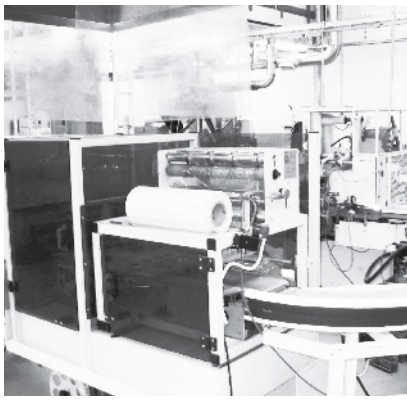
MISCONCEPTIONS ABOUT ARC-FLASH HAZARD ASSESSMENTS



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There are some common misconceptions about Arc-Flash Hazard Assessments which reduce the effectiveness of the Assessments and can increase electrical hazards. These misconceptions exist because of the confusion about the laws and standards that apply regarding Arc-Flash Hazard Assessments. It is important to note that the Occupational Safety and Health Administration (OSHA) may rely on numerous consensus standards to enforce their regulations, and this may vary by state. Further confusion is caused by the various methods used to calculate and quantify Arc-Flash hazards. When deciding to do an Arc-Flash assessment, it is vital to determine what is being offered by a service company and what is required by OSHA or local authority having jurisdiction (AHJ). The goal of this paper is to discuss some of the common misconceptions regarding Arc-Flash Hazard Assessments and clarify what OSHA and the National Fire Protection Association® (NFPA®), actually require.

An Arc-Flash Hazard Assessment is part of a complete electrical hazard assessment required by OSHA, NFPA 70E and CSA-Z462. An Arc-Flash Hazard Assessment determines the degree to which a worker may be exposed to potential Arc-Flash Hazards and what kind of Personal Protective Equipment (PPE) is required to protect workers from the heat, light, and blast associated with an Arc-Flash accident.

MISCONCEPTION 1

OSHA does not enforce NFPA 70E for Arc-Flash and electrical safety compliance.

FACT

OSHA is the "Shall" and NFPA 70E is the "How" for electrical safety compliance.

OSHA has adopted Electrical Safety-related work practices in OSHA 1910 Subpart "S" (1910.301 to 1910.399). OSHA is using NFPA 70E as a guideline for "enforcing" OSHA electrical safety rules. The Occupational Safety and Health Act of 1970 requires employers to provide their employees with a workplace that is free from recognized hazards that may cause death or serious injury to their employees. NFPA 70E, Standard for Electrical Safety in the Workplace, was developed by NFPA® to help employers meet OSHA regulations. OSHA compliance officers look to NFPA 70E for guidance on how to evaluate Arc-Flash Hazards and minimize or prevent Arc-Flash accidents. OSHA 1910.132(d) and OSHA 1910.335(a)(1)(i) requires employers to assess the workplace and identify electrical and other hazards, select and provide PPE for their employees, inform their employees about the hazards that are present, and train qualified employees how to use protective equipment. In addition to safety-related work practices, OSHA 1910 Subpart "S" specifically requires employers to establish an electrical safety program including safe electrical design, safe electrical maintenance requirements, and safe work procedures for special electrical equipment. OSHA 1910.332 requires employers to train and qualify their employees in safe work practices and standard operating procedures to reduce hazards and increase worker safety. OSHA regulations are written in general terms and do not give detailed information about how to meet the regulations.

NFPA 70E addresses how to implement an electrical safety program, how to establish safety-related work practices, how to establish methods and use mathematical formulas to evaluate electrical shock and Arc-Flash Hazards, and how to select and use electrical shock and Arc-Flash PPE. NFPA 70E defines what type of safety training is necessary and how to qualify workers. OSHA refers to NFPA 70E as an acceptable national consensus standard that can be used to meet OSHA regulations. OSHA is considered the "Shall" and NFPA 70E is the "How" of electrical safety. In order to be OSHA compliant you must follow a consensus standard such as NFPA 70E.

MISCONCEPTION 2

When equipment is determined to be a Hazard Risk Category 0, it is assumed that all other equipment, fed downstream, is also a Hazard Risk Category 0.

FACT

Incident energy and Hazard Risk Categories can increase if fault current drops below the current-limiting range or the instantaneous trip setting of the overcurrent protective device. According to OSHA, NFPA 70E and CSA-Z462 <u>all</u> equipment must be assessed for hazards rated 50 volts or greater.

