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## STANDARDIZING ARC FLASH PPE LABELS

### 1.0 THE STRATEGY OF STANDARD PPE LABELS

The labeling of electrical equipment with regard to arc flash PPE level is an important and essential part of the safety program at every industrial facility. Some of the details of what goes on the labels are specified in NFPA-70E. The 70E recommendations include arc flash information only, but commonly the labels are applied with both arc flash and shock hazard information. Two basic approaches to labeling are generally used.

1. Individual Labels - One approach is to calculate the arc flash parameters at each piece of equipment in the plant and to apply a label which specifically includes the incident energy and flash protection boundary at that piece of equipment, as well as the name of that piece of equipment.
2. Standard Labels - The second approach is to calculate the arc flash parameters at each piece of equipment, but then to group pieces of equipment in certain ranges of incident energy and then to use the same label on all of those pieces of equipment. This approach results in a limited number of *Standard Labels* and is an attempt to simplify the interpretation of the information for the electrical worker, while maintaining high levels of safety in the work environment.

Another factor in the labeling strategy is that most industrial plants have taken the approach of using two or three PPE levels for their staff. Three common incident energy levels are 1.2 cal/cm<sup>2</sup>, 8 cal/cm<sup>2</sup>, and 40 cal/cm<sup>2</sup>. (Some are using other levels such as 11 cal/cm<sup>2</sup> and 65 cal/cm<sup>2</sup>, since it is possible to obtain clothing rated at those levels.) In this document the levels of 1.2 cal/cm<sup>2</sup>, 8 cal/cm<sup>2</sup>, and 40 cal/cm<sup>2</sup> are used, as these have become the most common levels, and they are referred to here as PPE Levels of 0, 2, and 4, respectively. (This designation comes from the historical use of these levels in NFPA 70E for use with the *Arc Flash PPE Categories Method*.)

Based on the concept of using three PPE levels, the labeling can be simplified if the labels are also based on using only PPE Levels of 0, 2, and 4. For locations where the calculated incident energy is  $\leq 1.2$  cal/cm<sup>2</sup>, a PPE = 0 label would be used. For locations where the calculated incident energy is  $> 1.2$  cal/cm<sup>2</sup> and  $\leq 8$  cal/cm<sup>2</sup>, a PPE = 2 label would be used. For locations where the values are  $> 8$  cal/cm<sup>2</sup> and  $\leq 40$  cal/cm<sup>2</sup>, a PPE = 4 label would be used. It should be noted that it is possible to use other PPE Level designations, such as A, B, C rather than 0, 2, 4.

In summary, the advantages of using *Standard Labels* are the following:

1. The labels simplify the information for the electrical worker.
2. Small changes in system parameters in the future would not require a label change as long as the energy was still in the range.

- As more arc flash testing is done, it is likely that some of the equations will change for calculating the incident energy. If the changes are relatively minor resulting in energy values in the same range, the labels would not change.
- The calculation of the incident energy is not accurate to within 0.1 calories, as is often implied by the values that are often given on the labels.
- Using Standard Labels gives a uniformity of labeling for larger companies that have multiple plants.
- The labels meet all of the requirements of NFPA 70E-2021.

## 2.0 EXAMPLES OF STANDARD LABELS

The example labels given in this document are based on using Standard Labels. These labels are generally applicable to industrial power systems, but they do not include the specific detailed calculations for each particular location.

The specific philosophy outlined here is based on implementing standard labels, which use only the PPE levels of 0, 2, and 4, as defined in Section 1.0. These standard labels provide a framework for developing similar labels for other standard operating practices, other system voltages, other working distances, and the use of remote switching or remote racking. These labels could be easily modified for variations in these parameters.

In Table 1, typical parameters are given for some standard labels.

