XYZ CORPORATION

ABC FACILITY

REQUEST FOR PROPOSALS

REQUEST FOR QUOTES

REQUEST FOR BID

ARC FLASH HAZARD ANALYSIS

Request # RFP 123ABC

Requested by: John Q. Smith

Due Date: Yesterday/202X

SECTION 16941
ELECTRICAL ARC FLASH HAZARD ANALYSIS STUDY SPECIFICATION

For XYZ Corporation – ABC Facility

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PART 1 - GENERAL

1.1 DESCRIPTION

A. XYZ Corporation – ABC Facility desires to implement an arc flash hazard program to supplement/enhance our existing electrical safety program, provide additional safety measures for our employees, and provide compliance with OSHA mandates. XYZ Corporation – ABC Facility desires to retain a qualified firm to assist in the development and implementation of the arc flash and electrical safety programs. XYZ Corporation – ABC Facility desires that the process be interactive, with XYZ Corporation – ABC Facility employees contributing to the development/enhancement of the arc flash safety program. XYZ Corporation – ABC Facility desires that the successful firm will assist XYZ Corporation – ABC Facility with the following:

1. GAP Analysis – review our existing safety program, resources, and facility conditions to determine what steps need to be taken to help XYZ Corporation – ABC Facility comply with industry arc flash mandates and requirements.

2. An electrical arc flash hazard analysis, including:

   a. The development of an up-to-date electrical system one-line diagram and model to provide staff members with an accurate representation of the installed electrical system.

   b. Determination of system operating modes and conditions that can impact short circuit currents and arc flash hazard energy levels.

   c. Short circuit and equipment duty study to verify that equipment is rated to safely handle short circuit currents without creating hazardous conditions.

   d. Protective device coordination study and review to help ensure proper electrical system reliability and to determine if arc flash hazard energy levels can be reduced.

e. Arc flash hazard analysis study to determine arc flash energy levels, recommend mitigation measures, and guide the selection of Personal Protective Equipment (PPE).

f. A copy of the power system model and database electronic file that is fully compatible with arc flash and electrical safety program implementation software.

3. **[Optional]** Support services for implementation of the arc flash hazard and electrical safety program in the XYZ Corporation – ABC Facility, including:

a. Power System Modeling and Arc Flash Analysis software for ongoing use by XYZ Corporation – ABC Facility staff members maintaining and updating the system study as the plant changes.

b. Arc flash and safety program implementation software for ongoing use by XYZ Corporation – ABC Facility staff members for arc flash and safety program management and tracking.

c. Arc flash hazard labeling.

d. Assistance with the development of Energized Work Permits.

e. Arc flash and electrical safety training.

f. Personal Protective Equipment (PPE) training.

g. Consulting services to assist XYZ Corporation – ABC Facility with development of safe work practices and procedures.

B. An electrical arc flash hazard analysis shall be performed on the ABC Facility to determine incident energy, arc flash protection boundaries, and required PPE for all electrical equipment in the facility. The calculations shall comply with the latest version of NFPA-70E, and IEEE-1584.

C. The purpose of this study is to provide a comprehensive software model of the XYZ Corporation – ABC Facility electrical distribution system, which will document XYZ Corporation – ABC Facility compliance with NFPA 70E mandates as described below. This model will serve as an integral part of an ongoing safety program by providing necessary work permits and arc flash calculations in compliance with NFPA-70E 2021 Article 130.1, 130.2 and 130.5 for each electrical equipment in the facility.

1. **Article 205.2, 120.2(B):** Updated and verified one-line diagram for all electrical distribution voltages including all sources for lock-out and tag out procedures.

2. **Article 210.3, 210.5:** Updated short circuit and equipment duty verification study showing all electrical equipment is properly rated to withstand and interrupt the available short circuit duty per ANSI Standards and NEMA/UL/NEC requirements.

3. **70E (2004) Article 400.6, 410.9:** *(Removed in current 70E but should be referenced for a complete specification).* Updated protective device coordination study showing the system protective devices are properly set to coordinate and clear a fault without extensive equipment damage or personnel risk.

4. **Article 130.5:** Updated arc flash study providing maximum incident energies, arc flash boundaries, and PPE requirements for each equipment in the system. In addition, these calculations shall be integrated with 70E compliant work permits as part of an ongoing safety program.
5. **Article 130.5(H):** Updated labeling displaying the worst-case arc hazard values for each equipment in the facility.

D. The analysis shall consist of the following:

1. Field data collection by qualified personnel (as defined by NFPA 70E)
2. Data entry and system one-line modeling in EasyPower® power system software
3. Model verification
4. Short Circuit and equipment duty study
5. Protective device coordination study
6. Arc flash hazard study
7. Detailed report and findings of the analysis
8. Electronic copies of the Project Report and the EasyPower® System Model
9. Review of a draft copy of the report and presentation of the final copy of the report in person, via teleconference, or via teleconference and web conference.
10. Hard copies of the project report (note all printing, postage, etc.) shall be included in proposed project pricing as an option.

E. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.