Some companies assume that equipment supplied from a panel assessed as Hazard Risk Category 0 must also be Hazard Risk Category 0. They stop assessing any panels or equipment supplied from a Hazard Risk Category 0. This practice, if followed, will result in violation of industry standards, such as OSHA, NFPA 70E and CSA-Z462 regulations and greatly compromise worker safety. OSHA, NFPA 70E and CSA-Z462 require employers to assess all equipment operating at 50 volts and higher for shock and Arc-Flash Hazards. In addition to shock hazards, incident energy and Hazard Risk Categories can increase the further into your electrical distribution system and farther away you are from the power source. The severity of a potential Arc-Flash depends on the available fault current where the Arc-Flash occurs and the opening time of the upstream overcurrent protective devices. Because of the impedance of cables or bus ducts, etc., the maximum available fault current decreases the farther away you are from the power

source. The lower the fault current, the longer the fuse or circuit breaker will take to open. In some cases, a slightly lower fault current can double or triple the opening time of the upstream fuse or circuit breaker. This can easily escalate the incident energy possible and increase the Hazard Risk Categories at panels and equipment downstream of the protective device. If there are long cable runs, transformers, or other overcurrent protective devices downstream of a Hazard Risk Category 0, the incident energy and Hazard Risk Categories will often increase. Never assume Hazard Risk Categories. Always confirm the possible incident energy at all equipment supplied from panels assessed at Hazard Risk Category 0.

Figure 1 is a partial one-line drawing of a facility supplied by a 1500 kVA Utility transformer with a bolted pressure switch on the secondary with 2000 Ampere Class L fuses supplying the main switchgear bus. MCC-1 is supplied from the switchgear by LLSRK 400 Amp UL Class RK1 fuses. MCC-2 is supplied from the switchgear by a 400 Amp TB4 frame circuit breaker. And MCC-3 is supplied by LLSRK 400 Amp UL Class RK1 fuses. Each MCC is 220 ft. away from the switchgear supplied by 3 -#500MCM copper cables. The Arc-Flash Incident Energy available at the switchgear bus is over 40 cal/cm² and is considered DANGEROUS.

