



Arc Flash Hazard Studies

Hood-Patterson & Dewar, Inc.

What You Should Know

Arc Flash Hazard (AFH) Definition

An arc flash is the result of the rapid release of energy due to an arcing fault between a phase bus bar and another phase bus bar, neutral or ground.

An arc flash:

- *happens very quickly; faster than the human eye can perceive*
- *produces a pressure wave, hot gases, molten metal and shrapnel*
- *includes a high intensity blast, acoustic and thermal energy*
- *travels a distance determined by the amount of energy released and the equipment involved*
- *can be caused by human, environmental or equipment factors*
- *causes 75 to 80 percent of all serious electrical injuries*

Industry Standards Related to Arc Flash Hazard

Multiple industry standards directly or indirectly address AFH safety. These include:

1. OSHA 29 Code of Federal Regulations (CFR) Part 1910 Subpart S - mandatory
2. NFPA National Electrical Code Article 110.16 - mandatory
3. NFPA 70E Standard for Electrical Safety

Requirements for Employee Workplaces - recommended

4. IEEE Standard 1584 Guide for Performing Arc Flash Hazard Calculations - reference

OSHA enforces safety practices in the workplace. In 29 CFR Part 1910.333 OSHA says that "safety related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts." Also, Section 1910.132(d) requires that employers assess the workplace to determine if hazards are present, and if present, must select proper personal protective equipment (PPE) to protect personnel. Although there are some other related requirements in these standards, the OSHA standards themselves are not very specific about arc flash hazards. Instead, OSHA refers to NFPA 70E as a "how to" reference.

The 2002 National Electric Code (NEC) was the first code book to address AFH safety. The current NEC in Article 110.16 entitled "Flash Protection" says "Switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling occupancies and are likely to require examination, adjustment, servicing or maintenance while energized shall be *field marked* to warn qualified persons of potential electric arc flash hazards. The

marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.” The NEC field marking, or labeling, requirement certainly applies to all new equipment, but employers may want to also consider labeling all existing equipment to comply with OSHA’s safe workplace mandates.

NFPA 70E goes in to much more detail about safe work practices including defining a safety program, providing calculations for arc flash hazard and specific requirements for PPE. In addition to OSHA considering NFPA 70E as an industry recognized practice, the notes in the NEC refer to NFPA 70E for determining the appropriate PPE for a particular hazard. Notes in the NEC are not part of the code but are clarifications and recommendations in reference to meeting the code.

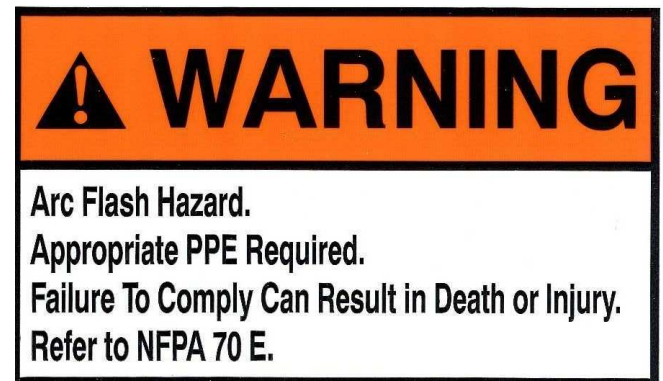
IEEE Standard 1584 provides calculation steps that support NFPA 70E. It outlines the method for calculating the anticipated incident energy level so personnel can select the appropriate PPE for a task or so a formal arc flash hazard study can be performed and incident energy labels can be applied to each piece of electrical equipment.

Arc Flash Hazard Labeling

Employers have to make a choice whether they want to use generic labels or site specific incident energy labels.


Generic labels are available and usually ship (unapplied) with new equipment to meet the “field marked” requirement of NEC 2005. If equipment is existing, generic labels can be purchased and applied. If generic labels are used, then qualified personnel will need to determine the PPE required by referring to the NFPA 70E table or by calculating

the incident energy available as part of the risk hazard assessment prior to work. The NFPA 70E tables are necessarily conservative. The downside to this choice is that overly conservative PPE levels are possible which lead to overdressing.



