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Power System Study Procurement & Implementation

So you have determined that you need a power system study for your facility. There are many companies that perform power system studies. Some with more experience than others. Now that OSHA is enforcing NFPA 70E and arc flash hazard assessments, the demand for these studies has been increasing. Because of this increased demand, there are a lot of companies rushing to get in the business of power system studies and electrical safety training. Many of these companies are new to the business and the art of performing power system studies. Also, some of these companies are not always ethical in their proposals and stating your true costs for the power system studies. This has led to disappointments and, at worst, law suits.

It is extremely important that you select a vendor who is experienced and ethical. The vendor should be very specific in their proposal what they are supplying, how much of the distribution system will be included, and what you must provide (i.e. labor to collect the data or remove equipment covers.) (Please see the sample proposal at the end of this document.)

So what steps do you take to make sure that you get a proposal that you can get competitive bids and evaluate them? How do you select a vendor who will provide you with what you need?

Below are the major steps in obtaining a successful power system study for your facility. Some of the steps may not apply for new facilities that are not yet completed or under construction.

Major Power System Study Procurement & Implementation Steps

- Specifications
- One Line Drawings
 - If one line drawings are not available, then
 - Provide an equipment type inventory count or
 - Vendor Site Visit
- Evaluate vendor proposal to specification requirements
- Award the study to the vendor
- Compare submitted report to specification requirements and vendor proposal.
- Review the study results



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- Implement recommendations stated in the report
 - Replace underrated equipment
 - Correct NEC code violations or other unsafe conditions
 - Set protective devices to settings listed in the study
 - Test and calibrate protective devices
 - Install Arc Flash Hazard labels.

Specifications

It starts out with a good set of specifications. The more specific you are with what you want, the better the proposals (quotes) will be from the vendors. It is extremely important that you take the time to specify the study requirements. Not stating what equipment is to be included in the study is a recipe for disaster. PowerStudies.com can provide you with specifications for a number of different power system studies. Please contact our office or go to our website for sample specifications that you can modify for your project.

One Line Drawings & Equipment Inventories

Another important item that the vendor will need is an updated one line drawing. The “road map” of the distribution system will graphically show the vendor the size and extent of your distribution system. If your one line is not totally up to date but is at least 90% accurate, then it will be good enough for estimating. However, it is extremely important to tell the vendor that the drawings are not complete and we suggest that you list or hand draw the known missing equipment.

If you do not have a one line drawing, then provide an equipment inventory sheet listing the total of the types of equipment. (i.e. transformers, panelboards, motor control centers, switchboards...etc.) You can call our office and request an Excel spreadsheet to enter these equipment counts.

Another method is invite the vendors to visit the site and perform the equipment inventory count. Beware that different vendors will come up with different equipment totals if you do not state what equipment should be included in the study.

Evaluate Vendor Proposals

The hardest part of this process is evaluating the vendor proposals. There are many factors that will effect your vendor selection. Price should never be the



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sole reason. The proposals / quotes should be detailed and specific. If not, then buyer beware! An extremely low price should be thoroughly scrutinized. At the end of this article, we have included a spreadsheet to help you evaluate proposals from different vendors. We have also included a sample proposal that shows the specific information that should be included in every proposal.

The major factors in your evaluation should be 1) the firms experience, 2) the firms references or testimonials 3) the project engineer's experience and does he perform studies full time or occasionally.

Power System Studies are important because they are the foundation for reducing facility costs by increasing reliability, efficiency, equipment protection, and personnel safety. You need experience engineers and engineering technicians to perform your power system studies.

Another factor in comparing proposals is to make sure that the work scope is the same for all. Many times, vendors will have hidden additional costs which will increase the overall cost of the study. These costs must be factored in to the total cost of the study. An example of a hidden cost would be the vendors requirement that the owner must supply an electrician at all times to open doors, remove equipment covers, or supply existing data requested by the vendor.

Also important is to evaluate the quantity and quality of the deliverables. This usually includes reports, drawings, data files, equipment nameplate data gathered in the field, and other items.

Review of the Deliverables

After the vendor has completed the study, they should provide you one or more sets of deliverables. These deliverables include report, drawings, arc flash labels, equipment database and others. At a minimum, the items delivered should match the deliverable items listed in the power system study specifications. Also compare the deliverables to the vendor's quotation and verify the items listed were indeed completed and submitted to you.

Because the studies are very technical in nature, it may be difficult for you to review. Because of the importance of these studies, we recommend that you hire an independent electrical consultant (experienced in power system studies) to review the study.

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If this is not possible, just performing simple checks will quickly give you an idea of the quality of the report.

