

*ARC Flash Study
Short Circuit Study
Coordination Study*



Custom Engineering
SOLUTIONS

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Arc Flash Analysis

Reduce Risk

Improve Safety

Enforce Compliance

⚠ DANGER ⚠	
Flash & Shock Hazard with covers or doors open Appropriate PPE Required	
Flash Protection	Shock Protection 13800 VAC
Flash Hazard Category: 2	Shock Hazard when: covers removed
Incident Energy (cal/cm ²): 7.9	Limited Approach Boundary: 19 ft
Flash Boundary Protection: 20.5 ft	Restricted Approach Boundary: 2.16 ft
<i>FR long-sleeve shirt (minimum arc rating of 8), worn over untreated cotton T-shirt with FR pants (minimum arc rating of 8)</i>	Prohibited Approach Boundary: 0.6 ft
	PPE: Class 2 V-Rating 17600 VAC
Equipment ID: Sub 2B	
Equipment Name: Sub 2B	
Source Protective Device: CB19	
Contract #: OIL-11345678	
Engineer: Operation, Technical Serv. Inc. Date: 04.19.2006	

⚠ DANGER ⚠

64-19-2006

OSHA & ANSI Arc Flash Labels

⚠ WARNING ⚠

Arc Flash and Shock Hazard

	Flash Protection Boundary: 7.1 ft	
	Incident Energy: 2.762 cal/cm ²	
	Working Distance: 36 in	
	Required PPE Level: 1	
	Shock Hazard Voltage: 13800 VAC	
	Limited Approach: 19 ft	
	Restricted Approach: 2.16 ft	
	Prohibited Approach: 0.6 ft	
	Equip. ID: CB11	04-19-2006

Arc Flash and Shock Hazard

Flash Protection Boundary: 19.4	
Incident Energy: 16.423 cal/cm ²	
Working Distance: 24	
Required PPE Level: 2	
Shock Hazard Voltage: 4160 V	
Limited Approach: 19	
Restricted Approach: 2.16	
Prohibited Approach: 0.6	
Equip. ID: Sub 3	

⚠ DANGER ⚠

Arc Flash and Shock Hazard

	Flash Protection Boundary: 4.8 ft	
	Incident Energy: 11.536 cal/cm ²	
	Working Distance: 18 in	
	Required PPE Level: 3	
	Shock Hazard Voltage: 480 VAC	
	Limited Approach: 19 ft	
	Restricted Approach: 1.8	
	Prohibited Approach: 0.18	
	Equip. ID: Sub 1	04-19-2006

CEngS' Arc Flash study estimates the Incident Energy released in the event of an arc fault and determines the required Flash Protection Boundary. Study module helps to design safer power systems and to comply with OSHA regulations by using the NFPA 70E-2004 or IEEE Std. 1584-2002 & 1584a-2004 Arc Flash calculations. Arc Flash Analysis is performed in conjunction with either ANSI/IEEE or IEC 3-phase bolted short circuit calculations. It determines the required Personal Protective Equipment (PPE) Arc Rating (ATPV) along with the suitable NFPA 70E Approach Boundaries to live parts for shock protection.