1. NFPA-70E, 2021 Standard for Electrical Safety in the Workplace
2. IEEE-1584-2018 Guide for Performing Arc Flash Hazard Calculations
3. IEEE-242 “Buff Book” Protection and Coordination of Industrial Power Systems
4. IEEE-399 “Brown Book” Power System Analysis
5. IEEE-141 “Red Book” Electric Power Distribution for Industrial Plants
6. IEEE-551 “Violet Book” Calculating Short Circuit Currents in Industrial Power Systems
7. IEEE-3002.3 Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems
8. IEEE-3007.1 Operation and Management of Industrial and Commercial Power Systems
9. IEEE-3007.2 Maintenance of Industrial and Commercial Power Systems
10. IEEE-3007.3 Electrical Safety in Industrial and Commercial Power Systems

1.2 DATA COLLECTION

A. Field data collection shall be performed by a qualified (as defined by NFPA 70E – 2021) consultant/contractor to ensure accurate equipment modeling.

B. Consultant/contractor field personnel shall have up-to-date training in electrical safety and shall supply and utilize their own Personal Protective Equipment for electrical shock hazards and arc flash hazards. Consultant/contractor shall provide an Energized Work Permit for all field work where live parts are exposed. XYZ Corporation – ABC Facility personnel shall not be responsible for reviewing or evaluating successful consultant/contractor safety program for suitability. Attach information describing your safety training and program.

C. Consultant/contractor shall review all XYZ Corporation – ABC Facility safety requirements and shall comply with all requirements (enclosed).

D. Field data collection and system modeling shall be based on the system represented by the following drawings provided by XYZ Corporation – ABC Facility personnel:

1. Electrical one-line drawing E-1

2. Electrical one-line drawing E-2…

For the purposes of this proposal the drawings shall represent the existing facility but are not deemed complete or accurate. It is estimated that the drawings are X% complete and represent conditions in **(Enter Year Here)**. Consultant/contractor shall take this into account when providing study pricing for the XYZ Corporation – ABC Facility's arc flash study.

[**Alternate**] XYZ Corporation – ABC Facility personnel have provided an estimate of the number of substations, panels, motor control centers, motor control panels and electrical equipment. Consultant/contractor shall develop project pricing based on this estimate.

E. Equipment shall be visually inspected to collect the necessary nameplate data used in the analysis. Consultant/contractor is responsible for visual verification of this data, including transformers, switchgear and breakers, relays, direct-acting trip units, etc. Data that may not be readily accessible or may not have nameplate data such as conductors, busway, etc. can be taken from drawings. Prior to field data collection, consultant/contractor shall build a preliminary system model with equipment and connectivity established as much as practical. During field data collection, consultant/contractor shall document data gathered for each piece of equipment with pictures and notes. Images and notes shall be associated with the appropriate equipment directly in the system modeling software so it can be used later for data entry, quality control, and asset health information.

F. Plant/facility shall provide qualified personnel to show contractor/consultant equipment location and to open all equipment doors, locks, etc. necessary to collect nameplate data.

G. Where equipment data is available from the plant/facility on updated drawings or in database format, consultant/contractor may use this data in building the model, but shall field verify information when necessary.

H. Data collection shall include the step-down transformer from the utility service (including primary relaying) down through each panel operating at 208V or greater

with more than 2000 A of short-circuit current available per section 4.3 of IEEE 1584-2018.

I. Consultant/contractor shall obtain from the utility the minimum, normal, and maximum operating service voltage levels, three-phase short circuit MVA and X/R ratio, as well as line-to-ground short circuit MVA and X/R ratio at the point of connection as shown on the drawings.

J. Consultant/contractor staff shall have an internal safety program and up-to-date electrical safety training that includes arc flash hazards. Consultant/contractor shall comply with all of the consultant/contractor safety program requirements and the plant/facility safety regulations during field data collection. XYZ Corporation shall not be responsible for development of consultant/contractor safety program or safety procedures utilized during the data gathering process. A minimum of 8 cal/cm^2 PPE shall be worn by field data collection personnel at all times.

1.3 SYSTEM MODELING

A. The system model shall be developed using a commercially available, fully integrated software package that meets the performance specifications developed in this Section. To ensure compliance with NFPA-70E 2021, ANSI, and IEEE Standards, and OSHA mandates, no exceptions or substitutions to the performance specification are allowed.

B. The system model shall be laid out in one drawing/view and in a manner that provides for easy viewing of all analysis results. The one drawing/view requirement ensures that problem areas found and highlighted by the program are easily seen and not hidden or buried in multiple drawings, eliminating potential human errors where multiple drawing verification is required.

C. All one-line symbols shall be spaced properly to facilitate viewing results on the one-line.

D. Equipment names used in the modeling software shall be identical to the equipment and naming convention shown on the existing facility drawings and equipment unless conflicts exist. Consultant/contractor shall bring all naming convention conflicts or deficiencies to the attention of XYZ Corporation – ABC Facility staff members for clarification.

E. The XYZ Corporation – ABC Facility may have multiple operating conditions, including, but not limited to, generation on/off, shutdown, bus-ties, start-up, emergency operation, etc. Consultant/contractor shall discuss facility operation with designated XYZ Corporation – ABC Facility to determine the possible operating scenarios of the system. Each of the operating scenarios shall be documented and modeled in the software in order to determine the worst-case arc flash hazard and associated parameters for the electrical equipment. For the purpose of this proposal consultant/contractor shall assume that up to four (4) operating scenarios are possible.

F. The software shall model each operating scenario in a manner such that each mode is a scenario or change case from the base case. Each scenario shall be a simple differential algorithm storing only the difference from the base case and the scenario. Modifications to the base case model shall automatically update all scenarios to eliminate the necessity to store complete databases for each condition, providing for

a manageable file size that can be Emailed and eliminating the associated time, man hours, and errors with updating each database individually.