**Table 1**  
**Summary of Standard XYZ Company PPE Labels**  
**Based on NFPA 70E-2021**

Label Name	Nominal System Volts	Working Distance (Inches)	PPE Category	Min PPE Rating (cal/cm <sup>2</sup> )	Arc Flash Boundary (feet)	PPE = 2 Distance (feet)	Glove Class	Shock Boundaries		Label Size (Inches)	Equipment	
								Limited Approach	Restricted Approach		Metal Enclosed	Open Air
<b>Equipment Labels</b>												
XYZ480-0	480	18	0	1.2	1.5		0	3 ft 6 in	1 ft	4 x 3		X
XYZ480-2	480	18	2	8.0	6.0		0	3 ft 6 in	1 ft	4 x 3		X
XYZ480-4	480	18	4	40.0	17.0	5.0	0	3 ft 6 in	1 ft	4 x 3		X
XYZ480>4	480	18	> 4							4 x 3		X
XYZ4160-2	4,160	24	2	8.0	10.0		1	5 ft	2 ft 2 in	4 x 3		X
XYZ4160-4	4,160	24	4	40.0	30.0	10.0	1	5 ft	2 ft 2 in	4 x 3		X
XYZ13800-2	13,800	36	2	8.0	15.0		2	5 ft	2 ft 2 in	4 x 3		X
XYZ13800-4	13,800	36	4	40.0	45.0	15.0	2	5 ft	2 ft 2 in	4 x 3		X
XYZ-P	PPE									4 x 6		
XYZ-B	Boundaries									7 x 4		

In industrial facilities with metal enclosed switching devices, the following observations are often applicable, based on the standard labels in Table 1:

- At MCC's and PDP's on 208V to 600V systems, the calculated incident energy at the incoming feed is frequently < 8 cal/cm<sup>2</sup>. In those cases a PPE level of 2 is adequate, and Example Label #2 could be appropriate for a 480V system.
- At the main switchgear on 208V to 600V systems, the calculated incident energy at the main bus is frequently < 40 cal/cm<sup>2</sup>. In those cases a PPE level of 4 is adequate for the feeder switches or breakers. Example Label #3 could be appropriate for a 480V system.

3. For equipment that is down-line of MCC's and PDP's, the calculated incident energies are frequently in the categories of the PPE Levels of 0 and 2. Example Labels #1 and #2 could be appropriate for a 480V system.
4. For 4.16 kV systems, Example Labels #6 and #7 are given for metal enclosed equipment with PPE Levels of 2 and 4.
5. For 13.8 kV systems, Example Labels #7 and #8 are given for metal enclosed equipment with PPE Levels of 2 and 4.
6. At other voltage levels, similar labels can easily be derived from the example labels #1 thru #8.

Example Label #9 provides a definition of what PPE is appropriate for each category level. This label could be placed at key points to provide the facility electrical workers with a reference for this information.

Example Label #10 provides definitions of the various boundaries. This label could be placed at key points to provide the facility electrical workers with a reference for this information.

### Example Label #1



#### **ARC FLASH AND SHOCK HAZARD APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 0:** **0**  
Working Distance  $\geq$  18"  
Minimum PPE Rating = 1.2 cal/cm<sup>2</sup>  
Arc Flash Boundary = 1 ft 6 in

#### **SHOCK PROTECTION - 480 VAC**

Insulating Glove Class 0  
Limited Approach Boundary 3 ft 6 in  
Restricted Approach Boundary 1 ft

#### **CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ480-0

### Example Label #2



#### **ARC FLASH AND SHOCK HAZARD APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 2:** **2**  
Working Distance  $\geq$  18"  
Minimum PPE Rating = 8 cal/cm<sup>2</sup>  
Arc Flash Boundary = 6 ft

#### **SHOCK PROTECTION - 480 VAC**

Insulating Glove Class 0  
Limited Approach Boundary 3 ft 6 in  
Restricted Approach Boundary 1 ft

#### **CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ480-2

### Example Label #3



#### **ARC FLASH AND SHOCK HAZARD APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 4:** **4**  
Working Distance  $\geq$  18"  
Minimum PPE Rating = 40 cal/cm<sup>2</sup>  
Arc Flash Boundary = 17 ft  
Note: PPE = 2 at a working distance of 5 ft.