- Are there a lot of assumptions? If so, this may indicate that the vendor did not take the time to obtain the actual equipment data.
- Does the equipment count of the final study meet or exceed the vendor's equipment count estimate in the proposal?
- Are there numerous spelling and grammatical errors.
- Are the equipment names in their study matching the equipment nameplates in your facility?
- Did they contact the utility and obtain the utility fault current, transformer, and protective device data?
- Did they use infinite available fault current for the utility transformer primary?
- Are the conductor lengths measured or assumed?
- Are the transformer impedances actual nameplate data or assumed?
- For short circuit studies, did they apply multiplying factors to equipment short circuit ratings where the calculated X/R ratio is greater than the device test X/R value? (Failure to do so indicates a lack of detail and possible underrated equipment.)
- For arc flash studies, did they use the NFPA 70E task table instead of performing detailed calculations.
- Did they run multiple operation scenarios to determine worst case short circuit current and arc flash energy? (i.e. emergency generator operation or utility power)

Because a power system study is so important and critical, it is important that it is done accurately and completely. That is why it is so important to create a set of specifications that accurately state the details and requirements of the study. Without these detailed specifications, you could receive several quotes that vary greatly from each in scope and price.

The second important item is to evaluate the proposals and verify that they follow your specifications and include your requirements. Also pay attention to the exceptions and verify that this will not severely affect the price or scope of the project. Paying attention to these details will ensure that you will get the type of high quality power system study that you seek.

If you need a power system study or electrical safety training, then please feel free to contact our office. We can provide you with specifications, quotations, and the study or training seminar that you need. Contact Robert E. Fuhr, P.E. @ ph. 253-639-8535 or <mailto:fuhr@PowerStudies.com>

CHECKLIST FOR PROPOSAL COMPARISON
 (NFPA 70E Shock and Arc Flash Hazard Assessment)

	Analysis of Proposals' Scope of Work Attributes	Example	Provider 1	Provider 2	Provider 3
1	Are criteria to develop the proposal the same? (Y/N)	(Confirm same method, i.e., drawings, walk-through, etc.)			
2	At what voltage does the study STOP and are all circuits/panels included? (BEWARE- some vendor "excluded" branch circuits or process-equipment circuits, or bus plugs and control panels, etc)	(480, 240, 208, 120, 50, etc.) Down to 208 V fed by >125 kVA Transformer			
3	Has vendor presented a "Fixed" Price or "Variable" Price? (BEWARE of limited number of man-days on-site or statements involving change orders, or additional customer responsibilities)	Example of a variable cost- "All data not collected is responsibility of customer with provided forms." (Customer must supply an electrician to remove all panels and accompany electrical engineer)			
4	Is the type of Arc-Flash Calculation Method valid (NFPA/IEEE)? (BEWARE- some proposals utilized non-industry defined methods or may utilize the NFPA 70E Task Table Method)	IEEE 1584 NFPA 70E NFPA 70E Task Table			
5	Is vendor providing Shock Hazard Analysis and putting VR Glove PPE and Approach Boundaries on Labels (Y/N) (BEWARE- some vendors only provide limited data on labels)	Quote should give show an example or provide a sample label with the proposal			

6	<p>Are new drawings provided the same and/or limited in range? (BEWARE- vendor may provide drawings of just the main gear, or provide electrical systems schematics instead of AutoCAD drawings)</p>				
7	<p>Does Customer's RFP required the engineering source Electronic files and is vendor providing same? (BEWARE- some vendors will not provide their source files. This must be established as a condition of sale)</p>				
8	<p>Is vendor producing the Arc Flash labels (Y/N) (BEWARE- vendor may not produce the labels)</p>				
9	<p>Is vendor installing the Arc Flash labels (Y/N) (BEWARE- vendor may not include installing the labels.)</p>				
10	<p>Is vendor going to make recommendations to reduce hazards and update the study before labeling equipment (Y/N) (BEWARE- vendors require a change order, or increased cost to do this)</p>				
11	<p>Is vendor providing Electrical SAFETY & HAZARD Training with job aides for workers (Y/N) (BEWARE- some vendors do not provide "safety" training with worker job aides, or have little experience in this area)</p>				
12	<p>Is Vendor providing a "plan" for Compliance and will equipment be analyzed & labeled down to 50V?</p>				
13	<p>Does the quote include a protective device coordination study? If so, how many time current curves will be created and the total number of devices will be plotted on the curves?</p>	56 Devices plotted on 10 time current curves.			