G. Project files created by the software shall be single files and not project directories containing multiple files. The file shall be self-contained and have all necessary information to describe the one-line, system data, settings, and analysis information. Files shall be easily transferable to any site via email or disk and operable with no setting changes to the database file to eliminate the maintenance and administrative problems associated with multi-file project directories, and to provide an easy method to transfer the file for engineering review.

H. The software shall accurately model daisy-chained MCC's, panels, and sub-transformers without the use of intermediate buses, nodes or fake impedances.

I. Lumped motor groups for MCC's shall be modeled per IEEE standards using groups >50 Hp, and <50 Hp. Where motor list data is not available, single lumped groups may be modeled per IEEE-141 "Red Book".

J. Medium voltage motors greater than 1.0 kV shall be modeled individually on their respective buses including all protective phase and ground overcurrent relays and fuses. This model will provide individual work permits for each starter/motor on the one-line.

K. All low voltage power circuit breaker (LVPCB), insulated case (ICCB), molded case (MCCB) and fuse data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

L. All relay data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

M. All overcurrent relay types for the distribution system shall be modeled on the one-line diagram (and database) including phase and ground overcurrent, differential, residual, ground neutral, etc. to establish a complete and detailed system model where protective device data can be easily modified and updated by the facility and all data is available for a comprehensive protective device coordination study if required in the future.

N. Relay models shall depict the actual connection requirements. Programs using generic CT and overcurrent symbols are not acceptable since they do not depict the actual protective system and can lead to confusion in determining arc flash results and proper protective device modeling.

O. Multi-function relays shall have all their overcurrent devices modeled in a single device and shall be able to accept multiple CT's.

P. All equipment modeling must have a corresponding one-line diagram symbol. This means that there can be no hidden database models. The purpose is for the facility to easily see all equipment, its associated data, to be able to link documents to the equipment as a data repository, etc. and to see problems right on the one-line.

Q. All system modeling shall conform to accepted modeling practices as outlined in IEEE-3002.3. Contractor/consultant may provide more advanced modeling techniques where compliance with the specification is maintained.

1.4 MODEL VERIFICATION

The system model shall be verified by reviewing the results of short circuit current flows for all buses/equipment in the system. The results shall be viewed on each branch and total flow into a bus/equipment on the system one-line diagram. The purpose is to visually spot check all substations with recognized industry benchmarks as to the expected amount of short circuit current and correct any problem areas.

1.5 SHORT CIRCUIT STUDY

A. A short circuit study shall be performed to verify all equipment duties in the system. The calculations shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-3002.3. The short circuit study shall verify the system electrical equipment is properly rated to withstand and interrupt the expected bolted and arcing faults in the system. Improperly rated and applied equipment may not protect personnel against arc flash hazards even if properly applied PPE is used. The software program must comply with the above standards in order to properly verify equipment installed in North America. No substitutions will be allowed.

B. The equipment duty verification shall determine both the line side and load side fault current through each equipment and use the highest current to verify equipment ratings. Standard bus faults are not acceptable for protective devices in that they do not accurately model the current through the device and consequently they provide erroneous results. For solidly grounded systems, both three-phase and single-line-to-ground faults should be modeled. For other grounding configurations only a three-phase fault is required.

C. Equipment duty results shall be graphically displayed on the electrical one-line and available in tabular report format.

D. The results of the equipment duty verification tabular format report shall provide the following data:

1. Equipment name and kV
2. Manufacture, type, style, and ratings of the device
3. Actual line or load side currents through the device and percent over/under duty
4. Flag for the device showing VIOLATION or WARNING level for visual identification

E. A report of all problem areas shall be provided. Consultant/contractor shall notify XYZ Corporation – ABC Facility personnel immediately of all problems found in this system before proceeding in the study. A recommended action list shall be provided for all underrated equipment in the system.

1.6 PROTECTIVE DEVICE COORDINATION REVIEW OR STUDY (SELECT ONE)

A. A PDC review shall be performed in order to determine if the system protection characteristics are sufficient to provide selectivity and sensitivity for the facility's power system. The PDC review will also determine if the existing settings entered in the software will provide proper personnel protection in the arc flash portion of this study. For facilities where the main distribution is low voltage (under 600 volts) and only instantaneous breakers or fuses are used, this section may not apply.

[**Alternate**] A PDC study shall be performed in order to determine if the system protection characteristics are sufficient to provide selectivity and sensitivity for the facility's power system. The PDC study will also determine if the existing settings entered in the software will provide proper personnel protection in the arc flash portion of this study, and may recommend additional elements, protection, or changes. For facilities where the main distribution is low voltage (under 600 volts) and only instantaneous breakers or fuses are used, this section may not apply.

B. The PDC review shall consist of selecting several key areas in the system and plotting the time-current curves (TCC's) to verify proper selective operation of the protective devices. The review should also determine if the settings could be enhanced to provide increased personnel/equipment protection without sacrificing selective coordination. The consultant/contractor shall determine in conjunction with XYZ Corporation – ABC Facility engineers the areas to be reviewed. It is expected that at least two (2) medium voltage and two (2) low voltage areas will be reviewed.