#### **SHOCK PROTECTION - 480 VAC**

Insulating Glove Class 0  
Limited Approach Boundary 3 ft 6 in  
Restricted Approach Boundary 1 ft

#### **CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ480-4

### Example Label #4



#### **ARC FLASH AND SHOCK HAZARD**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL >4:** **>4**  
The potential arc flash incident energy is greater than 40 cal/cm<sup>2</sup> for a working distance of 18".

Operation or insertion/removal (racking) of switching device is not to be done unless the equipment is deenergized and confirmed to be deenergized.

No work is to be done on energized electrical conductors.

#### **SHOCK PROTECTION - 480 VAC**

Energized parts are not to be exposed.

XYZ480>4

Example Label #5



**ARC FLASH AND SHOCK HAZARD  
APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 2:**  
Working Distance ≥ 24"  
Minimum PPE Rating = 8 cal/cm<sup>2</sup>  
Arc Flash Boundary = 10 ft

**2**

**SHOCK PROTECTION – 4160 VAC**

Insulating Glove Class 1  
Limited Approach Boundary 5 ft  
Restricted Approach Boundary 2 ft 2 in

**CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ4160-2

Example Label #6



**ARC FLASH AND SHOCK HAZARD  
APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 4:**  
Working Distance ≥ 24"  
Minimum PPE Rating = 40 cal/cm<sup>2</sup>  
Arc Flash Boundary = 30 ft

**4**

Note: PPE = 2 at a working distance of 10 ft.

**SHOCK PROTECTION – 4160 VAC**

Insulating Glove Class 1  
Limited Approach Boundary 5 ft  
Restricted Approach Boundary 2 ft 2 in

**CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ4160-4

Example Label #7



**ARC FLASH AND SHOCK HAZARD  
APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 2:**  
Working Distance ≥ 36"  
Minimum PPE Rating = 8 cal/cm<sup>2</sup>  
Arc Flash Boundary = 15 ft

**2**

**SHOCK PROTECTION – 13,800 VAC**

Insulating Glove Class 2  
Limited Approach Boundary 5 ft  
Restricted Approach Boundary 2 ft 2 in

**CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ13800-2

Example Label #8



**ARC FLASH AND SHOCK HAZARD  
APPROPRIATE PPE REQUIRED**

Based on NFPA 70E-2021 & XYZ Company Safety Directives

**ARC FLASH PPE LEVEL 4:**  
Working Distance ≥ 36"  
Minimum PPE Rating = 40 cal/cm<sup>2</sup>  
Arc Flash Boundary = 45 ft

**4**

Note: PPE = 2 at a working distance of 15 ft.

**SHOCK PROTECTION – 13,800 VAC**

Insulating Glove Class 2  
Limited Approach Boundary 5 ft  
Restricted Approach Boundary 2 ft 2 in

**CAUTION:**

Ensure that all of the appropriate safety procedures are followed. The PPE Level designation on this equipment is based on the proper installation and maintenance of the up-line protective device.

XYZ13800-4

## Example Label #9

*This label is to provide a definition of what PPE is appropriate for each category level.*

# PROTECTIVE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT PPE

Based on NFPA 70E-2021 & XYZ Company Safety Directives

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### **ARC FLASH PPE LEVEL 0 (For Tasks $\leq 1.2$ cal/cm<sup>2</sup>)**

Nonmelting fiber underlayers (e.g. cotton)	Safety glasses or safety goggles
Nonmelting fiber long sleeve shirt & pants (e.g. cotton)	Hearing protection (ear canal inserts)
Arc Flash PPE Level 2 is required if any part of the body or clothing is exposed to energized circuit parts within the defined working distance.	Leather gloves
	Insulating gloves and tools as needed

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### **ARC FLASH PPE LEVEL 2 (For Tasks $\leq 8$ cal/cm<sup>2</sup>)**

Nonmelting fiber underlayers (e.g. cotton)	Hearing protection (ear canal inserts)
Arc-rated long sleeve shirt & pants or coverall ( $\geq 8$ cal/cm <sup>2</sup> )	Insulating gloves with leather protectors
Safety glasses or safety goggles	Heavy-duty leather shoes
Hard hat, arc-rated face shield, and arc-rated balaclava	Insulated tools

