PowerStudies INC. ®
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Answers to Common Questions about Arc Flash Labels

By Audra Justice & Robert E. Fuhr, P.E.; P.Eng

Arc Flash Labels – You need them, But Now What?

Introduction

Arc Flash labels are now required on electrical equipment per Sections 110.16 of the NEC (NFPA 70) and 130.5.(H) of NFPA 70E. So who is responsible for producing the labels and maintaining them? Where should the labels go on the equipment? What does all the information on the labels mean? Why do I have two labels for some equipment? These are important questions that you need the answers to before you apply the labels to any of the equipment. This short tutorial will provide simple clear answers to those common questions.

Questions Answered

1. **Who is responsible for producing and maintaining the Arc Flash Assessment Labels?**

   Per NFPA 70E, Section 130.5.(H), The owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the field-marked label.

2. **How do how do I create Arc Flash Labels, what is required, and where can I get help?**

   We have created a paper that outlines the steps that must be done to perform an Arc Flash Hazard Assessment. Please refer to AF - Description & Options.pdf for the steps and options available.

3. **Now that you have the labels, where should the labels be placed on the equipment?**

   The labels need to be placed on the outside front cover of the equipment. However, when it comes to panelboards, it is acceptable to place the labels on the inside of the door. They need to be clearly visible to any person who will be working on the piece of equipment while it is energized. Also, there are some instances where you will have line side and load labels for one piece of equipment. See question #5 for further explanation of this.

4. **What does all of the information on the labels mean?**

   [Refer to Figure 1] This is a sample of an arc flash label produced by PowerStudies, Inc. The notations explain what each line of information means.

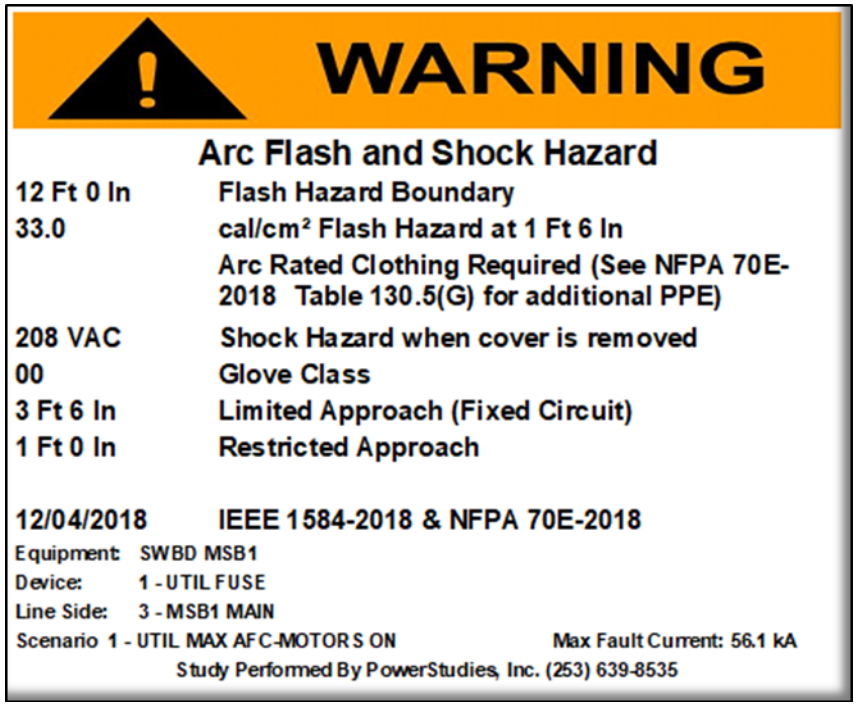

Figure 1 – Sample Arc Flash Label

#1 – If you are within 12 Ft front of the source of the arc flash, you are within the flash hazard boundary* (1.2 Cal/cm^2). This is where you could receive a second degree (blister) burn and have possible ignition of non-arc rated clothing. However, if you are more than 12 Ft away from the source of the arc flash, then you are considered safe and not at risk from the arc flash.

