




<b>Department of Health &amp; Safety Guideline</b>		<b>GUIDELINE NO.</b>	FCX – 03
		<b>REVISION NO.</b>	2
		<b>SUPERSEDE</b>	
<b>Arc Flash PPE Protection</b>		<b>TASK CLASSIFICATION</b>	 Highly Critical
			 Critical
			 Non-Critical
<b>APPROVAL DATE</b> FEBRUARY 9, 2010	<b>ORIGINAL DATE</b> – OCTOBER 30, 2008	<b>RELEVANT SOPS</b> – N/A	

### 1. PURPOSE

Establish minimum requirements for the use of approved personal protective equipment where there is an Arc Flash and/or Shock Hazard potential for all operations and contractors working at FMI locations.

*Note:* This guideline is not intended to lessen more stringent requirements that may already be in place

### 2. SCOPE

This guideline applies to FMI operating properties and contractors.

### 3. GENERAL INFORMATION

Effective January 2009, NFPA/NEC Standards will require “short circuit studies and arc flash hazard labeling” of all electrical equipment. FMI is going one step further to require short circuit studies utilizing software programs such as SKM, Easy Power, and ETAP which will enable users to calculate arc flash zones/distances and provide the category of PPE required for working within these zones.

### 4. PROCEDURES/REQUIREMENTS

- These requirements should be followed if work requires that circuits be energized. It is not intended for work performed on de-energized equipment.
- Always attempt to have the circuits de-energized when working on or near them.
- De-energized circuits should be “locked, tagged and tried out” (LOTOTO) per local safety policy.
- Work shall be performed only by qualified employees.
- Arc flash and shock hazard analysis should be performed with appropriate warning labels attached.
- All arc flash analyses should be validated by an electrical engineer.
- All personnel inside the designated flash zone should wear the appropriate **flame resistant** clothing and PPE prescribed on the arc flash label.
- Guarding should be provided to demarcate the flash zone and restrict access to unauthorized personnel prescribed on the arc flash label.
- Personnel not wearing appropriate required PPE required for arc flash work should remain outside the defined flash zone as prescribed by the arc flash label.
- Where protective barriers/doors do not exist, or must be left open and/or personnel are required to be in an electrical compartment while switching or investigating energized circuits, appropriate **flame resistant** clothing and PPE should be worn prescribed on the arc flash label. This does not preclude the use of other required PPE requirements for the job and/or facility.
- **Flame resistant** clothing worn by personnel should be the required arc thermal rating for combined value of layered clothing per NFPA 70E Table 130.7(C) (11).
- Ensure that all local safety/standard operating procedure, job safety analysis or other procedures are reviewed and followed before starting each task.

- Cleaning and inspection procedures for PPE should be established per regulation and manufacturer's recommendation to ensure they are ready for use. Laundering of **flame resistant** clothing by a reputable service provider is recommended. This ensures proper repair and correct washing techniques to maintain the integrity of the **flame resistant** properties of the clothing.
- Caution should be exercised to ensure limitations of the category 4 full flash suits and hoods (moon suits) are understood by employees working in the flash arc zones. Limitations may include but are not limited to; visibility, bulkiness, working in tight quarters, heat and humidity. These limitations should be considered when developing procedures for arc flash work related tasks.
- Employees involved in working in or around Arc Flash situations listed in this requirement should be trained thoroughly on the requirements of this guideline with at least an annual review. This training should also include related safety procedures for arc flash labeled equipment they will be working on.

### Examples:

When possible all equipment circuits to be worked on should be de-energized and "locked, tagged and tried out" (LOTOTO). In circumstances where this is not possible and there is a possibility of exposure to live conductors while switching or working on cabinets with open doors, etc., the use of qualified personnel, appropriate PPE and safety procedures is critical. **Proper labeling based on NFPA/NEC guidelines will prescribe the proper PPE and Arc Flash Zones and must be affixed to equipment to alert employees who may work on or around exposed voltages.**

The following are **examples of jobs** for the 5 hazard/risk categories utilizing the charts and labels on Appendixes 1 & 2:

Note: Both larger and smaller available short circuit currents could result in different arc flash energies for the listed job examples. Studies should be performed to identify actual energies with labels posted to provide a specific warning of the hazard.

### Arc Flash Clothing Risk Categories:

#### Category 0

- Resetting a 600 volt class motor starter overload using an external reset button with the door closed and secure.
- Operating a 600 volt class disconnect with the door closed and secure.
- Reading a panel meter located on the closed and secure door of a 2.3 – 7.2 kV breaker.
- PPE: Untreated Cotton + Hearing Protection

#### Category 1

- Resetting a 600 volt class motor starter overload using the reset button on the motor starter with the door open.
- Operating a 600 volt class disconnect with the door open.
- PPE: FR Shirt & Pants + **Approved Face Shield** + Leather Work Shoes + Hearing Protection

#### Category 2

- Working on the energized control circuit of a 600 volt class motor starter.
- Removal of bolted covers to expose bare energized parts of 600 volt class equipment.
- Insertion or removal (racking) of a 2.3 – 7.2 kV motor starter with door closed and secure.
- PPE: FR Shirt & Pants + **Approved Face Shield** + Appropriate Gloves + Leather Work Shoes + Hearing Protection

