What Are the Qualifications to Conduct Arc Flash Studies? Where Do You Begin?

How to compare apples-to-apples bids.

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What Is An Arc Flash?
An arc flash occurs when electric current passes through the air instead of its intended path. The result is extremely high heat that causes severe burns, blinding light, and an explosion causing hearing damage or bodily injury and can be fatal.

What Is Shock Hazard Analysis?
NFPA 70E-2012 130.4 requires that a shock hazard analysis be performed before beginning energized work. A shock hazard analysis should be included as part of an arc flash hazard analysis. Shock protection boundaries should pre-printed on the labels.

This guide will help you to plan and execute a successful arc flash hazard analysis, by showing you how to:

- Build internal support for your analysis
- Identify the components necessary for compliance
- Compare bids equally and effectively.

Conducting an arc flash hazard study is the cornerstone for worker safety when working with live equipment. Conducting a study requires electrical engineering expertise and an in-depth knowledge of a facility's electrical system. The purpose of an arc flash hazard study is to determine the location and severity of potential hazards and to suggest appropriate courses of action to minimize them and protect workers from injury.

Article 110.2 of NFPA 70E 2012 specifies the safety training requirements when working on equipment that presents an electrical hazard:
"Such employees shall be trained to understand the specific hazards associated with electrical energy. They shall be trained in safety-related work practices and procedural requirements, as necessary to provide protection from the electrical hazard associated with their respective job or task assignment. Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury."
It also specifies what is required, including specifying the requirements for qualified person training and unqualified person training. There also are requirements for maintaining training documentation.

Although the NFPA standard only mentions employees as needing training, you should be providing arc flash safety training to anyone else who may be exposed to an arc flash hazard, including vendors, contractors, or anyone else who comes in contact or close proximity to potentially hazardous electrical equipment.
Recent OSHA decisions include anyone within your workplace as being within the workplace owner's or the workplace operator's scope of responsibility for safety. So these arc flash training requirements apply to everyone at some level, without regard to whether they are your employees.

OSHA does not have specific requirements directed toward arc flash safety. It falls under the OSHA General Duty Clause. This clause requires employers to “furnish to each of his employees employment and a place of employment, which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.”

This does not mean you can be passive about safety.
As an example, OSHA 29 CFR 1910.269(a)(2)(iii) requires: “The employer shall determine, through regular supervision and through inspections conducted on at least an annual basis, that each employee is complying with the safety-related work practices required by this section.”

Simply put, this means for arc flash compliance under OSHA you must be in compliance with NFPA 70E, “Standard for Electrical Safety in the Workplace.”

NFPA 70E defines its scope: “This standard addresses electrical safety requirements for employee workplaces that are necessary for the practical safeguarding of employees during activities such as the installation, operation, maintenance, and demolition of electric conductors, electric equipment, signaling and communications conductors and equipment, and raceways.”

What Are The Qualifications To Conduct Arc Flash Studies?
Let’s begin with state law. The practice of engineering is governed and regulated in all 50 states and the District of Columbia. The language and specifics are somewhat different depending on state law and board rules. It is unlawful to practice engineering or use the title of engineer unless an individual is authorized by the state board that governs the practice. In some states it is also unlawful to practice engineering unless the engineering firm is also registered with the board.

The “practice of engineering” is defined differently among states. In most states any engineering analysis must be performed by a Registered Professional Engineer (P.E.). In a few states registration is only required for design work. Arc flash hazard analysis is clearly engineering analysis by any recognized standard or rule. It is also required that the P.E. be a full-time employee or other principal of the firm to be recognized as the “responsible engineer in charge.”

It is not adequate to be registered in the state of residence. The registration must be active in the state where the facility is located.

Intra-Company Work: Can The Arc Flash Study Be Conducted In-House?
Various states have registration exceptions for government workers who are working in their own facilities and not offering services to other parties. Likewise, it is not illegal for a qualified person to perform work for the employer on employer-owned facilities. Frequently in-house engineers do not have training or expertise with arc flash calculations, or they do not have available time or other resources, such as software and label printers, to conduct the analysis or to produce the warning labels. In this case total responsibility and liability rests with the employer.