Calculate the Potential Arc Flash Hazard

Key Features

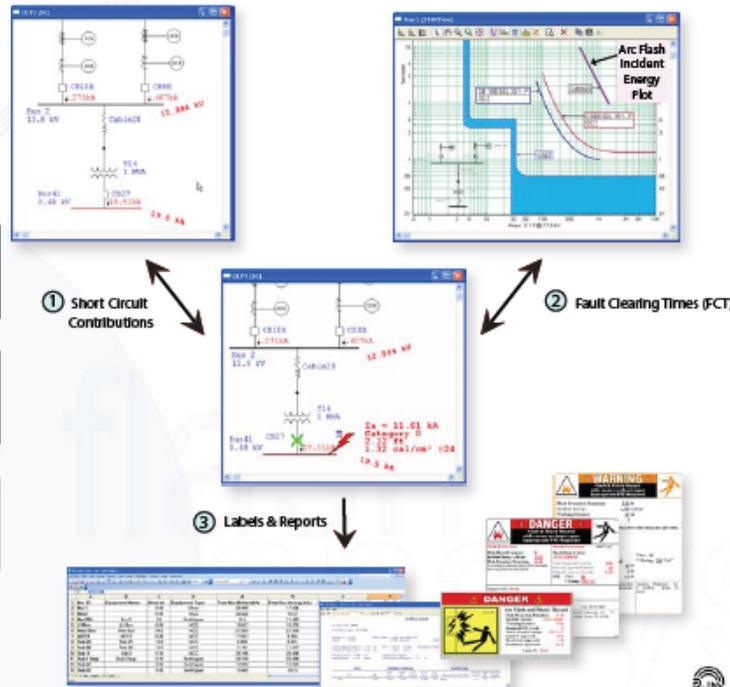
IEEE 1584-2002 & 1584a-2004 Methods
 NFPA 70E-2004 Methods
 Cubic Box & Open Air Calculations
 Integrated with ANSI & IEC Short-Circuit
 Integrated with Star Device Coordination

Capabilities

- Automatic measurement of arc fault clearing times (FCT) from ETAP Star
- Use ½ cycle or 1½ to 4 cycle short circuit current
- Automatically determines individual arcing current contributions
- System-wide incident energy calculation & flash protection boundary for buses & individual protective devices (PDs)
- Limits incident energy based on maximum FCT (based on IEEE 1584-2002)
- Distinguish between line & load side PDs to determine worst case incident energy scenarios
- Export results to Microsoft Excel spreadsheets to interface with third party label printing software
- Prints assorted sizes (4"x6", 4"x4", 3"x3") of arc flash labels to Brady & DuraLabel printers
- ANSI Z535 arc flash label templates available with user-defined text fields & PPE requirements

- Print arc flash labels to Avery Permanent Durable ID label templates
- Automatic creation of labels for buses & individual protective devices
- User interface for defining PPE requirements for each hazard/risk category
- Automatic determination of hazard/risk categories for selecting NFPA 70E-based & user-defined PPEs
- Automatic selection of prohibited, restricted, & limited approach boundaries for NFPA 70E-based shock hazards
- Complete analysis reports including result summaries
- Use system-calculated or user-defined short circuit currents & system grounding
- Automatic simultaneous application of calculated & user-defined FCT
- Automatic application of arcing current variation to identify worst case incident energy scenarios
- Incident energy calculator (bus arc flash page for individual analysis)
- Complete arc flash results tabulated for particular tasks & working distance on the same equipment
- Plots for the calculated incident energy vs. time & arcing current in Star (device coordination)
- Calculated results are displayed on the one-line diagram together with high incident energy alerts

- 1 Upon execution of the Arc Flash module, ETAP calculates ANSI or IEC short circuit contributions.
- 2 ETAP automatically determines the primary source protective device and Fault Clearing Time.
- 3 Labels and reports are generated on demand based on the calculated incident energy.



Arc Flash Study Overview

Custom Engineering Solutions has created a program and steps necessary for an effective ARC Flash Study and Safety Program:

Developing and implementing an arc flash hazard program that meets the requirements of IEEE-1584, NFPA 70E, and OSHA Standard 29 is challenging. Meeting these requirements on a constrained budget and with limited manpower assets requires proper planning and execution.

1] Acknowledge

Become aware of arc flash hazard dangers through industry events and resources such as the NFPA, IEEE, and trade publications Arc Flash Hazard Resource Center.

Arcing faults release dangerous levels of radiant heat energy and arc blast pressure waves capable of causing severe and possibly fatal, injuries.

2] Evaluate

The OSHA General Duty Clause makes it clear that the employer has an obligation to protect workers from known hazards. In addition, an effective Arc Flash and Electrical Safety Program can save millions of dollars in losses from a single arc flash or shock event. Developing an economic benefit case will help you obtain management buy-in and funding.

The incurred costs can include:

- Treatment for victims
- Legal defense fees
- OSHA Fines
- Lost worker productivity
- Workers' compensation premium increases
- Lost facility production/downtime

3] Define

Define specific and measurable goals. Determine the gap between your current electrical safety program and your goals. Develop an action plan, budget, and timeline. Outline the steps necessary to provide tangible safety improvements in your facility that will comply with NFPA and OSHA Safety Standards.