FIGURE 1

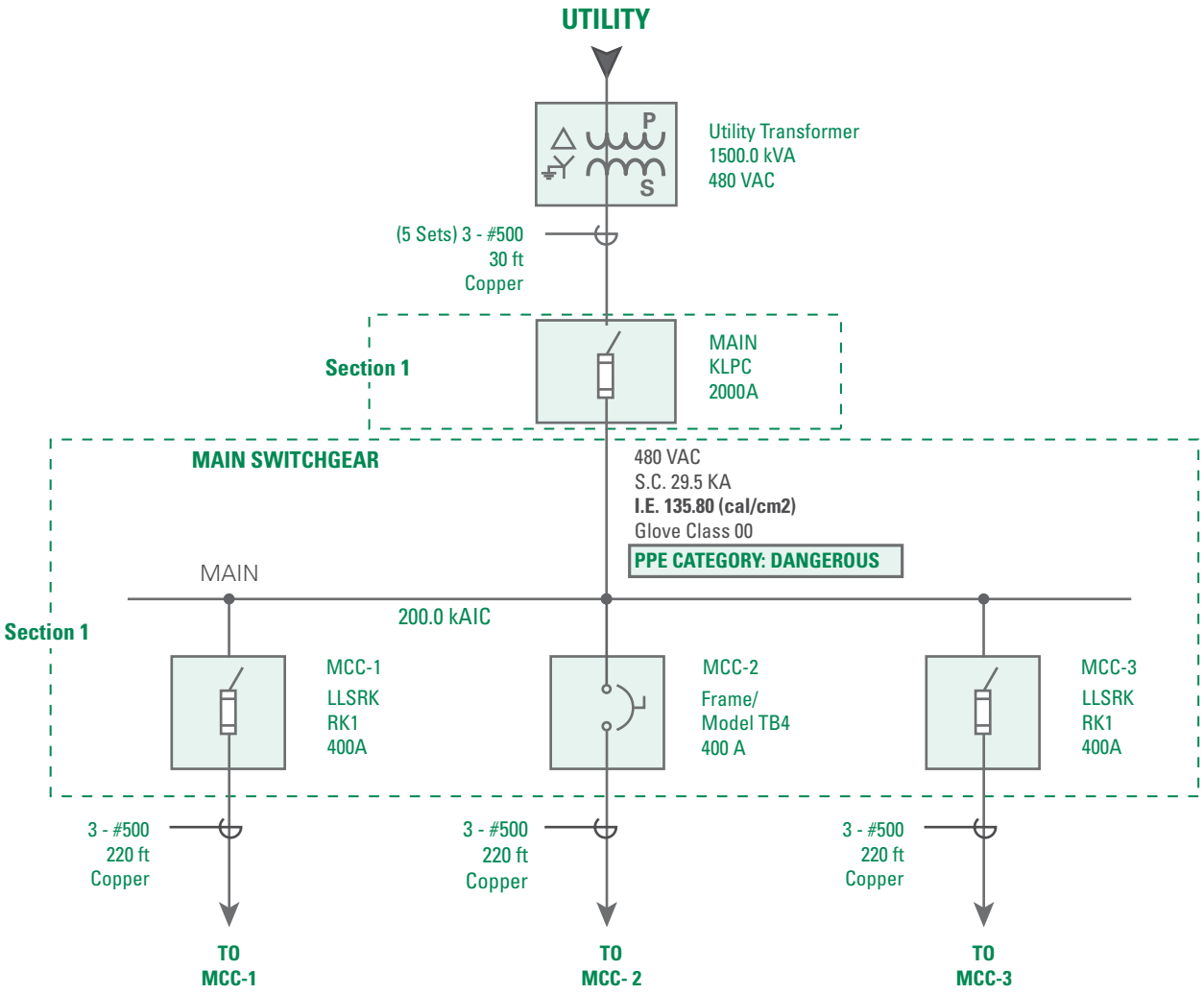


Figure 2 shows **Hazard Risk PPE Category 0** at the MCC-2 bus, based on the available fault current of 13.6 kA and the clearing time of the 400 Amp TB4 frame circuit breaker at the switchgear. If the assessment process ceased at this point and did not proceed further down to Disconnect Motor #4, workers would be unaware of the potential danger at this location. Because of the reduction in available fault current (3.1 kA) due to the impedance of 250 ft. of cables and the clearing time of the 100 Ampere FA frame circuit breaker at MCC-2, workers would be exposed to **Hazard Risk PPE Category 3** at motor disconnect switch #4.

Figure 3 shows **Hazard Risk PPE Category 0** at the MCC-1 bus, based on the available fault current of 13.6 kA and the clearing time of the 400 Ampere LLSRK UL Class RK1 fuses at the switchgear. If the assessment ceased and did not proceed further to Disconnect Motor switch #2, workers would be exposed to **Hazard Risk PPE Category 1** due to the reduction in available fault current (3.1 kA) and the opening time of the 100 Ampere FLSR UL Class RK5 fuses at MCC-1.

Upgrading fusible power distribution systems to the most current-limiting fuses throughout the electrical distribution system will decrease Arc-Flash incident energy and Hazard Risk Categories. For example, if UL Class RK5 fuses are used downstream of a UL Class RK1 fuse, Hazard Risk Categories can increase and possible nuisance opening of the upstream fuse may occur. See Figure 3.

If the 100 Ampere UL Class RK5 fuse at MCC-1 for Motor 2 in Figure 3 were upgraded to a 100 Ampere UL Class RK1 fuse, selective coordination would be assured and the Hazard Risk Category at Disconnect #2 would be reduced to Hazard Risk Category 0.

In Figure 4, we see the effect that upgrading from UL Class RK5 fuses to RK1 fuses can have on incident energy and Hazard Risk Categories. Motor Disconnect switch #6 is the