14	Does the quote include a short circuit study which will compare the equipment short circuit ratings to the calculated fault current? If yes, how many locations (nodes/buses) are being evaluated?	Short circuit calculations for 85 buses.			
15	Does the quote include an Arc Flash study which will calculate the arc flash energy and include labels? If yes, how many labels are being produced?	Arc Flash Label Count = 307			
15a	Does the proposal separate the pricing for the electrical equipment or various tasks? (Study, Training, Testing, etc.) <small>(BEWARE- some vendor will lump all the pricing together. This makes it difficult to determine the actual costs of the study and training)</small>	Short Circuit - \$4,500 PDC - \$1,400 AF - \$20,000 Testing - \$5,000 Safety Training - \$2,500			
15b	Determine PDC cost / device. Divide the PDC Study Cost by the number of devices to be plotted on the TCCs. (Item #13 above)	$\$4,500 / 85 \text{ buses} = \52.94 per bus.			
15b	Determine SC cost / bus. Divide the SC Study Cost by the number of buses (locations) (Item #14 above)	$\$4,500 / 85 \text{ buses} = \52.94 per bus.			
15c	Determine AF cost / label. Divide the AF Study Cost by the number of labels (Item #15 above)	$\text{AF Cost} = \$20,000 / 307 \text{ labels} = \$65 / \text{label}$			
	Total Study and Training Costs				
	Provider Name: Contact Phone Number Email Years in Business Number of Studies Completed Project Engineer's Name Number of years Experience Number of Studies Completed				

QUOTATION: #080107 - Thompson Plastics – Las Vegas, NV - Short Circuit, Protective Device Coordination, Arc Flash Study and Low Voltage Electrical Safety (NFPA 70E) Training Workscope

PowerStudies.com, P.S. agrees to furnish the following for the power system study listed above. The Study will be performed as referenced in the specifications RFQR3.doc. PowerStudies.com will use SKM Power*Tools for Windows software to perform this study. This equipment is shown on the Power One Line Diagram(s) listed below. Purchaser agrees to pay for the following:

Comment: Note that the specifications used to prepare the quotation is listed.

ELEC-SHT-01	ELEC-SHT-02	ELEC-SHT 03	ELEC-SHT-04	ELEC-SHT-05
ELEC-SHT-06	ELEC-SHT-07	ELEC-SHT-08		

Comment: One line drawings used to prepare the quote are listed.

SHORT CIRCUIT STUDY:

A short circuit study will be performed to verify that the interrupting rating is greater than the available fault current for fuses, circuit breakers and relays. The study will include the following:

- A computer print out of the calculated fault current values for 140 different locations.
- A list of the equipment the interrupting rating and the calculated values.
- List of recommendations for the devices that are underrated.

Comment: Number of buses or nodes to be included in the study are listed.

IMPEDANCE DIAGRAM:

PowerStudies.com will create an impedance one-line diagram. All electrical equipment wiring to be protected by the overcurrent devices installed under this project and each location where the fault current will be calculated will be shown. The impedance one-line will show the schematic wiring of the electrical distribution system. The impedance one-line will show the following:

- X/R ratios, utility contribution, and short circuit values (half cycle asymmetrical and symmetrical) at the bus of the main service, and all downstream equipment containing overcurrent devices that are shown on the project one line drawing(s).
- Transformer kVA and voltage ratings, percent impedance, and winding connections.
- Voltage at each bus.
- Identifications of each bus.
- Conductor feeder sizes, length, and number per phase.
- Motor Horsepower.

PROTECTIVE DEVICE COORDINATION STUDY:

A protective device coordination study will be performed to determine the correct settings and sizes for fuses, circuit breakers and relays. The study will include the following:

- Plots of transformer protection curves, motor starting curves, fuse sizes, circuit breaker and relay settings for 9 different and unique devices.
- 3 time current curves plotted on log-log paper demonstrating selective coordination of devices (when achievable). Time current curves will show device characteristics, equipment protective limits and fault values at device locations.
- List of devices displaying device or circuit name, device type, ampere rating, ampere frame,

Comment: The number of protective devices or transformers to be plotted on the time current curves.

Comment: This lists the number of anticipated time current curves that will need to be created.

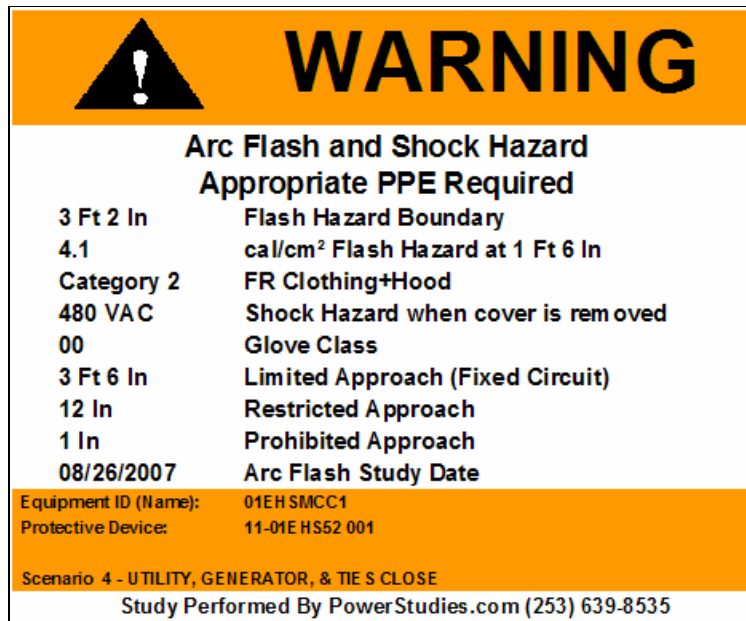
and device settings.