#2 – If you are 1 Ft 6 in away from the source of the arc flash, you will physically receive 33 Cal/cm^2 of energy. This distance is also referred to as "the working distance", which is the distance measured from the arc flash source to the upper torso or face.

#3 – This equipment voltage is 208 volts. If you remove the cover of the equipment while it is energized, you must protect yourself from shock by wearing insulated gloves or covering the energized parts with an insulated rubber blanket.

#4 – This shows what minimum class of protective insulated gloves that need to be worn when working on this equipment while it is energized.

#5 – This is the limited approach boundary*. An unqualified person has to be at least the distance listed or farther away from the energized equipment. For the example label above, an unqualified person has to be 12 Ft or farther away from the exposed energized conductor due to the arc flash. If the Arc Flash Boundary is less than the limited approach boundary and there is no arc flash hazard**, then an unqualified person can be escorted by a qualified person up to the restricted boundary.

#6 – This is the restricted approach boundary. Only a qualified person wearing the proper PPE can be within the distance listed of the energized equipment. According to figure 1, a qualified person wearing the proper PPE can get no closer than 12 In from the panel while it is energized. (The qualified person must also have an Energized Electrical Work Permit EEWP to work on the equipment. Trouble shooting is exempt.)

#7 – This is the date the label was printed, and which edition of IEEE and NFPA 70E the label was based on. (Note that per NFPA70E – 130.5(G) states that the Arc Flash study must be reviewed every five years.)

#8 – The "Equipment ID (Name)" is the actual piece of equipment that the label is for and should be applied to. The "Protective Device" is the upstream device that is protecting this specific piece of equipment and its tripping time was used in the calculation.

#9 – For some protective devices such as switchgear and switchboard mains, a calculation is performed on the line side. If the "Line Side of" is not shown, then the label would be for the main bus of the equipment. (See Question #5 below)

#10 – If the equipment has a main breaker, it may have an arc flash label for the line side of the main breaker. This label should be place on the main breaker enclosure or cubicle. If the line side is missing, then this is the equipment bus arc flash label.

#11 – This line shows which operating scenario the information on the label applies to. When arc flash hazard calculations are performed, they are calculated under different possible operating scenarios of the electrical system. This is done in order to find the worst possible case of arc flash incident energy at each piece of equipment.

For example, let's say there is an electrical system that has many motors and can be fed from a utility source or generator source. There would be four operating scenarios in which the calculations would be performed; two would be when the system is being fed power from the utility source, one with all the motors running at full capacity and one with all the motors out of service. The other two operating scenarios would be when the system is fed power by the generator, with all motors running in one scenario and the other with all motors out of service. Performing the calculations this way tells us the different incident energies at each piece of equipment under various circumstances. The label provided for each piece of equipment is the worst possible case out of all the operating scenarios calculations.

#12 – This shows the maximum short circuit current that was determined by the short circuit study (if calculated) or the maximum short circuit current from the Arc Flash operating scenarios.

* - Place temporary barrier tape or rope at the greatest distance of either Arc Flash Boundary or Limited Approach boundary.

** - To determine if there is an arc flash hazard, see NFPA 70E Table 130.7(C)(15) (a) or (b)Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems.

5. Why do I have two labels for some equipment?

[See Figure 2] This typically occurs when there is a label for both the line side and load side of the equipment. This will be noted on arc flash labels provided by PowerStudies, Inc., and both of these labels need to be applied to their respective line and load side locations on the equipment.