FIGURE 2

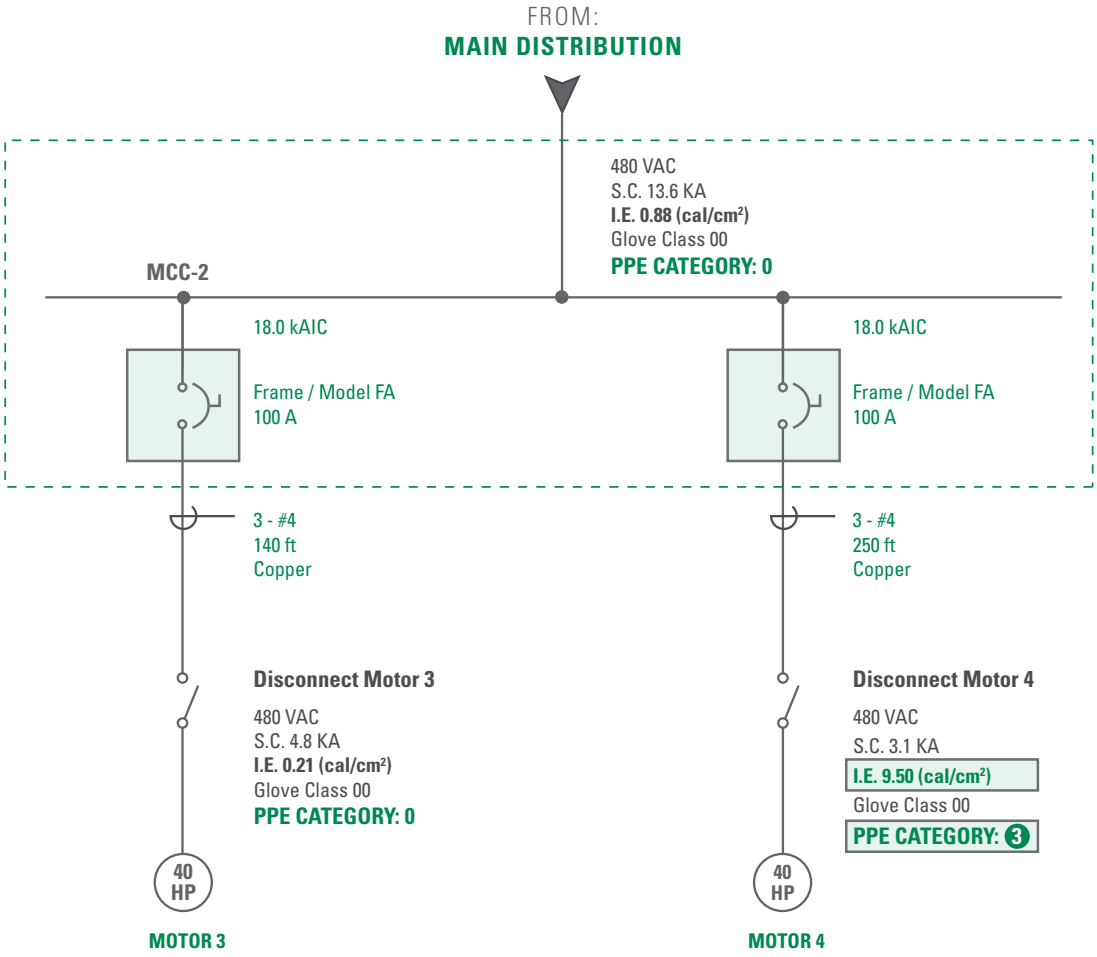
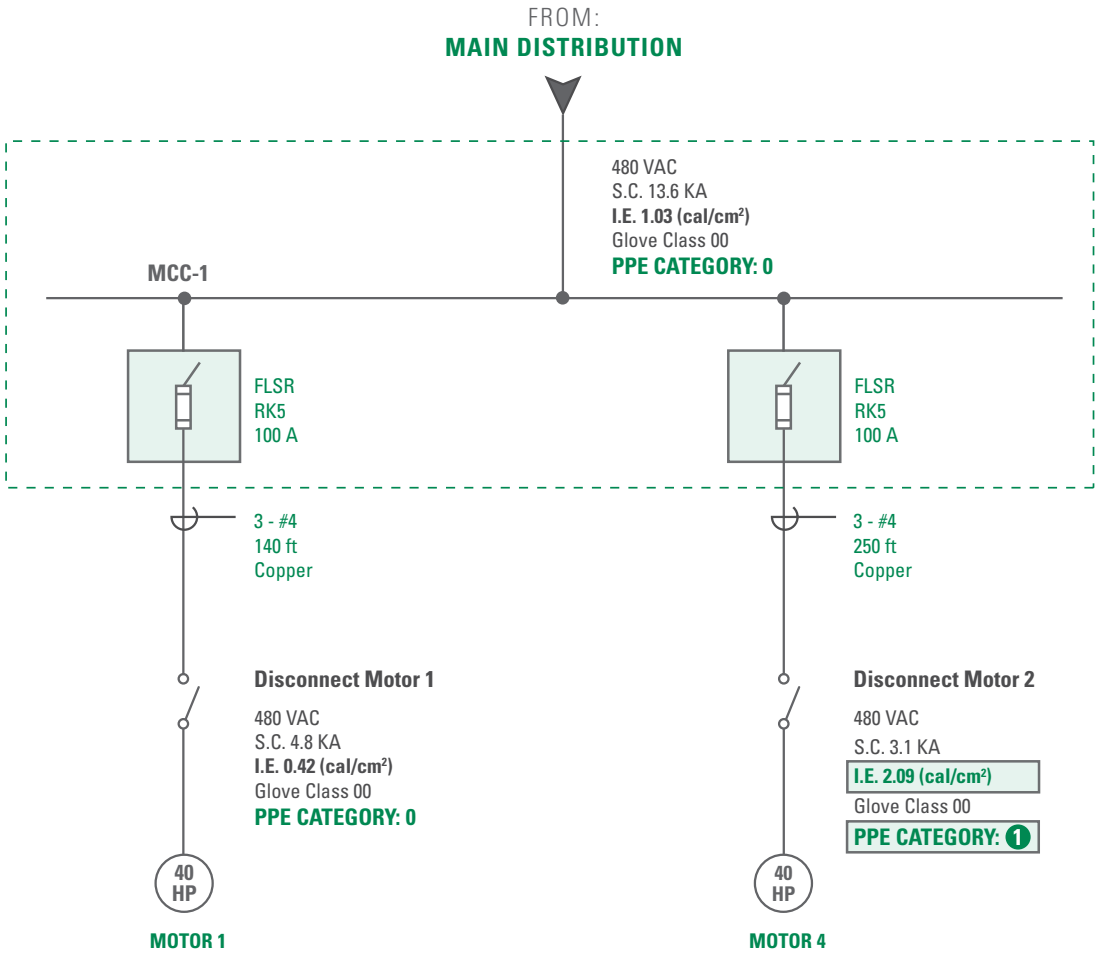