Make Sure Consulting Engineers Are Registered P.E.s
If you are seeking an arc flash hazard analysis and the party offering the service is not a Registered Professional Engineer, and in some cases a registered engineering firm, it may be a violation of state law and is reportable to the state board as such. An engineer who offers services without the proper licensing is violating engineering ethics and is subject to discipline by the board. Specific training and expertise is required to produce accurate results. Make sure the firm you select is qualified.

What Does It All Mean?
When seeking an arc flash hazard analysis, require that the parties offering the service have a Registered P.E. on staff and, where required, that the firm is authorized by the state to provide engineering services. Examine the experience and qualifications for conducting the analysis. If you intend to use in-house engineers, prepare to dedicate the time and resources necessary to complete the work and to accept full liability for the outcome of the work.

Plan Carefully For A Successful Arc Flash Hazard Analysis
What do you need for a successful arc flash hazard analysis? The success of your arc flash hazard analysis depends on the support of people committed to protecting personnel from arc flash hazards. A narrow focus on costs or shortcuts offered by some engineering firms typically comes at the expense of personnel safety.

Get support. From the CEO to the electrician's helper, your entire team needs to understand the value of a comprehensive analysis. Communicate, communicate, communicate. Once people understand the injuries and fatalities this study can prevent and the significant financial liabilities, they are more likely to join you in supporting this project.

Allocate resources, before, during, and after the analysis. The ability to implement mitigation recommendations, schedule training, and support a strong preventive maintenance program will all contribute to the success of your analysis.
Multiple arc flash incidents occur in workplaces across the United States every day. The risk of an arc flash explosion occurring at your facility is not negligible. The ongoing trend toward increasing power usage combined with an aging electrical infrastructure actually forecasts greater risk in the near future.

The Electrical Power Research Institute estimates direct and indirect costs to an employer from a fatal electrical accident are in the millions. These include:

- Medical costs
- Lost productivity
- Workers compensation
- Hiring and re-training
- Equipment replacement
- Facility repair
- Insurance premium increases
- OSHA citations
- Litigation and punitive damages

In the end, OSHA will enforce compliance, including performing an arc flash hazard analysis, through a succession of inspections that can leave you scrambling. While every facility will have its own unique set of costs, , it is far more expensive to allow one serious arc flash accident to occur than it is to prevent it.

Before You Get Started

Use this checklist as a guide to avoid common mistakes that can sabotage your analysis before it even starts.

1. Read the current edition of the NFPA 70E.
2. Attend a training course.
3. Share arc flash hazard analysis plans with your electrical workers and ask for their feedback.
4. Collect existing one-line diagrams.
5. Collect electrical equipment maintenance records.
6. Collect any previous engineering study data, such as short circuit studies, protective device coordination or Load Flow Studies.
7. Confirm the loads are properly identified in the panel board directory to streamline the data gathering process.
8. Select a plant electrician or technician familiar with equipment within the facility to accompany the engineering technician during data collection.
9. Communicate the schedule and purpose of the engineering technician who will be performing data collection to all facility personnel.
10. Arrange for special access clearance, as required, to reach areas with electrical equipment.
11. Determine if there are acceptable conditions for the engineering technician to take photographs within your facility.
12. Identify safety requirements specific to your facility that the engineering technician will need to follow during data collection.
13. Select the person who will review the draft arc flash hazard analysis report during the review period.
14. Enroll electrical personnel in a NFPA 70E safety course.

What's The Process?

AVO Electrical Engineering Division adheres to a standardized process in performing every Arc Flash Hazard Analysis. This correlates with IEEE Standard 1584, Chapter 4. Prior to beginning the actual study, we will hold a project meeting (via conference call or on site) with all personnel who will be involved, to establish roles, responsibilities and the plan for data gathering. A standard analysis will apply to three phase equipment rated 240 Volts or greater and rated lower than 240 Volts when served from a transformer 125 kVA and larger. You will need to determine if you want an expanded scope that includes all 208 V or DC equipment, or if you want a single phase analysis.

The entire project will be performed under the supervision of a Registered P.E.