   [**Alternate**] The PDC study shall consist of selecting major system feeders and plotting the time-current curves (TCC's) to verify proper selective operation of the protective devices. The study should also determine if the settings can be enhanced to provide increased personnel/equipment protection without sacrificing selective coordination. The consultant/contractor shall determine in conjunction with XYZ Corporation – ABC Facility staff the systems to be studied. It is expected that the protective device coordination includes all substation equipment and major feeders. **Provide any additional scope/description here:**

   - **Insert additional scope and description.**

C. The consultant/contractor shall notify XYZ Corporation – ABC Facility staff of any potential problems in the protective device settings that affect either selective operation and reliability or personnel protection before continuing with the study. XYZ Corporation – ABC Facility personnel may then opt to continue with the study using existing settings or to extend the contract for a complete PDC study to correct the settings before continuing with the arc flash study.

   [**Alternate**] The consultant/contractor shall notify XYZ Corporation – ABC Facility staff of any potential problems in the protective device settings that affect either selective operation and reliability or personnel protection and shall provide recommendations for changes to the settings in writing before continuing with the study. XYZ Corporation – ABC Facility personnel may then opt to utilize existing settings or to change the settings before continuing with the arc flash study.

D. As specified in the data collection and modeling sections, all PDC data shall be modeled on the one-line diagram and in the equipment database. Notes and images from data collection shall be associated with equipment on the one-line diagram for easy reference.

E. The consultant/contractor shall contact the serving utility and obtain protective device settings for all service entrance overcurrent devices in series with the facility and affecting coordination with facilities distribution system.

F. **TCC Specifics:** The TCC's shall graphically illustrate on log-log scale that adequate time separation exists between series devices. The specific time-current characteristics of each protective device shall be plotted in such a manner that sufficient upstream devices will be clearly depicted on one sheet to prove selective coordination.

1. TCC's shall include a system one-line diagram and protective device coordination curves for each device in the selected area. The one-line diagram shall be part of the TCC and include all protective devices, equipment names, and short circuit currents calculated from the main one-line. The purpose of this requirement is to provide all necessary information on one sheet, in a format easily readable and standard to the industry.

2. For low voltage systems, TCC's shall be developed for both phase and ground protective devices. One phase and one ground TCC should be developed for each unit substation. The TCC should show the largest feeder/motor protective device in the MCC or panel up through the switchgear/switchboard feeder breaker, transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker. For secondary switchboards serving large loads or a wide variety of loads that may affect upstream coordination, additional TCC's may be required.

3. For medium voltage systems, TCC's shall be developed for both phase and ground protective devices. The TCC should show the largest feeder/motor protective device in the lineup up through the switchgear/transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker.

4. The following specific information shall also be shown on the coordination curves:

    a. Device identification.

    b. Voltage and current ratio for curves.

    c. Transformer three-phase and single-line-to-ground ANSI damage curves.

    d. Transformer inrush points.

    e. Minimum melting, and clearing curves for fuses, and if available the no-damage curve.

    f. Cable damage curves.

    g. Motor starting locked rotor curves, and if available the motor locked rotor damage point.

    h. Maximum short circuit cut-off point.

    i. Clearly marked short circuit current levels through each protective device/branch, which should be based on the appropriate current through the device, i.e. Momentary, Interrupting or 30 Cycle current.

    j. Protective device one-line diagram clearly showing all protective devices on the time-current curve, labels for each device, open breakers, faulted buses, and the short circuit current flowing in each branch.

    k. Each TCC sheet shall have appropriate identification and a one-line diagram that applies to the specific portion of the system associated with time-current curves on that sheet.

    l. Each protective device curve shall be terminated (clipped) at a point reflecting maximum symmetrical or asymmetrical fault current through the device.

m. Identify the device associated with each curve by manufacturer type, function, and setting – i.e. tap, time delay, and instantaneous, pickup, etc.

n. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1) Secondary Line-To-Ground Fault Protection: Provide primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.

2) Secondary Line-To-Line Faults: Provide 16 percent current margin between primary protective device and associated secondary device characteristic curves.

o. Typical time separations for curves:

Consultant/contractor shall discuss the advantages and disadvantages of various time separation settings between device curves with XYZ Corporation – ABC Facility personnel to help determine how the system settings shall be optimized for selectivity and arc flash hazard reduction.

G. A setting table shall be developed to summarize the settings selected/existing for the protective devices. The table shall include the following:

1. Device identification.

2. For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long-time, short-time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.

3. Fuse manufacturer, type, style, and rating.

4. Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

H. The software shall provide complete integration of the one-line, database, short circuit, protective device coordination and arc flash analysis functions to provide accurate calculations and avoid errors and inefficiencies associated with multiple data entry programs. Programs using separate PDC or TCC plotting packages are not allowed. Complete PDC integration is defined as the following:

1. TCC's shall be developed by simply selecting (highlighting) with the mouse the one-line area to be coordinated. The TCC shall automatically be plotted for the selected area including all short circuit levels. The TCC plot shall automatically include the selected one-line area in a drag and drop window on the TCC showing all one-line attributes without user additions required. These attributes shall automatically include all short circuit currents and voltages displayed on the main one-line, equipment names, etc. and update automatically without additional user input.

Programs requiring the user to build a separate TCC one-line are not integral with system short circuit calculations and do not automatically update as the system one-line changes, requiring additional man-hours for one-line development and are consequently prone to errors as the system changes. These types of programs shall not be considered for the study.