ARC FLASH STUDY:

An Arc Flash study will be performed to determine the Incidental Energy, Flash Boundary, and PPE Requirements for Panelboards and Switchboards shown on the one line drawings. The study will use the IEEE 1584 calculation method and the study will be done on equipment 208/120 Volts and above. The study will use NFPA 70E Standards for boundary calculations, Hazard Categories, and recommended PPE. The study will include the following:

- A. Incidental Energy and Flash Boundary calculations for up to 140 different locations.
- B. ANSI compliant Color coded Arc Flash Warning labels listing PPE requirements at each location. An Example of this label is shown below.

Comment: Number of labels (locations) that will be created.



Comment: Sample Arc Flash Label

- C. Warning Label Installation is included in the price.

Comment: Labels to be installed by the vendor.

ON SITE DATA GATHERING FOR EXISTING EQUIPMENT:

PowerStudies.com will provide personnel to obtain existing conductor, transformer, motor, panelboard, switchboard, circuit breaker, and relay data needed to perform this study. The personnel will be on site for approximately 52 hour(s) collecting this data. We anticipate that the data gathering time will take 1.5 weeks to complete. Owner must supply personnel to open electrical rooms and vaults to provide safe access to the equipment.

Comment: Number of anticipated on site hours.

Comment: Statement stating owner must open electrical rooms.

REPORT:

The final report will be written to discuss the study findings and recommendations. The report will include the following:

- A. Introduction.
- B. Executive Summary and Recommendations.
- C. Short Circuit Study description, assumptions, and results.
- D. Short Circuit Study Computer Printout.
- E. Equipment Summary List Comparing calculated to rated fault values.
- F. Distribution system one line drawing(s) and impedance diagram. Protective Device Study description, assumptions, and results.
- G. Color Time current curves demonstrating selective coordination.
- H. Protective device settings list showing device data and settings.
- I. Copies of manufacturer's time current curves used in the study. Arc Flash Study description, assumptions, and results.
- J. Arc Flash Evaluation Bus Report.
- K. Arc Flash Bus Labels.

ELECTICAL WORKPLACE SAFETY – LOW VOLTAGE QUALIFIED (ARC FLASH AND NFPA 70E) ON SITE TRAINING:

Power Studies.com will provide one class up to 8 hours of NFPA 70E / Electrical Safety in the workplace electrical training developed by e-Hazard.com. The the price below includes 10 attendees. Additional attendees can attend for an additional cost of \$85 per student. The class will be taught at the owner's facility. The class or manual will cover the following topics.

Comment: Length of the seminar

Comment: Number of attendees included in the base price.

Comment: Cost for additional students above 10.

- A. Work Practices and Governmental Requirements
- B. Hazards & Protection Strategies
- C. Personal Protection
- D. Flash Hazard Assessment
- E. Flash Hazard Assessment Results at your Facility
- F. Hazard Assessment Checklist
- G. Safe Work Practice
- H. General Rules
- I. Be Safe Out There
- J. Energized Electrical Work Permit (NFPA 70-E)
- K. Selecting the Right Extension Cord
- L. Care & Inspection of Gloves and Sleeves
- M. Excerpts from OSHA 1910

Short Circuit Study	\$11,562
Protective Device Coordination Study	\$2,569
Arc Flash Study	\$18,169
Electrical Workplace Safety Training	\$4,350
Power System Studies and Training Total Cost	\$36,650

Comment: Price Break down for the various studies and training.

Exceptions:

1. The price above is for completing the study using the existing equipment nameplate data and the equipment shown in the submittal drawings. Any changes of equipment (circuit breaker types, relays, fuse sizes...etc) or device settings that require the study to be revised will be billed Time and Material using our normal published billing rates.
2. The power system studies include 140 short circuit calculations and arc flash labels for up to 140 locations or pieces of electrical equipment. Any additional equipment can be included in the study for an additional cost of \$65 / location.
3. The price above is valid for 6 months from the date shown above.

Comment: Limits the number of times the study must be re-performed.

Comment: Additional cost for equipment found in the field not shown on the one line diagrams or equipment inventory.

Comment: The length of time the quotation price is valid.

Prepared by,
Bob Fuhr
President

Comment: Who prepared the quotation.