FIGURE 3



same distance from MCC-3 as Motor Disconnect switch #2 is from MCC-1, yet simply replacing RK5 fuses with LLSRK UL Class RK1 fuses reduces the Hazard Risk to Category 0 at Motor Disconnect switch #6. For optimum safety, performance and reliability, always use the most current-limiting UL Class RK1, J or L fuses throughout your electrical distribution system.

In addition to recognizing the effect of reduced fault currents due to circuit impedance, other factors such as large motor loads, alternate power sources during emergency service, or auxiliary generators can affect the available fault currents and opening times of overcurrent protective devices. It is essential to consider all possible power sources and available fault currents from the power utility, on-site power generators, or UPS systems when performing an Arc-Flash Hazard Assessment. Utilize NFPA 70E or CSA-Z462 methods to calculate worst case incident energy scenarios before establishing Hazard Risk Categories and selecting PPE.

MISCONCEPTION 3

There is no need to perform an electrical hazard assessment on equipment rated under 240 volts.

FACT

There are documented cases of Arc-Flash events below 240 volts. To be in compliance, OSHA, NFPA 70E and CSA-Z462 require <u>all</u> equipment be assessed for hazards rated 50 volts or greater.

All equipment operating at 50 volts and higher must be assessed for electrical shock and potential Arc-Flash hazards per OSHA regulations and NFPA 70E and CSA-Z462 standards. IEEE 1584, Guide for Performing Arch-Flash Hazard Calculations published by the Institute of Electrical and Electronic Engineers (IEEE), provides a method of calculating the amount of Arc-Flash incident energy possible at certain working distances from exposed live conductors. IEEE 1584 helps to determine the Hazard Risk Category and PPE