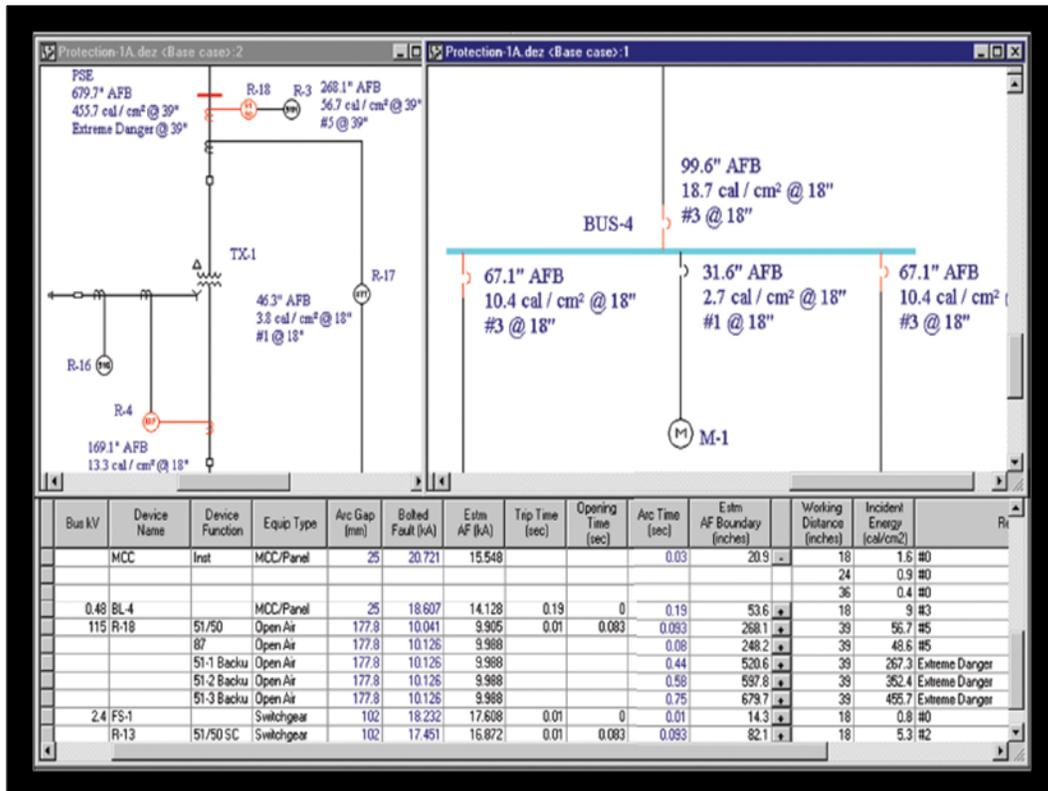
These standards include:

- Up-to-Date Electrical Drawings [NFPA 70E Article 120.1(F)(1), 205.2] used for planning work, verifying voltages, alternate sources, capacitor back feeds, etc.
- Short Circuit/Equipment Duty Analysis [400.5, 400.6] required to ensure all equipment is properly rated to withstand and interrupt the available short circuit current.
- Protective Device Coordination [410.9] required to ensure that all protective devices will operate properly on the available short circuit current in the system.
- Arc Flash Hazard Analysis

CEngS will create
your one-line diagrams and
accurately perform the required
70E calculations.

4] Analyze

Analyze your electrical power system to determine accurate Incident Energy, PPE Requirements, Flash Hazard Boundary, Shock Hazard, and the Limited, Restricted and Prohibited Approach Boundaries for Shock Hazard in accordance with NFPA 70E Articles 130.1, and 103.3. Arc flash hazard evaluation should include the following steps:



A) Develop accurate one-lines that help workers identify equipment voltage levels, sources, tie breakers, and various system configurations that impact hazard calculations. These will also be used for planning purposes to determine back feeds and energized sources. Article 120.1(F)(1), 205.2

B) Field data collection of electrical equipment name-plate parameters. These parameters in conjunction with the CEngS' software library provide a comprehensive model and database of the electrical system to perform all types of analysis.