2. Each TCC shall have momentary (1/2 cycle), interrupting (5 cycle), or 30 cycle short circuit currents (tick marks) displayed on the TCC plot for each protective device or as required to properly model the tripping characteristics of the device. The tick marks shall be user adjustable for visual appearance. The purpose is to provide accurate tripping currents for each device.

3. The software model shall allow each protective device to model momentary (1/2 cycle), interrupting (5 cycle), and 30 cycle short circuit currents simultaneously depending on the characteristics of the device.

4. The software shall model remote voltages and currents for any single fault and display them on the TCC showing all trip cutoffs based on the remote currents. The purpose is to accurately model and verify backup relaying to ensure selective operation under all fault conditions. PDC programs that perform only batch faults or fail to model remote voltages and currents for all fault types shall not be considered.

5. The software shall model and display time difference calculations for any selected pair of protective devices. The difference calculator shall include bracketing bars with the calculated difference to clearly show the selective time between the devices. The calculated time shall update dynamically for instant visual setting as the devices are dragged (settings modified). In addition, Windows tool tips shall clearly show the time difference and the protective device settings for all devices as they are dynamically changed or set to allow the user to accurately determine the proper setting between devices in the most efficient manner, reducing coordination time and providing more accurate results.

6. The software model shall provide for WYSIWYG drag and drop modeling of all protective devices and provide for tool tips and notes to display all settings dynamically. The purpose is to provide accurate adjustments and settings in the most time efficient and accurate manner.

7. TCC’s shall have the ability to display short circuit currents and arc flash hazard results within the fully integrated system one-line in the PDC focus. Short circuit currents are available at any equipment with a single mouse click. Short circuit currents and arc flash hazard values shall change on the fly as the protective device settings change, allowing the user to instantly see the results of PDC changes and the associated impact to short circuit currents and arc flash hazard values.

8. The software model shall provide a detailed library for the most common protective devices available in North America. The library shall be user definable.

1.7 ARC FLASH STUDY

A. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2021, and IEEE-1584 2018. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E and XYZ Corporation – ABC Facility ongoing safety program, and to provide a comprehensive

software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.

B. The arc flash study shall determine the following results for each system mode of operation developed in Section 1.3 E (Modeling Scenarios). The results shall be provided in spreadsheet format for each scenario and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged, and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and reduced arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:

    1. Equipment name and voltage.
    2. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
    3. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
    4. Equipment arc gap.
    5. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
    6. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
    7. Worst-case arc flash boundary for each bus/equipment in the model.
    8. Worst-case arc flash hazard incident energy in cal/cm^2 for each bus/equipment in the model.
    9. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
    10. Working distances for up to five different distances showing items 7, 8, and 9 for each distance.
    11. Indicate “Danger/Hazardous” areas where incident energy is greater than 40 cal/cm^2 and provide recommendations to reduced arc flash energy levels for these areas.
    12. Flag results where reduced arcing current provided worst-case results.

C. Each mode of operation shall include a write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.

D. Consultant/contractor shall provide a detailed arc flash analysis report including as a minimum:

    1. Introduction
    2. Methodology

3. Information Sources
4. Key Assumptions
5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.)
6. Arc Energy at 100% and reduced currents
7. IEEE 1584-2018 Considerations
8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure
9. Explanation of Data in Arc Flash Hazard Report Tables
10. NFPA 70E Information.
    a. Shock Hazards with covers removed
    b. Shock Hazard Approach Boundaries
        1) Limited Approach Boundary
        2) Restricted Approach Boundary
        3) Prohibited Approach Boundary
    c. Arc Flash Hazard Boundaries, and PPE boundary for selected minimum PPE rating
11. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    a. Working distances
    b. Energy Levels
    c. PPE Requirements
    d. Recommendations to reduce arc flash hazard energy and exposure
12. Arc Flash Hazard Report
    a. 1 Electronic Copy
    b. 3 Hard Copies
13. Electronic file for Power System Modeling Software as developed and utilized for this analysis

E. Contractor shall provide an option to print labels for XYZ Corporation – ABC Facility (see options section below) or for XYZ Corporation – ABC Facility to print labels for all equipment in the system from the project study file. Assume three (3) labels per equipment/bus in your estimate using 4” x 6” labels or one (1) 6” x 8” label per equipment bus. The labels shall be UV resistant vinyl labels (white with orange warning strip and black letters) conforming to ANSI-Z535. The labels shall be printable directly from the power system software utilized for the study with a Graphic

Products, Duralabel, Brady PowerMark or GlobalMark printer to ensure that XYZ Corporation – ABC Facility personnel have the option of printing the labels without the extra expense of going to an outside printing service, converting arc flash results to spreadsheet format or performing tedious manual data entry.

F. **Software Requirements:** The software shall provide complete integration of the one-line, database, short circuit, PDC and Arc flash functions, such as EasyPower®. Software using separate short circuit, PDC, TCC or arc flash programs is not allowed. Spreadsheet calculations are not allowed. The purpose of this section is to ensure that the arc flash hazard calculations comply with NFPA-70E and IEEE-1584, and that the calculations are programmed with necessary requirements to help eliminate possible errors in the arc flash calculations. The additional purpose is to establish a detailed software model of the XYZ Corporation – ABC Facility electrical distribution system, which will document XYZ Corporation – ABC Facility compliance with the OSHA requirements and NFPA 70E mandates. This model will serve as an integral part of XYZ Corporation – ABC Facility's ongoing safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E Article 110.4(B) for each electrical equipment in the facility.