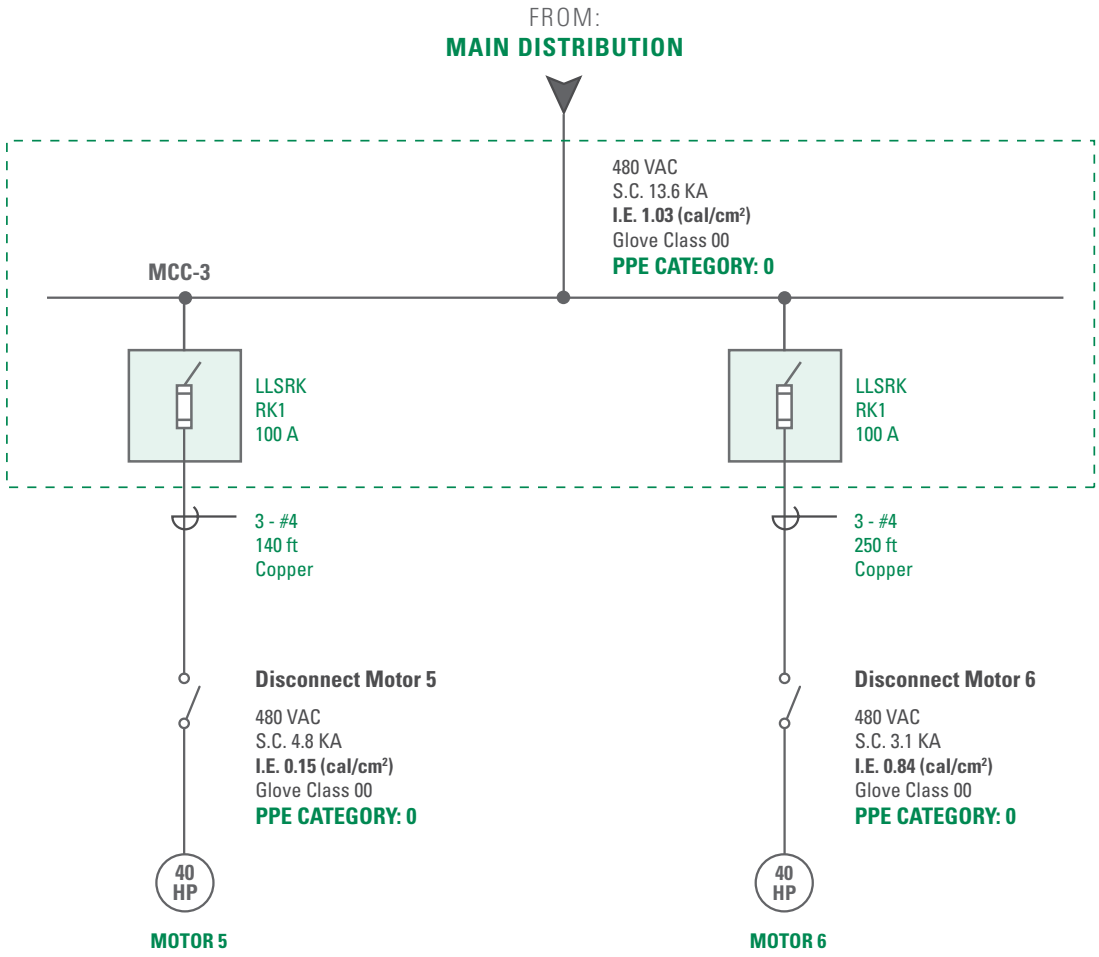
requirements of NFPA 70E and CSA-Z462. NFPA 70E and CSA-Z462 reference the IEEE 1584 calculation methods in their Annexes.

IEEE 1584 states, "Equipment below 240 V need not be considered unless it involves at least one 125 kVA or larger low-impedance transformer in its immediate power supply." This statement refers to the incident energy exposure possible under these conditions as observed during testing. The IEEE statement means that it may not be necessary to calculate incident energy on equipment under 240V fed from a transformer less than 125 kVA, because the available fault current is not high enough to sustain an Arc-Flash and release significant energy. It is important to remember that this statement only refers to incident energy calculations, and does not release employers from the responsibility to assess all equipment operating at 50 volts and higher in the workplace for other electrical hazards, such as shock and overload conditions which may lead to electrocutions, fires, or other hazards.

As stated in OSHA 1910.303(g)(2), OSHA 1910.333, and NFPA 70E Article 110.8(B), all equipment operating at 50 volts and higher must be assessed for electrical shock (establishing protection boundaries and PPE) and potential Arc-Flash hazards (incident energy levels, Hazard Risk Categories, PPE and flash protection boundaries). In addition to OSHA and NFPA 70E requirements, Article 110.16 of the National Electrical Code® (NEC®)[1] requires all equipment that may be worked on while energized to be identified and marked with an Arc-Flash warning label. See Figure 5.

[1] National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Quincy, MA.