Generic arc flash hazard label

Incident energy or site specific labels are only available if you have a complete arc flash hazard study performed. These labels are generated by the AFH study software and must be field applied. Site specific labels come with their own set of questions and issues. What information should go on the labels? Industry has yet to standardize the label information. Some studies contain multiple scenarios that are specific to the site’s design and system operation; normal power, generator power, motor contribution, no motor contribution, etc. Each run may have different incident energy label results. Do you label for the worst case scenario? Some AFH software manufacturers allow you to choose NFPA 70E or IEEE Standard 1584 as the basis for your calculations. These two references can result in different conclusions. Which standard do you use for the study? An experienced study provider will make choices resulting in the safest settings with the appropriate risk categories.

 WARNING - Arc Flash Hazard									
Client Our Customer - Atlanta, Georgia									
Location Tenth St. Chiller Plant									
Job #		Date August 2005			Engineer				
Bus BUS-07MCC (LV Bldg)		Category LV MCC							
Rated Volts 480		Rated Amps 800			MfTy/Desc CUTLER-HAMMER, Freedom, 600-3200A				
Main Device 07MCC MAIN									
Device Settings									
CUTLER-HAMMER, HMDL RMS 310		Phase LTPU (1.0 x P)		LTD (Fixed)		STPU (2-8 x P)		STD (Inst-300 ms) INST (5500A)	
LSI 400-800A Fixed Plug		FIXED (400A)		FIXED		4 (1600A)		200 ms(P2 T Out) FIXED (5500A)	
Frame 800		Sensor 800		Plug 400		Ground		GFPU (5 x lg) GFD (Inst-500 ms)	
						5 x lg (800A)		300 ms(P2 T Out)	
Arc Flash Calculation Data Sheet - IEEE 1584-2004a									
Bolted Short Circuit Fault		4.4 kA 3Phase		Trip/Delay		Breaker Open		Arcing Duration	
Arcing Fault in Protective Device		3.6 kA 3Phase		0.200 s		0.000 s		0.200 s	
Arc/Equipment Type		Panel		Gap: 25		Grounded			
Arc Flash Boundary		24 inches @ 1.2 cal/cm ² - 2nd Degree Burn Boundary of Bare Skin							
Working Distance		18 inches		21		24		30 48	
Incident Energy		1.90 cal/cm ²		1.48		1.19		0.82 0.38	
PPE Clothing Class		Category 1 - FR Shirt & Pants							
Personnel Protection Equipment Table									
Clothing Description		Hazard Risk Category		Clothing Layers		Arc Rating (cal/cm ²)		Notes	
Untreated Cotton		0		1		N/A		Safety Glasses	
FR Shirt & Pants		1		1		4		head, eye protection	
Cotton Underwear + FR Shirt & Pants		2		1 or 2		8			
Cotton Underwear + FR Shirt & Pant + FR Coverall		3		2 or 3		25			
Cotton Underwear + FR Shirt & Pant + Multi Layer Flash Suit		4		3 or more		40			
Proper Protective Equipment Required									

This label describes the arc flash hazard associated with working inside the equipment while energized. It gives the specific location and settings of the protective device that protects the location. Various boundaries are described and the minimum PPE is named.

Incident energy arc flash hazard label

Determining Factors

In addition to the steps discussed above, all determinations for incident energy whether calculated or from reference tables assume that electrical equipment is in proper working order. If equipment is not appropriately maintained, then any study, calculation or assumption could be wrong.

Recommendations:

- Follow NFPA 70B *Recommended Practice for Electrical Equipment Maintenance*.
- Adhere to settings determined by a short circuit and coordination study. These settings are used in AFH study calculations. If the settings have been changed, then the AFH calculations can be wrong.
- Incorporate AFH awareness, assessment and training into existing safety program.

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