C) Perform short circuit and equipment duty calculations to ensure all equipment is properly rated to withstand and interrupt the available short circuit current. Improperly rated equipment can result in catastrophic failure. Article 400.5, 400.6

D) Perform protective device coordination (circuit breakers, fuses, protective relays, etc.) to en-sure that each device will operate properly on the available bolted and arcing short circuit current. Proper protective device selection and coordination (settings) will reduce arc flash hazards and worker exposure, increasing plant reliability. Article 410.9

E) Perform arc flash hazard calculations based on IEEE-1584 or NFPA 70E formulas and guidelines. Worst-case calculations should be determined for all equipment. Article 130.1, 130.3

F) Create labels from CEngS' Software to provide Article 400.11 compliance and ensure worst-case hazards are posted and visible for all equipment (Refer to Section 5, Label). Article 400.11 CEngS' used software will create your one-line diagrams, document the electrical system parameters, accurately perform the required 70E calculations, and evaluate options to reduce hazards and risk to personnel. A detailed analysis can prevent the mistakes of over or under protection common to other methods of analysis, increasing electrical system reliability.

5] Label

CEngS recommends the use of high quality UV resistant vinyl labels. ANSI Z535 compliant labels are required. Always label for the worst-case conditions in the equipment (Switchboard, Motor Control Center, etc.) based on the arc flash hazard calculations (Refer to Section 4, Analyze), then utilize Energized Work Permits to reduce the energy and PPE requirements based on the work task and a job hazard risk analysis. Article 110.7(G)

6] PPE

PPE (personal protective equipment) is your last line of defense should an accident occur; thus, the choice of appropriate PPE for the hazards involved is essential.

The evaluation of PPE should be completed in conjunction with an arc flash hazard study using appropriate Software (Refer to Section 4, Analyze). NFPA 70E contains several categories of PPE to address the hazards. Since it can be confusing and costly to obtain gear for protection in each of these divisions, an arc flash hazard study will help you manage PPE into a limited number of categories avoiding unnecessary confusion and expense.



7] Work Permits

Energized Work Permits are required by NFPA 70E Article 130.1 for all energized work above 50 volts (except for diagnostics). Work Permits are a key aspect of NFPA 70E. They document the safe work practices and procedures used, job briefing and planning, arc flash hazards, and the PPE requirements for the specific task. Work Permits require that management as well as the electricians sign-off that the job can be performed safely. Work Permits help prevent unnecessary risks and poor planning practices that lead to accidents.

Energized Work Permits should take into consideration: system operating conditions, the hazards involved, company work procedures and policies, safety requirements, etc. They should be logged electronically and backed-up to help ensure compliance and avoid liability due to lost documentation. Custom Engineering Solutions can do these tasks automatically as part of the Arc Flash Hazard Analysis (Refer to Section 4, Analyze).

8] Safety Program

Electrical safety is the heart of the NFPA 70E requirements and should be the goal of all companies and their employees. Defining safe work practices, procedures, and providing adequate documentation is essential in forming the basis for a safety program and developing a safety culture in your facility. Arc flash is one key aspect of a safety program that should also include practices and procedures for lock-out/tag-out, shock hazard, testing, tools, inspections, diagnostics, PPE, and a host of other safe work practices documented for reference. A proper electrical safety program will be centered on a company's Electrical Safe Work Practices Document.

9] Training

All employees should receive training based on an Electrical Safe Work Practices Document every two years. Training should emphasize the major thought processes in working safely (i.e. training workers to evaluate each system/condition and making safe decisions).

This is a key aspect in building a safe work culture that prepares workers to handle emergency situations. Additional types of training should also be considered for potentially hazardous day-to-day activities in your facility. These are site specific and may include: removing and installing MCC buckets, feeder bus duct plug-ins, or racking in breakers.

10] System Maintenance

System maintenance (including cleaning, breaker testing, insulation testing, etc.) is an integral part of electrical safety. Equipment maintenance and testing helps ensure that the equipment will be ready and operational to protect workers in the event of a hazard.

