ELECTRICAL SAFETY WORKPLACE GUIDELINES

ARE YOU OSHA & NFPA 70E COMPLIANT???

Cementex *Products, Inc.* PROTECTING PEOPLE, PROPERTY AND PRODUCTIVITY

650 Jacksonville Road • P.O. Box 1533 • Burlington • NJ • 08016-1533
phone 800.654.1292 • fax 609.386.8885
email tools@cementexusa.com • web www.cementexusa.com

INTRODUCTION

The first question on this subject typically is, “What’s the deal on this new arc-flash rule?” As with most things, it is best to start at the beginning. First of all, what is NFPA? NFPA is the acronym for the National Fire Protection Association. As an organization, the NFPA has worked closely with OSHA over the years in the formulation of various safety standards. Each maintains representation on the other’s respective committees. NFPA authored the first edition of the 70E standard for electrical safety in the workplace in the year 2000. The standard was subsequently adopted by OSHA and parts of the standard have also since been incorporated into the National Electrical Code.

The code was revised and adopted as an American National Standard on February 11, 2004. The major changes emphasize safe work practices and provide further clarity within the standard. The NFPA’s safety-related work practices place further emphasis on a point which needs to be continually stressed by all—that work on live parts is a last alternative. When all other alternatives fail, as they sometimes may, the standard offers guidelines of best work practices in those circumstances.

The purpose of this document is to provide an abbreviated version of the electrical safety workplace guidelines to help broaden the understanding of the standard regarding the various safety components Cementex Products, Inc. supplies. This is only a general guide to identify who, what, where, when and why for those in the trade who are trying to make some sense of the rules. For additional information or to acquire a complete copy of the standard we encourage you to contact the NFPA directly at One Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101 or online at www.nfpa.org.

BOUNDARIES

According to NFPA 70E, 2004 edition, 130.3(A) states that “for systems rated at 600V or less the default flash protection boundary should be 4.” There are other criteria that may alter this to some extent however, when addressing arc hazard that arc hazard analysis is required any time you may be performing tasks on or near energized systems within the defined limited approach boundary for shock protection.

FLASH HAZARD ANALYSIS

Now that we’ve identified when and where, the next question is how do you perform a flash hazard analysis? There are lots of tools available for you to do this. According to NFPA 70E 2004, Annex D.6 there are three minimum pieces of data required to make the calculations on systems rated at 600V and below:

1) The maximum “bolted fault” three-phase short-circuit current available at equipment and the minimum fault level at which the arc will self sustain.

2) The total protective device clearing time (upstream of the prospective arc location) at the maximum short-circuit current, and at the minimum fault level at which the arc will sustain itself.

3) The distance of the worker from the prospective arc for the task to be performed.

Where or how do you even find this information and once you have found it, what do you do with it? For those with the answers this may not be so hard, but to many people in the workplace today this is where the trouble really begins. For those of you who are dealing with a set of static circumstances you may have engineering staff that can or have already performed a detailed coordination study of your systems. If you do not have the capability to conduct these studies, there are a number of engineering services who may be able to perform these studies for a fee. You or your company can do these calculations on your own with the assistance of a software package. The following two resources can assist you in your arc flash hazard calculations:

- IEEE Guide for Performing Arc Flash Hazard Calculations from the IEEE Standards Association at http://grouper.ieee.org/groups/1584/P%201584%20Archive%20Data/
- Arc Flash Calculator from Cooper-Bussman at http://www.bussmann.com/apen/arcflash/

These programs can provide a very accurate assessment of the hazard, but they require a great deal of detail in order to do so. The IEEE-1584 formula operates upon the input of a whole host of variables, many of which are only likely to be obtained by an electrical engineering professional or an individual very familiar with the design and operation of their network.

There is a segment of the electrical trade that is especially challenged in finding the right mix to address the whole host of safety issues identified in 70E—the electrical contractor. Even though the ultimate responsibility lies with the facility owner/operator, the contractor is *not* off of the hook when it comes to 70E compliance. It is likely that the contractor will encounter situations where a flash hazard analysis is required but has not been performed and they are unable to obtain all of the data required for such detailed analysis. In those cases, we offer a free download, a rudimentary MS-DOS-based program developed at Duke Power that may help in those situations. This Heat Flux Calculator has been around for several years and follows a formula detailed in NFPA 70E (2004), Annex D.7 for calculations greater than 600V. Please note that the values found with this calculator are typically overstated, as it does not take into account all variables that impact the outcome. However, we believe, that it is a valuable tool for those who may need to perform a hazard assessment in circumstances where not all of the variables in the 1584 formula can be obtained.