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### **ARC FLASH PPE LEVEL 4 (For Tasks $\leq 40$ cal/cm<sup>2</sup>)**

Nonmelting fiber underlayers (e.g. cotton)	Hearing protection (ear canal inserts)
Arc-rated long sleeve shirt & pants or coverall	Arc-rated gloves
Arc-rated arc flash suit and hood (system $\geq 40$ cal/cm <sup>2</sup> )	Heavy-duty leather shoes
Safety glasses or safety goggles	Insulated tools
Hard hat	

XYZ-P

## Example Label #10

*This label is to provide definitions of the various boundaries.*

# APPROACH BOUNDARIES FOR SHOCK & FLASH PROTECTION

As Defined in NFPA 70E-2021

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## DEFINITIONS OF APPROACH BOUNDARIES:

**LIMITED APPROACH BOUNDARY** – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. (It is the closest distance an unqualified person can approach, unless accompanied by a qualified person.)

**RESTRICTED APPROACH BOUNDARY** – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part. (It is the closest distance to exposed energized electrical conductor or circuit part a qualified person can approach without proper PPE and tools.)

**ARC FLASH BOUNDARY** - When an arc flash hazard exists, an approach limit at a distance from an arc source at which incident energy equals  $1.2 \text{ cal/cm}^2$  ( $5 \text{ J/cm}^2$ ).

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## BOUNDARY REQUIREMENTS WHEN THERE IS AN EXPOSED ENERGIZED ELECTRICAL CONDUCTOR OR CIRCUIT PART:

**UNQUALIFIED PERSONS** must stay beyond the *limited approach boundary* and/or the *arc flash boundary*, as dictated by the tasks being performed.

**QUALIFIED PERSONS** must stay beyond the *restricted approach boundary* and/or the *arc flash boundary*, unless equipped with the proper PPE and tools, as dictated by the tasks being performed.

XYZ-B

## 3.0 CAUTIONS

The following items are noted here:

1. **Equipment Maintenance** – The PPE labels are based on the proper operation of the up-line protective equipment. The protective equipment must be maintained and working properly for the PPE recommendation on the label to be appropriate for that location.
  - a. Consequently, the proper maintenance of all equipment is a basic requirement for a good safety program.
  - b. There is a note at the bottom of each label that emphasizes this point.
2. **Switching** – As described in NFPA 70E-2021 110.4(D) and Table 130.5(C), the normal operation of a circuit breaker, switch, contactor, or starter does not require arc flash PPE if all of the following are true:
  - a. The equipment is properly installed.
  - b. The equipment is properly maintained.
  - c. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
  - d. All equipment doors are closed and secured.
  - e. All equipment covers are in place and secured.
  - f. There is no evidence of impending failure.

If any one or more of these items is not true, arc flash PPE is generally required. This guidance is part of NFPA 70E-2021, Section 130.5, *Arc Flash Risk Assessment*, Table 130.5(C). A common policy is that the PPE Level determined for a given location is to be used for the switching of that device unless a Risk Assessment has determined that it is not required.

3. **PPE = 0** – In this document PPE = 0 corresponds to a maximum incident energy of 1.2 cal/cm<sup>2</sup> at the defined working distance. If any part of the body or clothing is exposed to energized circuit parts within the defined working distance, then PPE = 2 is required.

For example, if the qualified person is working on energized equipment with exposed energized circuit parts, the person must wear the appropriate PPE. If the working distance is 18", the PPE level is 0, and the person is wearing cotton clothing (which is permissible) and leather gloves, it is essential that the parts of the body with exposed cotton clothing be beyond the 18" working distance. If the person is wearing leather and rubber gloves (as needed) and is working directly on the energized equipment, there may be a part of the arms that is covered with cotton sleeves but is within the 18". If that is the case, PPE = 2 is required.

This issue is significant, because the cotton clothing is flammable and as the working distance is reduced the incident energy increases exponentially. Consequently, if cotton clothing is exposed within the working distance, it could catch on fire during an arcing event.