1. Arc flash calculations shall be performed with IEEE-1584 2018 equations, as this is the established and accepted industry standard.

2. Arc flash calculations shall be based on the fastest clearing upstream protective device protecting the equipment for single sources and the slowest upstream protective device for multiple sources. The calculations shall automatically compare all series and parallel upstream protective devices in the system to determine the fastest series device or a conservative parallel clearing time. The algorithm shall incorporate a traversing routine that can search back an unlimited number of buses/nodes and consider all series and parallel branches in the comparison to ensure accurate answers and to prevent hazards associated with incorrect results. Software shall not have trace back limits (5-10 buses) that can provide incorrect answers for low voltage faults that require high voltage protective device clearing to prevent potential errors.

3. The arc flash calculations including arc flash boundary, incident energy, PPE requirements, and working distance shall be displayed on the software one-line diagram and TCC simultaneously. The software must show visually the arc flash values as the settings are incrementally changed (dragging curves) so the protection can be optimized in the most efficient manner, allowing the protection engineer to visually balance the competing objectives of personnel protection with that of system selectivity.

4. The arc flash calculations shall include four (4) calculation options to ensure that the software provides the flexibility required to meet any system configuration or training requirement that may be considered. Each calculation option shall comply with the graphic and spreadsheet display requirements of this section. Each option is more specifically described below.

    a. The detailed option shall provide the let-through energy for each protective device in the system or on a selected equipment. This is the energy on the load side of the protective device. The equipment shall be highlighted when the let-through energy exceeds a user defined threshold-clothing limit.

b. Worst-case including main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the equipment's main protective device. If the equipment is not equipped with a main device, the program must traverse back the entire system to determine the fastest series upstream protective device.

c. Worst-case excluding main protective device. This option shall provide the worst-case arc-hazard energy for the equipment based on the let-through energy of the fastest upstream series protective device in the system. The program shall traverse back the entire system to determine the fastest upstream protective device.

d. Worst-case excluding and including the main protective device. A combination of options 'b' and 'c' as stated above.

5. The arc flash calculations shall provide integral "Work Tasks" for the listed equipment types. The tasks shall be derived from NFPA 70E Table 130.5(C) and be specific to the equipment type. Work tasks shall be user definable in the software to allow customization and integral with the "Work Permit" feature of the software. Listed equipment types shall include:

   a. Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, Conductor for 100-200 volt equipment.

   b. Switchgear, Switchboards, Panelboards, MCC, VFD, UPS, ATS, Interrupting Switch, Conductor, Open Air for 200-1000 volt equipment.

   c. Switchgear, MCC, VFD, UPS, ATS, Interrupting Switch, Conductor, Open Air for 1.0-5.0 kV equipment.

   d. Switchgear, MCC, VFD, ATS, Interrupting Switch, Conductor, Open Air for 5.0-15.0 kV equipment.

   e. Switchgear, Interrupting Switch, Conductor, Open Air for 15.0-38.0 kV equipment.

   f. Interrupting Switch, Conductor, and Open Air for 38.0-1500 kV equipment.

6. Work Tasks shall have a user-defined library that provides the following customizable features for each work task:

   a. Work Tasks for each specific equipment type and voltage range.

   b. Working distance units English or Metric.

   c. Work distance for each task.

   d. V-rated gloves and tool requirements.

   e. Job description and procedures.

   f. Safe work practices description.

   g. Hazard Risk Assessment. *Note: based on a documented risk assessment as an integral part of a safety program.

7. Work tasks shall be accessible from the one-line diagram for any equipment through a mouse click on the equipment in the electrical system model one-line. A dialog box shall appear listing all 70E and user definable work tasks for the specific equipment selected. The work task dialog shall include a user definable working distance for each work task and allow the user to select tasks specific to any equipment feeder or the incoming main. Work tasks for each equipment type shall be voltage specific and user definable in the library. The purpose of these requirements is to integrate 70E work tasks to the one-line diagram for specific equipment types. This will provide the basis for a customized safety program and work permit process compliant with 70E mandates. The level of detailed requirements for the “work task” software is necessary to ensure that any variation of equipment type, equipment layout, or work procedure can be handled and documented in the software.

    a. The software interface shall allow the user to select any breaker fuse or switch on the one-line and get a specific work task generated for that device showing the load side arc flash hazard (let-through energy) for that device. The purpose of this requirement is to detail specific feeder hazards when work tasks dictate working downstream from a feeder protective device.

    b. The arc flash calculations shall provide integral work permits for compliance with NFPA-70E, 2021 Article 130.2. The work permits shall be integral with the system one-line diagram and the arc flash calculations and shall detect and account for work between feeder and main breaker.