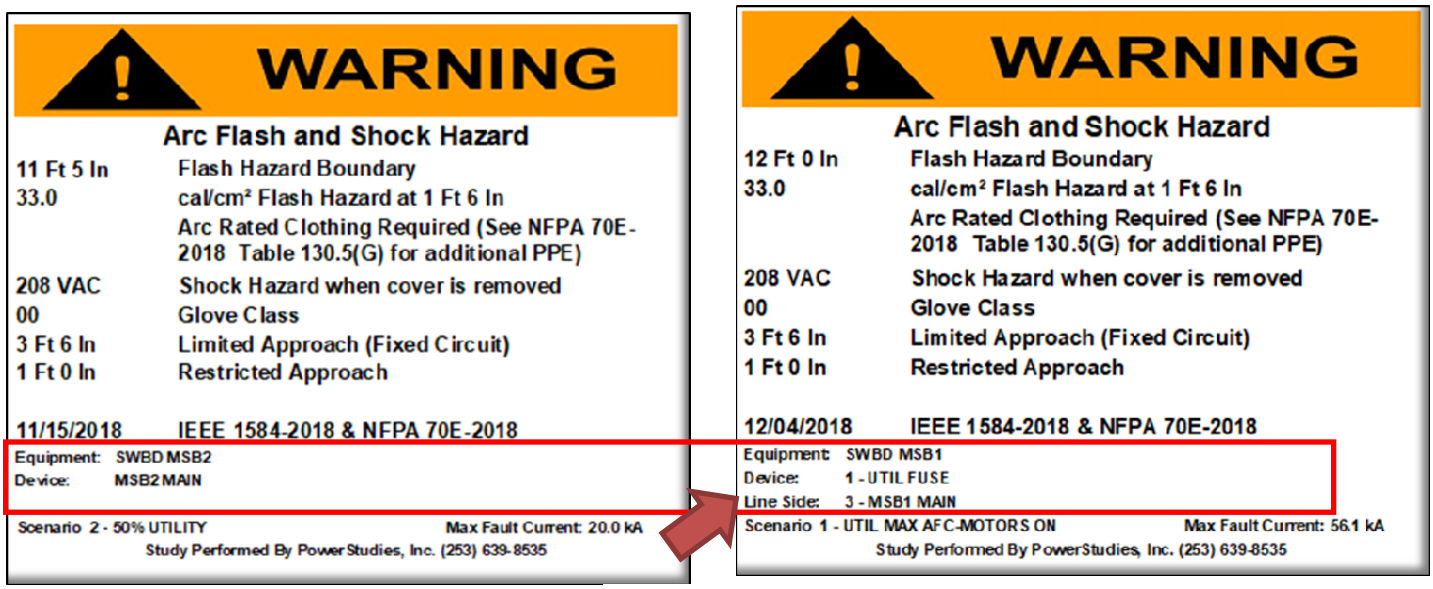

Figure 2

Both of the labels look similar. However, notice that for the label on the right under the protective device listing it says "Line Side of: FS-2 Fuse". This label is for the line side on the this protective device in Disc-FS-2; whereas the other label on the left, which does not say anything extra about "Line Side of", is for the bus downstream of Disc-FS-2.

Ready to Apply the Labels

Well, how do you feel when you look at that pile of arc flash labels now? Hopefully you feel confident and ready to install those bad boys, especially now that you understand what all the information means and where they should go! Only 5 common questions about arc flash labels were covered in this short article, and we know there are many more out there. Feel free to contact PowerStudies, Inc. at any time with any arc flash label related questions you may have!

Still not Sure?

Check out the Arc Flash Poster at the end of this document for additional information or call the experts at PowerStudies, Inc. at 253-639-8535.

About the Authors

Audra Justice graduated from Green River Community College with an associate's degree majoring in business. Mrs. Justice started working as an electrical engineering tech for PowerStudies, Inc. in 2012. Audra performs power system studies and assists the Protection Engineers with larger more complex projects.

Robert Fuhr graduated with a B.S.E.E. from the University of Wisconsin in 1980. Before graduating, Mr. Fuhr worked for Madison Gas and Electric in Madison, WI and Tennessee Valley Authority in Knoxville, TN. After graduation, he worked for General Electric Company from 1980 to 1986 as a Field Engineer, performing commissioning and start up tests on many different types of power distribution equipment. Mr. Fuhr worked as a Senior Facilities Engineer at the University of Washington from 1986-1989. There he re-commissioned the electrical power distribution system for University Hospital.

