearing times of the phase overcurrent devices shall be computed together with the arc flash calculations and not retrieved from a separate short circuit study to avoid errors. Ground overcurrent relays shall not be taken into consideration when determining the clearing time when performing incident energy calculations.
- E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios shall be compared and the greatest incident energy shall be uniquely reported for each equipment location in a single table. Calculations shall be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation shall assume that the utility contribution is at a minimum. Conversely, the maximum calculation shall assume a maximum contribution from the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.
- F. The incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations shall consider the changing

current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond 5 cycles.
- G. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides, or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required, and it shall be based on a device located upstream of the equipment to clear the arcing fault.
- H. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions shall be included in the fault calculation.
- I. Include scenarios when the main source protective devices are or are not adequately isolated from the bus and may fail to operate or be capable of de-energizing the arc fault before it escalates into a line-side arc fault.
- J. Mis-coordination shall be checked using Star-Auto or Sequence-of-Operation (SQOP) software capability.
- K. Arc Flash calculations shall include electrode configuration (orientation) in addition to equipment height, width and depth dimensions making use of the Arc Flash software Enclosure Editor.
- L. Provide the following:
1. Results of the Arc-Flash Hazard Analysis shall be submitted in tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal-protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
  2. The Arc-Flash Hazard Analysis shall report incident energy values based on recommended device settings for equipment within the scope of the study. Power system model shall utilize data revisions to track system data changes such as "As Found" and "Recommended" settings.
  3. The Arc-Flash Hazard Analysis shall include any recommendations to reduce AFIE levels and enhance worker safety.
  4. Arc Flash reports shall compare results from the various arc flash hazard assessments and be capable of filtering the "worst case" Arc Flash analysis results coming from different scenarios in a single table report.
  5. Tabulated arc Flash reports that display the sequence of operation of protective devices during an arc fault.
- M. Software shall utilize data revisions to track system data changes such as "As Found" and "Recommended" settings

## PART 7 - EXECUTION

### 7.1 GENERAL

- A. In addition to the requirements specified herein, execution shall be in accordance with the requirements of specifications Section [26 00 10][16010], Section [26 08 00][16080] and Drawings.
- B. **Pre-Installation Conference:** Prior to commencing the installation, an onsite pre-installation conference shall review the material selections, installation procedures, and coordination with other trades. Attendees shall include, but shall not be limited to, the Contractor, the Installer, manufacturer's representatives, and

any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Engineer

## 7.2 FACTORY ACCEPTANCE TESTING [- NOT USED]

## 7.3 FIELD QUALITY CONTROL [- NOT USED]

- A. The [Contractor][Owner] shall, through the services of a qualified field technician, adjust parameters of existing equipment per the power system studies results as agreed upon by the Engineer and Owner. The technician shall report to the Engineer any discrepancies or issues with the adjustments.

## 7.4 ARC FLASH LABELS

1. Power System Study Supplier shall provide a thermal transfer type label of high adhesion polyester for each work location analyzed.
2. The labels shall be designed according to the following standards:
  - a. UL969 – Standard for Marking and Labeling Systems
  - b. ANSI Z535.4 – Product Safety Signs and Labels
  - c. NFPA 70 (National Electric Code) – Article 110.16
3. The label shall include the following information:
  - a. Location or Equipment ID
  - b. Nominal System Voltage
  - c. Flash protection boundaries:
    - Limited approach
    - Restricted approach
    - Arc Flash boundary
  - d. Site-Specific level of PPE
  - e. Available incident energy and corresponding Working Distance (cal/cm<sup>2</sup>)
  - f. Study report number, revision number and issue date
4. Labels shall be printed by a thermal transfer type printer, with no field markings.
5. Arc Flash warning label sample is shown below:



Arc Flash and Shock Hazard Present

Appropriate PPE Required

Arc Flash Boundary	5.7 ft	<b>Minimum PPE Requirements</b> FR long-sleeve shirt (minimum arc rating of 4), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8)
Incident Energy in cal/cm <sup>2</sup>	5.7	
Working Distance	24 in	
Shock Hazard Exposure	480 VAC	
Insulating Gloves Class	00	
Shock Hazard when covers removed		
Limited Approach Boundary	3.5 ft	
Restricted Approach Boundary	1.0 ft	

Equipment Location Main\_PNL

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6. Arc flash labels shall be provided by [Power System Study Supplier][Equipment Manufacturer][Contractor] for equipment as identified in the study and the respective equipment access areas per the following:
  - a. Floor Standing Equipment - Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
  - b. Wall Mounted Equipment – Labels shall be provided on the front cover or a nearby adjacent surface, depending upon equipment configuration.
  - c. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.
7. Label Installation: Labels shall be field installed by Power System Study Supplier. The technician providing the installation shall have completed an 8-Hour instructor led Electrical Safety Training Course including [NFPA 70E][CSA Z462] material including the selection of personal protective equipment.
  - a. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
    - 1) For each 600, 480 and applicable 208-volt panelboard, one arc flash label shall be provided.
    - 2) For each motor control center, one arc flash label shall be provided.
    - 3) For each low voltage switchboard, one arc flash label shall be provided.
    - 4) For each switchgear, one flash label shall be provided.
    - 5) For medium voltage switches one arc flash label shall be provided
    - 6) Labels shall be installed by the engineering services division of the Company under the Startup and Acceptance Testing contract portion.

## 7.5 FIELD TESTING AND COMMISSIONING [- NOT USED]

## 7.6 TRAINING [- NOT USED]

### A. Arc Flash Training:

1. The vendor supplying the Arc Flash Hazard Analysis shall train the owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET) or equivalent. The trainer shall be an authorized OSHA Outreach instructor.
2. The vendor supplying the Arc Flash Hazard Analysis shall offer instructor led and online [NFPA 70E][CSA Z462] training classes.

### B. Project Training

1. Training will be on-site and for duration of three (3) days for two (2) electrical engineers from Client's staff. The training will include:
  - a. Basic use of ETAP package as outlined in the software package tutorials and user's guide manuals.
  - b. Explanation of procedures that were used in developing the topology and the set-up of this project.
  - c. Steps that would be involved in modifying and/or expanding system topology for the future revisions and/or upgrades of the equipment and the plant electrical distribution configuration.

- d. The use of the device library and the procedures in creating new devices or modifying existing devices.

END OF SECTION [26 05 73.10][16050]

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