8. Work permits shall be activated by mouse click, for all equipment types on the one-line. Work permits shall have the following calculated values and provide the following information specific to the “work task” and equipment selected:

    a. Shock hazard

    b. Shock hazard boundaries

    c. Arc flash boundary – worst-case for each equipment

    d. Arc flash hazard incident energy in cal/cm2 for the equipment

    e. Required PPE based on calculated energy level and optional risk reduction

    f. Required PPE description

    g. Determination of V-rated gloves and tools

    h. Auto fill job description and procedures for each work task

    i. Auto fill safe work practices description for each work task

    j. Job briefing and planning check list

    k. Approval sign-off section

    l. Working distance measurements in English or Metric units

    m. Required work distance for each task

    n. Documentation for safety program in compliance with 70E 130

9. The work permits shall be created by the software in MS Word and have the following user customizable features:
    a. Work Tasks for each specific equipment type and voltage range
    b. Restricted shock boundary
    c. Arc flash boundary – worst-case for each equipment
    d. Arc flash hazard incident energy in cal/cm2 for the equipment
    e. Required PPE
    f. Working distance in English or Metric units
    g. Working distance for each task
    h. V-rated gloves and tool requirements
    i. Flame Resistant clothing requirements
    j. Job description and procedures for each work task
    k. Safe work practices description for each work task
    l. Job briefing and planning check list
    m. Approval sign-off section
10. The power system software shall allow the created work permits to be linked via Windows “hyperlinks” to each equipment on the one-line diagram. The purpose is to provide a data repository of work permits performed on each equipment for OSHA and 70E review, as well as providing a one-stop location where documents pertaining to the equipment can be accessed by maintenance and job planning.
11. The power system software shall be fully compatible with facility arc flash hazard and electrical safety implementation software that provides the following capabilities:
    a. Calculates shock hazards, shock hazard boundaries, arc flash boundaries, incident energies, PPE requirements, etc. for power systems modeled in EasyPower.
    b. Built in Work Permit Feature for creation of custom Energized Work Permits complying with the NFPA-70E requirements. Work permit feature shall include NFPA risk assessment categories based on the task performed for all types of electrical equipment and voltage ranges. The work permit feature shall include an extensive library of user definable work tasks, safety procedures and safe work practices, saving XYZ Corporation – ABC Facility plant engineering staff, maintenance staff and contractors hours of productive time.

c. Energized work permits, safety procedures, equipment instruction manuals, etc., shall be capable of being directly linked to the equipment one-line through a Hyperlinks feature, providing a one-stop data repository easily accessible to all plant and safety personnel, saving plant personnel and contractors significant productive time in locating the right instruction manual, equipment safety procedure, drawing, pictures, and maps for the equipment. This feature shall also help XYZ Corporation – ABC Facility comply with OSHA and NFPA 70E record keeping requirements.

d. Additional equipment information and records such as Maintenance Records, Maintenance Manuals, Operations Manuals, Lockout / Tagout procedures, etc. shall also be capable of being Hyperlinked to the equipment on the graphical one-line.

e. Program shall support creation of arc flash labels with direct output to high quality UV resistant vinyl label printers.

f. Program shall also have customizable output. Includes one-line printing, text report creation, export to AutoCAD, etc.

g. Program shall be a Windows based operating system and shall use Windows conventions.

h. Program shall be capable of being installed on stand alone personal computers or on networked systems and shall be compatible with all systems operating on Windows 10 or higher operating systems.

i. Program shall be easily operable by XYZ Corporation – ABC Facility staff without extensive specialized training.

1.8 REPORTING AND ANALYSIS SUMMARY

Provide a detailed written report that includes the following:

A. Executive Summary: The executive summary shall be brief 1-2 pages maximum and cover at an executive level the findings of the study, recommendations, and requirements for maintaining NFPA-70E compliance.

B. Scope of studies performed: The scope shall provide details of what actions were intended to be performed for each aspect of the study, including short circuit, protective device coordination, and arc flash.

C. Description of system and explanation of bus and branch numbering system.

D. Modes of operation studied: Each scenario/plant operating condition shall be thoroughly documented.

E. Detailed report and results of short circuit, coordination, and arc flash studies including:

1. Recommendations and additions to equipment rating and/or PDC characteristics.

2. Recommendations to reduce arc flash hazards for equipment with incident energies over 40 cal/cm^2.

F. Prioritized recommendations for all studies.

G. Action list and check off column for all recommendations.

1.9 SUBMITTALS

A. Three (3) printed copies (hardcopies) of the completed study report shall be provided and one (1) copy in Microsoft Word or Adobe Acrobat format.

B. The software database and library used to model the power system shall be submitted in native file format including all updates to the library necessary to complete the model.

C. The contractor shall conduct two meetings with the facility to review a draft copy of the report and to discuss the final report. This presentation may be conducted in person or via an online web presentation service.

1.10 QUALITY ASSURANCE

A. The studies shall be in conformance with the NFPA and ANSI Standards, and IEEE recommended practices detailed in this section. No substitutions in study methods or software conformance will be allowed.

B. Consultant/contractor shall attach brochures, resumes, references and other information indicating how your firm is qualified to provide the services outlined in this document.

C. The consultant/contractor is responsible for compliance with all performance specifications in this proposal. Any deviation from complete compliance must be noted on the performance specification submitted for review and approved before work begins. All work not in compliance with the performance specification will be deemed unacceptable and payment withheld, or work terminated without pay.

D. To be considered for this contract, consultant/contractor must submit a filled-out SPECIFICATION RESPONSE SHEET, initialed by the consultant/contractor for each section and item in this proposal. Any deviations must be explained in detail and documentation provided.

E. Consultant/contractor shall indicate compliance with XYZ Corporation – ABC Facility insurance requirements as outlined in the attached insurance requirements document.

F. The analysis shall be prepared with the EasyPower power system modeling software or pre-bid approved equal meeting all performance specifications.