In 1986, Mr. Fuhr established PowerStudies, Inc., a consulting firm that specializes in power systems studies, power quality services, and commissioning services. He also teaches classes in protective relaying, electrical systems, safety, power factor correction, harmonics and filter design. Mr. Fuhr is a Professional Engineer registered in Alaska, Arizona, California, Colorado, Delaware, Florida, Hawaii, Idaho, Iowa, Nevada, New Mexico, New York, New Jersey, Maryland, Oregon, Pennsylvania, Virginia, Washington, and British Columbia.

Mr. Fuhr has been actively involved in Institute of Electrical and Electronic Engineers (IEEE) and the Industrial Applications Society (IAS) since 1986. He served as an officer for IAS from 1988 to 1992 and was the 1991-92 Chairperson of IAS and was a Member-at-large for the Seattle Section of IEEE from 1992-93. Mr. Fuhr is an IEEE Senior Member, a member of the Building Commissioning Association, and a member of the Electric League of the Pacific Northwest. He is a member of the IEEE 1584 Working Group (Guide for Performing Arc-Flash Hazard Calculations)

A Quick Guide to NFPA 70E-2018 and CSA Z462-2018 Approach Boundaries for Arc Flash and Shock

Energized Electrical Equipment

RESTRICTED APPROACH BOUNDARY:

Only Qualified Persons wearing appropriate PPE for the Restricted Approach Boundary, as determined by the Shock Risk Assessment, may enter. Must have Energized Electrical Work Permit. (EEWP)

LIMITED APPROACH BOUNDARY:

An unqualified person MAY enter the Limited Approach Boundary, but ONLY if continuously escorted by a Qualified Person, and advised of the potential hazards. Both must be wearing appropriate PPE as determined by a Shock Risk Assessment.

ARC FLASH BOUNDARY:

Only Qualified Persons wearing appropriate PPE for the Arc Flash Boundary, as determined by the Incident Energy Risk Assessment, may enter.

Restricted Approach Boundary for Shock | **Limited Approach Boundary for Shock** | **Arc Flash Boundary**

Shock Protection Boundary* (Dependent on Voltage Magnitude)

Arc Flash Protection Boundary* (Dependent on Arc Flash Energy Magnitude)

WARNING

Arc Flash and Shock Hazard

11 Ft 5 In	Flash Hazard Boundary
33.0	cal/cm² Flash Hazard at 1 Ft 6 In
	Arc Rated Clothing Required (See NFPA 70E-2018 Table 130.5(G) for additional PPE)
208 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
1 Ft 0 In	Restricted Approach
11/15/2018	IEEE 1584-2018 & NFPA 70E-2018

Equipment: SWBD MSB2
Device: MSB2 MAIN

Scenario 2 - 50% UTILITY — Max Fault Current: 20.0 kA

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Sample Arc Flash and Shock Hazard Label for NFPA 70E – 2018

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* See Back for Shock Boundaries & Arc Flash PPE Tables

WARNING

Arc Flash and Shock Hazard

7 Ft 5 In	Flash Hazard Boundary
16.0	cal/cm² Flash Hazard at 1 Ft 6 In
	Arc Rated Clothing Required (See CSA Z462-2018 Table 3 for additional PPE)
480 VAC	Shock Hazard when cover is removed
00	Glove Class
3 Ft 6 In	Limited Approach (Fixed Circuit)
1 Ft 0 In	Restricted Approach

IEEE 1584-2018 & CSA Z462-2018

Equipment: SWBD-SUB-M1 (SWBD SUB M1)
Device: 9 - TO SWBD-SUB-M1
Line Side: 10 - SWBD-SUB-M1 MAIN
Scenario 4 - ALL GENS - NORMAL MOTORS ON — Max Fault Current: 66.0 kA

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Sample Arc Flash and Shock Hazard Label for CSA Z462 – 2018

Personnel Protective Equipment Matrix Table
(Data from 2018 Editions of NFPA 70E Table 130.5(G) and CSA Z462 Table 3)