The following information is needed when running the Heat Flux Calculator:

1. Available Fault Current (amps) – check with the local utility company to determine the power source being delivered to the facility
2. Arc Gap – distance between the differing potentials
3. Supply Voltage – voltage to ground
4. Distance (in inches) from Arc Source to Receiving Surface – Receiving surface is defined as the face and torso of the worker. The distance typically is 18” but must be based upon the work to be performed
5. Number of Cycles (clearing time) – this value will be learned by consulting manufacturer’s specifications for the current limiting device which applies for the environment. Older style fuses may have a value range from 8-20 cycles; 6-12 cycles for circuit breakers.

This program only performs a calculation based upon voltage to ground. For a 3-phase system the final result must be multiplied by a factor of 3 to account for potential arcs between each phase combination. If work is performed within an enclosure the final result must be multiplied by an

additional factor of 2, regardless of voltage. This is referred to as the “box factor” as referenced in NFPA 70E 2004, Annex D.6.2

When operating with this program, as with any other calculation programs, the worst case should be assumed. Running some sample cases with the Heat Flux Calculator also serves to provide a very good illustration of the tremendous value of low peak technology fuses.

EXAMPLE 1 –

Where **AFC** = 30,000 amps
Arc Gap = 1”
Voltage = 480
Distance = 16”
Cycles = 6

The **Heat Flux Calculator** produces a final result measured in **Cal/Cm2** of **1.584**
A 3-phrase system would be 1.584 x 3 = **4.75 Cal/Cm2**

This equates a Hazard Risk Category of **1**, requiring an **FR** shirt and pants or **FR** coverall with a minimum ATPV (arc thermal protective value) of **4 Cal/Cm2**, a **hard hat, safety glasses** and **Class 00 (500V) gloves w/ leather protectors**.

In the next example we will leave all other inputs the same except the cycles for arc duration. Low peak technology fuses typically have a ceiling of **.25 cycles** for clearing times. The heat flux calculator does not make any allowance for fractional entries in this input so we will represent the value with the lowest possible whole number of **1**.

EXAMPLE 2 -

Where **AFC** = 30,000 amps
Arc Gap = 1”
Voltage = 480
Distance = 16”
Cycles = 1

The Heat Flux Calculator produces a final result of **.264 Cal/Cm2**
A 3-phase system would be .264 x 3 = **.79 Cal/Cm2**

In reality this equals less than .25 Cal/Cm2 (.79 x .25 = .20), a Hazard Risk Category **0**. This task then would require only that the worker be wearing 100% natural fiber garments, safety glasses and class 00 gloves with leather protectors.

If we haven’t completely lost you on all this, but you’re still wondering “where’s the easy part of NFPA 70E?,” we’re coming to that now. However, it was necessary to give the foundations first.

PPE MATRIX & HAZARD RISK CATEGORIES

At the conclusion of NFPA 70E, 2004, 130.3(B) there is a provision for a shortcut to the arc flash hazard analysis. It states: "as an alternative, the PPE requirements of 130.7(C)(9) shall be permitted to be used in lieu of the detailed flash hazard analysis approach described in 130.3(A)."

The section of 70E that is cited here is a table of **Hazard Risk Category Classifications** (Table 3-3.9.1 from the 2000 edition). We have reproduced an abbreviated form of this table here, including only those tasks listed in categories up to 600V that indicate a requirement for voltage rated gloves and voltage rated tools in addition to the hazard risk category.

TASK (assumes equipment is energized and work is done within the FPB)	**Hazard/Risk Rated Category**	**V-Rated Gloves**	**V-Rated Tools**
Panelboards Rated < 240V			
Work on energized part, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Panelboards or Switchboards Rated > 240V up to 600V (w/molded or insulated case CBs)			
Work on energized parts, including voltage testing	2*	Y	Y
600V Class MCCs			
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits w/energized exposed parts 120V or below	0	Y	Y
Work on control circuits w/energized exposed parts 120V or greater	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC	3	Y	N
Application of safety grounds, after voltage test	2*	Y	N
600V Class Switchgear (w/power circuit breakers or fused switches)			
Work on energized part, including voltage testing	2*	Y	Y
Work on control circuits w/energized exposed parts 120V or below	0	Y	Y
Work on control circuits w/energized exposed parts 120V or greater	2*	Y	Y
Other 600V Class (277V-600V nominal) Equipment			
Work on energized parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Insertion or removal	2*	Y	N

Now it is clear which hazard risk category is associated with the various tasks to be completed. It could be likely that you recognize these instances where you may be performing any of the tasks

listed here that you are already familiar with at least the voltage glove requirements. You might also be familiar with the voltage rated tool portion of the work procedure. Each of the hazard risk category numbers (ranging from –1 to 4) has a corresponding **Personal Protective Equipment (PPE) Matrix**. This matrix runs roughly as follows:

Hazard Category	Personal Protective Equipment (PPE) Requirements
-1	Will consist of T-shirt, long pants and undergarments all made of untreated 100% natural fibers and safety glasses.
0	Will consist of long sleeve shirt, long pants and undergarments all made of untreated 100% natural fibers and safety glasses
1	Will consist of regular weight, untreated, denim cotton jeans in lieu of FR pants *or* FR pants with a minimum arc rating of 4 Cal/cm2, a long sleeved FR shirt with a minimum arc rating of 4 Cal/cm2, a hard hat and safety glasses. FR treated coveralls with a minimum arc rating of 4 Cal/cm2 may be used as an alternative to FR shirt and pants.
2	Will consist of untreated 100% natural fiber garments *beneath* either: • FR treated long sleeve shirt & FR treated pants w/ a minimum arc rating of 8 Cal/cm2, *or* • FR treated coverall w/ a minimum arc rating of 4 Cal/cm2 and a hard hat, safety glasses or goggles, an arc rated face shield w/ a minimum arc rating of 8 Cal/cm2, hearing protection (ear canal inserts), leather gloves (protectors) and leather work shoes. The arc faceshield must have a wrap-around guarding not only the face, but also the forehead, ears and neck.
2*	Hard hat and faceshield are replaced by an appropriately rated double-layer switching hood, in addition to the prescribed category 2 PPE requirements.
3	Consists of the same requirements as category 2*, but with the minimum arc rating of 25 Cal/cm2
4	Consists of the same requirements as category 2*, but with the minimum arc rating of 40 Cal/cm2

NFPA 70E, 2004 does have one more addition which is not technically part of its requirements, but typically requires additional clarification–**Annex H Simplified, Two-category, FR Clothing System.** In this annex, protective clothing is broken down into two categories: Everyday Work Clothing and Electrical "Switching" Clothing, which are also referred to as "daily wear" and "task specific wear." In short Annex H advises the use of the hazard category 1 or 2 PPE Matrix on systems operating at less than 1000V, with the exception of the insertion/removal of motor starter "buckets," power circuit breakers from switchgear cubicles or the removal of bolted covers from switchgear. For those tasks and work on systems operating above 1000V the category 3 or 4 PPE matrix will apply.

PPE MATRIX & HAZARD RISK CATEGORIES

FR clothing and Arc Flash Protective Suits are manufactured in the following incremental Arc Thermal Protective Values (APTV): 6 Cal, 11 Cal, 15 Cal, 25 Cal, 40 Cal, 50 Cal, 65 Cal, and 100 Cal.

The good news is the hard part is over! The balance of the 70E standard is actually a reiteration and reinforcement of OSHA standards that have been around since 1994. The 2004 edition of 70E identifies these requirements for other protective equipment under 130.7(D)(1). This section is nearly identical to the earlier OSHA standard, parts of which follow here.

1910.335 SAFEGUARDS FOR PERSONNEL PROTECTION:

(a) *Use of protective equipment. (1) Personal protective equipment. (i)* Employees working in areas where there are potential electrical hazard **shall be provided with, and shall use**, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

(ii) Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested, as required by 1910.137.

(iii) If the insulating capacity of protective equipment may be subject to damage during use, the insulating material shall be protected.

(iv) Employees shall wear non-conductive head protection wherever there is a danger of head injury from electrical shock or burns due to contact with exposed energized parts.

(v) Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electrical arcs or flashes or from flying objects resulting from an electrical explosion.

(2) *General protective equipment and tools.* (i) When working near exposed energized conductors or circuit parts, each employee **shall use insulated tools or handling equipment**, if the tools or handling equipment might make contact with such conductors or parts.

Not only does 70E expand upon the earlier OSHA requirements, you can see that these OSHA standards were at least in part a precursor to what we find in 70E today. This document does not address each and every one of these categories in detail, the current NFPA and OSHA standards specify the following materials for electrical safe work practices:

1. Insulated gloves – Alone or in kit form w/ storage bag and protectors in classes 00(500v), 0(1000V), 1(7.5Kv) & 2(17Kv)
2. Insulated Hand Tools – Individually or in kit form, all tested to 10Kv and rated for 1000V, conforming to ASTM F-1505 standard
3. Insulating Blankets – Available in classes 0,2 & 4
4. Insulating Protective Shielding – Available in classes 0 & 1, in PVC or rubber, widths of 3’ or 4’ in roll form 30-50’.
5. Insulating Sleeves - Available in classes 0,1 & 2
6. Switchboard Matting – Available in classes 1,2,3 & 4 in 3’ or 4’ widths up to 75’

These materials are in addition to those already identified in the Arc Flash PPE Matrix. Some or all of these may apply to what you have to do to be NFPA 70E/OSHA compliant. More importantly, these materials are available so you can **WORK SAFE**. **ALWAYS DE-ENERGIZE WHENEVER POSSIBLE**. When you can’t, or when it is too close follow these procedures. It could save a life, your equipment and likelya lot of trouble you just don’t need!

If you would like more information on this subject or want some assistance in ascertaining your needs, please contact us at:

ELECTRICAL SAFETY WORKPLACE GUIDELINES

ARE YOU OSHA & NFPA 70E COMPLIANT ???