1.11 PROJECT TIMELINE

XYZ Corporation – ABC Facility anticipates that a Purchase Order or Contract will be released on **(Insert: Month, Day, Year)**. Based on this, ABC Facility personnel desire the start date for this project to be **(Insert: Month, Day, Year)** and the project report to be finished by **(Insert: Month, Day, Year)**. Please indicate if consultant/contractor can meet this schedule and provide a proposed project timeline with your response. Timeline shall include contract award date, on-site data collection timeframe, system model development and analysis timeframe, draft report presentation and final report presentation.

[**Alternate**] Provide a proposed project timeline with your specification response. Timeline shall include contract award date, on-site data collection timeframe, system model development and analysis timeframe, draft report presentation and final report presentation.

1.12 PROJECT OPTIONS

Consultant/contractor shall provide options for support services for implementation of the arc flash hazard and electrical safety program in the XYZ Corporation – ABC Facility in this response (attach written proposal options to specification response) including:

A. Power System Modeling and Arc Flash Analysis software for ongoing use by XYZ Corporation – ABC Facility staff members for maintaining and updating the system study as the plant changes.

B. Arc flash and safety program implementation software for ongoing use by XYZ Corporation – ABC Facility staff members, for arc flash and safety program implementation, management, and tracking.

C. Arc flash hazard label printing services for high quality UV resistant vinyl labels with self adhesive backs (4” x 6” labels or 6” x 8” labels).

D. Arc flash hazard label printer(s) with full compatibility and direct output to arc flash analysis or safety program software for 4” x 6” labels or 6” x 8” labels.

E. Assistance with the development of Energized Work Permits.

F. Arc flash and electrical safety training.

G. Personal Protective Equipment (PPE) training.

H. Consulting services to assist XYZ Corporation – ABC Facility with development of safe work practices and procedures.

XYZ CORPORATION – ABC Facility

ELECTRICAL SYSTEM MODELING AND SYSTEM ARC FLASH STUDY
SPECIFICATION RESPONSE SHEET

This sheet should be completed by a representative of Supplier or the proposed Supplier and shall be returned with the specification response. An authorized representative of Supplier should review and sign this sheet. If the authorized representative is also the preparer, both sections should be signed by that individual.

For each section in the study specification, indicate whether Supplier provides full compliance and initial. Note any deviation from full compliance and explain in the specification response why deviation should be considered. Indicate if requested documentation is provided. This form needs to be filled out completely.

Specification Section	**Full (100%) Compliance** Indicate **Y** or **N** and initial	**Describe Any Deviation from Full Compliance** Must be filled out if marked **N** on column to left. Refer to additional attached information if necessary.	**Documentation Provided** Indicate **Y** or **N** and reference specific documentation
PART 1 GENERAL			
1.1 DESCRIPTION			
A.			
B.			
C.			
D.			
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1.2 DATA COLLECTION			
A.			
B.			

Specification Section	**Full (100%) Compliance** Indicate **Y** or **N** and initial	**Describe Any Deviation from Full Compliance** Must be filled out if marked **N** on column to left. Refer to additional attached information if necessary.	**Documentation Provided** Indicate **Y** or **N** and reference specific documentation
C.			
D.			
E.			
F.			
G.			
H.			
I.			
J.			
1.3 SYSTEM MODELING			
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B.			
C.			
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E.			
F.			
G.			
H.			
I.			
J.			
K.			
L.			
M.			
N.			
O.			
P.			
Q.			
1.4 MODEL VERIFICATION			
1.5 SHORT CIRCUIT STUDY			
A.			
B.			
C.			
D.			

Specification Section	Full (100%) Compliance Indicate **Y** or **N** and initial	Describe Any Deviation from Full Compliance Must be filled out if marked **N** on column to left. Refer to additional attached information if necessary.	Documentation Provided Indicate **Y** or **N** and reference specific documentation
E.			
1.6 PROTECTIVE DEVICE COORDINATION STUDY OR REVIEW			
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B.			
C.			
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1.7 ARC FLASH STUDY			
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Specification Section	**Full (100%) Compliance** Indicate **Y** or **N** and initial	**Describe Any Deviation from Full Compliance** Must be filled out if marked **N** on column to left. Refer to additional attached information if necessary.	**Documentation Provided** Indicate **Y** or **N** and reference specific documentation
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Specification Section	Full (100%) Compliance Indicate **Y** or **N** and initial	Describe Any Deviation from Full Compliance Must be filled out if marked **N** on column to left. Refer to additional attached information if necessary.	Documentation Provided Indicate **Y** or **N** and reference specific documentation
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10.			
11.			
1.8 ARC FLASH STUDY			
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B.			
C.			
D.			
E.			
F.			
G.			
1.9 SUBMITTALS			
A.			
B.			
C.			
1.10 QUALITY ASSURANCE			
A.			
B.			
C.			
D.			
E.			
F.			
1.11 PROJECT TIMELINE			
1.12 PROJECT OPTIONS			
Attach proposed options response and pricing to the specification response sheet along with any applicable product information, brochures, qualifications, etc. Options shall meet all specification requirements as outlined in the specification document. Are proposed options being submitted (circle one)? **Yes No** Is information attached? **Yes No**			

Response Prepared by: _____ Title: _____

Signature: _____ Date: _____

Reviewed & Approved by: _____ Title: _____

Signature: _____ Date: _____