

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 that 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 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/cm², 8 cal/cm², and 40 cal/cm². (Some are using other levels, such as 11 cal/cm² and 65 cal/cm² since it is possible to obtain clothing rated at those levels.) In this document, the levels of 1.2 cal/cm², 8 cal/cm², and 40 cal/cm² 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 ≤ 1.2 cal/cm², a PPE = 0 label would be used. For locations where the calculated incident energy is > 1.2 cal/cm² and ≤ 8 cal/cm², a PPE = 2 label would be used. For locations where the values are > 8 cal/cm² and ≤ 40 cal/cm², 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, and C, rather than 0, 2, and 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.
3. 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 will not change.

4. 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.
5. Using Standard Labels gives uniformity of labeling for larger companies that have multiple plants.
6. The labels meet all of the requirements of NFPA 70E-2024.

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 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 ²) | Arc Flash Boundary (feet) | PPE = 2 Distance (feet) | Glove Class | Shock Boundaries | | Label Size (Inches) | Equipment | |
|-------------------------|----------------------|---------------------------|--------------|---------------------------------------|---------------------------|-------------------------|-------------|------------------|---------------------|---------------------|----------------|----------|
| | | | | | | | | Limited Approach | Restricted Approach | | Metal Enclosed | Open Air |
| Equipment Labels | | | | | | | | | | | | |
| 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 | 3 ft 6 in | 2 ft 1 in | 4 x 3 | | X |
| XYZ4160-4 | 4,160 | 24 | 4 | 40.0 | 30.0 | 10.0 | 1 | 3 ft 6 in | 2 ft 1 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:

1. At MCCs and PDPs on 208 V to 600 V systems, the calculated incident energy at the incoming feed is frequently < 8 cal/cm². In those cases, a PPE level of 2 is adequate, and Example Label #2 could be appropriate for a 480V system.
2. At the main switchgear on 208 V to 600 V systems, the calculated incident energy at the main bus is frequently < 40 cal/cm². 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 MCCs and PDPs, 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 480 V system.

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 the 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-2018, 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/cm² 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 are covered with cotton sleeves but is within the 18". If that is the case, PPE = 2 is required.

This issue is significant because 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.