Incident Energy Exposure	Protective Clothing and PPE	PPE Clothing Characteristics and Descriptions
Equal to or Greater than 1.2 cal/cm² to 12 cal/cm² Arc-rated clothing and equipment with an arc rating equal to or greater than the incidental energy determined in the (IEEE 1584) arc flash risk assessment. (See note a) Other Personal Protective Equipment	Arc-rated long-sleeve shirt **and** Arc-rated pants (Note a) **and/or** Arc-rated coverall (Note a) **and/or** Arc-rated flash suit (SR) (Note a) Arc-rated face shield and arc-rated balaclava hood or arc flash suit hood (SR) (Note b) Arc-rated jacket, parka, or rainwear (AN) Hard hat Arc-rated hard hat liner (AN) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy-Duty Leather gloves or rubber insulation gloves with leather protectors (SR) (See Note c) Leather footwear	Arc-rated shirt and pants or arc-rated coverall or arc-rated flash suit
Greater than 12 cal/cm² to 40 cal/cm² Arc-rated Clothing and equipment with an arc rating equal to or greater than the incidental energy determined in the (IEEE 1584) arc flash risk assessment. (See Note a) Other Personal Protective Equipment	Arc-rated long-sleeve shirt **and** Arc-rated pants **and/or** Arc-rated coverall **and/or** Arc-rated flash suit (SR) Arc-rated flash suit hood (SR) Arc-rated gloves Arc-rated jacket, parka, or rainwear (AN) Hard hat Arc-rated hard hat liner (AN) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves or rubber insulating gloves with leather protectors (SR) (See Note c) Leather footwear	Arc-rated shirt and pants or arc-rated coverall or arc-rated flash suit
***Greater than 40 cal/cm²**	Danger! ***PowerStudies, Inc. does not recommend working or interacting with equipment in locations where the arc flash energy is greater than 40 cal/cm².**	

SR: Selection of one in group is required.
AN: As needed.
[a] Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.
[b] Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.
[c] Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.

Approach Boundaries to Energized Electrical Conductors Table for AC Systems
(Data from 2018 Editions of NFPA 70E Table 130.4 (D)(a) and CSA Z462 Table 1A)

(1) Nominal System Voltage Range, Phase to Phase	(2) Limited Approach Boundary – Exposed Movable Conductor		(3) Limited Approach Boundary – Exposed Fixed Circuit Part		(4) Restricted Approach Boundary – Includes Inadvertent Movement Adder	
Less than 50	Not Specified		Not Specified		Not Specified	
50 to 300	10 ft 0 in.	3.0 m	3 ft 6in	1.0 m	Avoid Contact	
301 to 750	10 ft 0 in.	3.0 m	3 ft 6in.	1.0 m	1 ft 0 in.	0.3 m
751 to 15 kV	10 ft 0 in.	3.0 m	5 ft 0 in.	1.5 m	2 ft 2 in.	0.7 m
15.1 kV to 36 kV	10 ft 0 in.	3.0 m	6 ft 0 in.	1.8 m	2 ft 9 in.	0.8 m
36.1 kV to 46 kV	10 ft 0 in.	3.0 m	8 ft 0 in.	2.5 m	2 ft 9 in.	0.8 m
46.1 kV to 72.5 kV	10 ft 0 in.	3.0 m	8 ft 0 in	2.5 m	3 ft 6 in.	1 m
72.6 kV to 121 kV	10 ft 8 in.	3.3 m	8 ft 0 in.	2.5 m	3 ft 6 in.	1.0 m
138 kV to 145 kV	11 ft 0 in.	3.4 m	10 ft 0 in.	3.0 m	3 ft 10 in.	1.2 m
161 kV to 169 kV	11 ft 8 in.	3.6 m	11 ft 8 in.	3.6 m	4 ft 3 in.	1.3 m
230 kV to 242 kV	13 ft 0 in.	4.0 m	13 ft 0 in.	4.0 m	5 ft 8 in.	1.7 m
345 kV to 362 kV	15 ft 4 in.	4.7 m	15 ft 4 in.	4.7 m	9 ft 2 in.	2.8 m
500 kV to 550 kV	19 ft 0 in.	5.8 m	19 ft 0 in.	5.8 m	11 ft 8 in.	3.6 m
765 kV to 800 kV	23 ft 9 in.	7.2 m	23 ft 9 in.	7.2 m	15 ft 11 in.	4.9 m