FIGURE 4



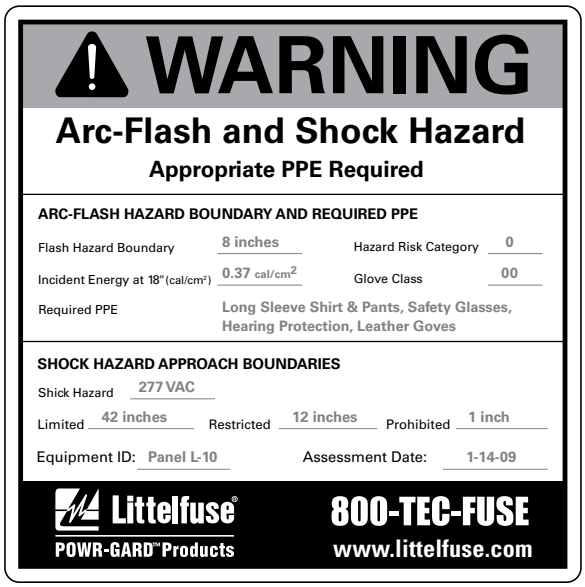


FIGURE 5: Example of NEC 110.16 Warning Label.

MISCONCEPTION 4

There is no need to assess equipment for Arc-Flash Hazards beyond the Motor Control Center.

FACT

Every electrical installation is unique. A thorough assessment must be completed to identify <u>all</u> system components that could affect the power contribution which in turn can alter electrical hazards.

There is a misconception that since a Motor Control Center (MCC) is the final access point of power for motor loads, there is then no need to assess any other loads which are fed from the MCC. This perception can potentially create a very serious and hazardous situation. It is not uncommon to install a motor disconnect switch near a motor controlled by the MCC or for a MCC to feed a 277/480 volt power panel or a 480/120-240 volt transformer that feeds an additional panel. Because of examples such as these and OSHA and NFPA regulations and standards, every panel, switchboard, or industrial control panel that is fed from a Motor Control Center that may be worked on while energized, must be assessed for Arc-Flash and shock hazards. This is particularly important because of the contribution to the available fault current that motor loads can produce at the MCC if a fault were to occur. In addition to potential Arc-Flash hazards, both OSHA 1910.303(g)(2) and NFPA 70E Article 110.8(B)(1) require an electrical shock hazard evaluation for all energized parts operating at 50 volts and higher. As stated in NEC Article 110.16, electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, motor control centers, and disconnect switches or circuit breakers that may be examined, adjusted, serviced, or maintained while energized, must be identified and marked prominently to warn qualified workers of potential electric shock and Arc-Flash hazards.

Summary

It is important to remember that performing an Arc-Flash Hazard Assessment is not an option. Arc-Flash Hazard Assessments are required by NFPA 70E to meet OSHA regulations as a part of an Electrical Hazard Assessment. Arc-Flash Assessments are a serious life safety issue and an essential part of a safe and comprehensive electrical safety program. OSHA and NFPA require employers to identify all potential electrical hazards in the workplace such as shock and Arc-Flash Hazards, reduce or eliminate the hazards, train and qualify their employees, and provide workers with PPE that will protect them from recognized hazards. Knowing what OSHA requires and how NFPA 70E can help meet the requirements will not only keep workers safe, but will also increase productivity and profitability for employers.

Littelfuse, Inc. offers products and services that can reduce Arc-Flash Hazards and help companies meet electrical safety regulations of OSHA, NFPA and CSA-Z462. For more information about electrical safety, Arc-Flash Hazards and Littelfuse POWR-GARD Engineering Services, please contact Technical Support at **1- 800-TEC-FUSE (1-800-832-3873)**, or visit us at **www.littelfuse.com/services**

References

OSHA Regulations 29 CFR 1910.300-399, *Subpart S, "Electrical"* Washington, DC: Occupational Safety and Health Administration, US Department of Labor

NFPA 70E, *Standard for Electrical Safety in the Workplace*, Quincy, MA: National Fire Protection Association, 2009.

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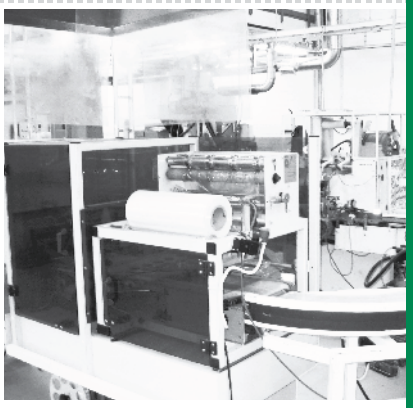

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