Step 1: Data Collection

Qualified staff must gather data from all applicable electrical equipment. Required information includes:

- Data from the utility, including available fault current, operating voltage, and specifics regarding the utility's protective equipment at the point of service

- Specifics for each protective device in the electrical system, including manufacturer, model, available time/current settings, and short-circuit interrupting rating
- Transformer impedance, tap settings and ratings
- Conductor specifics, including lengths, sizes, and types of all overhead lines, bus ducts, and cables

Step 2: Power System Modeling

One-line diagrams must be developed or updated to show the current configuration and modes of operation for the power system. Accurate electrical system drawings are necessary to identify power sources, voltage levels, electrical equipment and protective devices. If you already have one-line diagrams, we will update the data and work from them, if possible. We use SKM Power Tools for Windows, ETAP, ARC Pro and other available engineering software.

Step 3: Short Circuit Study

A short circuit study is required to determine the magnitude of current flowing throughout the power system at critical points at various time intervals after a “fault” occurs. These calculations will be used to determine the bolted fault current, which is essential for the calculation of incident energy and interrupting ratings of your equipment. Comparison of equipment ratings with calculated short circuit and operating conditions will identify underrated equipment. We perform this study in accordance with ANSI Std. C37 and IEEE Std. 141-1993 (Red Book).

Step 4: Protective Device Coordination

Protective device coordination should be performed to ensure selection and arrangement of protective devices limits the effects of an over-current situation to the smallest area. Results will be used to make recommendations for mitigation of arc flash hazards. Although this is an optional study, arc flash mitigation cannot be performed without completing this step. We perform this study in accordance with IEEE Std. 242- 2001 (Buff Book).

Step 5: Arc Flash Calculations

These calculations are based on available short circuit current, protective device clearing time and distance from the arc. Calculations of incident energy levels and flash protection boundaries will be completed for all relevant equipment busses. The magnitude of arc hazards are determined using methods from NFPA 70E, IEEE 1584 or NESC Tables 410 ‑ 1 and 410 ‑ 2, as applicable.

Step 6: Reporting

Upon completion of the calculations, we will prepare your Arc Flash Hazard Analysis Report. This will be supplied to you for a short review period, during which your team can review mitigation recommendations. At this point, we can hold a Management Summary meeting to interpret the report results. Upon approval, we will provide a final report and full sized one-line diagrams, stamped by our Registered P.E. The drawings and report will also be supplied to you in a digital format.

Step 7: Label Installation

We will generate and install arc flash hazard warning labels. These labels identify incident energy and working distance, nominal system voltage, and the arc flash boundary. In addition to standard requirements, our labels also include Limited, Restricted and Prohibited approach boundaries, date, upstream protective device and recommended personal protection equipment. We can also provide bolted fault current if desired. We provide labels that are compliant with NFPA 70E 130.3(c), NEC 110.24(A) and ANSI Z535.

So how long is this going to take?
The type of equipment and other conditions affects duration, but through experience we have established the following Project Duration Formula, where x is the number of electrical components: $\frac{3.2x}{100}$

About AVO Engineering Division
AVO Engineering, a division of AVO Training Institute — a subsidiary of Megger®, celebrates its 50th year keeping people safe from electrical hazards. From equipment application and maintenance procedures to safe work practices, arc flash hazard analysis and engineering services; AVO is the complete one-stop learning center. In addition to classroom lecture our difference is our hands-on approach to training. Students are required to perform tasks in equipment labs supervised by the most talented electrical instructors in the industry.

Courses are offered at our locations nationwide or on-site at your facility. We also develop custom safety programs for industrial, commercial, utility and government installations. Visit www.avotraining.com/ehs

About the Author
Dee has over 30 years experience in the electric utility industry. For over 10 years as a field manager and engineer he has designed, priced, managed, and contracted large and small construction projects for overhead and underground medium-voltage systems. He has been performing and managing arc flash studies as the engineer-in-responsible-charge since 2009. He has a solid background in project management, supply chain management, and material quality. He has specific expertise in team leadership, circuit analysis and planning, transformer design and application, wood products, underground medium-voltage cable, distribution feeder protection and financial analysis.

Mr. Jones has an excellent working knowledge of NFPA 70E, IEEE 1584, NEC, and NESC, holds a B.S. degree in Electrical Engineering and is a Registered Professional Engineer in multiple states. Mr. Jones is a member of the IEEE Power and Energy Society and a voting member of the IEEE 1584 working group.

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