### Category 3

- Insertion or removal of a 600 volt class motor starter bucket within the MCC.
- Opening hinged covers to expose bare energized parts of 2.3 – 7.2 kV class equipment.
- PPE: FR Shirt & Pant + Multi Layer Flash Suit + Appropriate Gloves + Leather Work Shoes (Boots) + Hearing Protection

### Category 4

- Breaker operation on 1 kV and above equipment with the door open.
- Insertion or removal (racking) of a 1 kV and above breaker with the door open.
- Work on energized parts including voltage testing on 1 kV and above equipment.
- PPE: FR Shirt & Pant + Multi Layer Flash Suit + Appropriate Gloves + Leather Work Shoes (Boots) + Hearing Protection

For questions concerning the implementation of this procedure, please contact the FMI ESST Team.

## **5. REFERENCES**

NFPA 70E Table 130.7 (C) (9) Hazard Risk Category Classification  
NFPA 70E Table 130.7 (C) (10) Protective Clothing and Personal Protective Equipment (PPE)  
NFPA 70E Table 130.7 (C) (11) Protective Clothing Characteristics  
FMI ESST (Electrical Safety Steering Team) Guidebook



## Appendix 1



NFPA 70E 2009 Edition  
Table 130.7(C) (11) Protective Clothing Characteristics



Hazard / Risk Category	Clothing Description	Required Minimum Arc Rating of PPE [J/cm <sup>2</sup> (cal/cm <sup>2</sup> )]
0	Non-melting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd <sup>2</sup>	N/A
1	Arc-rated FR shirt and FR pants or FR coverall	16.74 (4)
2	Arc-rated FR shirt and FR pants or FR coverall	33.47 (8)
3	Arc-rated FR shirt and pants or FR coverall, and arc flash Suite selected so that the system arc rating meets the required minimum.	104.6 (25)
4	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum.	167.36 (40)



Note: Arc rating is defined in Article 100 and can be either ATPV or E<sub>BT</sub>. ATPV is defined in ASTM F 1959, *Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing*, as the incident energy on a material or multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree burn based on the Stoll curve, cal/cm<sup>2</sup>. E<sub>BT</sub> is defined in ASTM F 1959 as the incident energy on a material or material system that results in a 50% probability of breakopen. Arc Rating is reported as either ATPV or E<sub>BT</sub>, whichever is the lower value.



Appendix 2



 <h1 style="margin: 0;">DANGER</h1>	
<small>SKM Modeled      Prepared on: 01/25/10</small>	
	<h2 style="margin: 0;">Arc Flash and Shock Hazard Appropriate PPE Required</h2>
<p><b>10 inches</b> <b>0.35 cal/cm<sup>2</sup></b></p> <p><b>Category 0</b></p>	<p>Flash Hazard Boundary Flash Hazard at 18 inches</p> <p>Untreated Cotton + Hearing Protection</p>
Shock Hazard Information	
<p><b>480 VAC</b> <b>00</b> <b>42 inches</b> <b>12 inches</b> <b>1 inches</b></p>	<p>Shock Hazard when cover is removed</p> <p>Glove Class</p> <p>Limited Approach</p> <p>Restricted Approach</p> <p>Prohibited Approach</p>
<p><b>BUS: Example Bus 0</b></p>	

 <h1 style="margin: 0;">DANGER</h1>	
<small>SKM Modeled      Prepared on: 01/25/10</small>	
	<h2 style="margin: 0;">Arc Flash and Shock Hazard Appropriate PPE Required</h2>
<p><b>37 inches</b> <b>3.8 cal/cm<sup>2</sup></b></p> <p><b>Category 1</b></p>	<p>Flash Hazard Boundary Flash Hazard at 18 inches</p> <p>FR Shirt &amp; Pants + Approved Face Shield + Leather Work Shoes + Hearing Protection</p>
Shock Hazard Information	
<p><b>480 VAC</b> <b>00</b> <b>42 inches</b> <b>12 inches</b> <b>1 inches</b></p>	<p>Shock Hazard when cover is removed</p> <p>Glove Class</p> <p>Limited Approach</p> <p>Restricted Approach</p> <p>Prohibited Approach</p>
<p><b>BUS: Example Bus 1</b></p>	

 <b>DANGER</b>	
	SKM Modeled <span style="float: right;">Prepared on: 01/25/10</span>
<b>Arc Flash and Shock Hazard Appropriate PPE Required</b>	
<p><b>54 inches</b> <b>7.2 cal/cm<sup>2</sup></b></p> <p><b>Category 2</b></p>	<p>Flash Hazard Boundary Flash Hazard at 18 inches</p> <p><b>FR Shirt &amp; Pants + Approved Face Shield + Appropriate Gloves + Leather Work Shoes + Hearing Protection</b></p>
Shock Hazard Information	
<p><b>480 VAC</b> <b>00</b> <b>42 inches</b> <b>12 inches</b> <b>1 inches</b></p>	<p>Shock Hazard when cover is removed</p> <p>Glove Class</p> <p>Limited Approach</p> <p>Restricted Approach</p> <p>Prohibited Approach</p>
<b>BUS: Example Bus 2</b>	

 <b>DANGER</b>	
	SKM Modeled <span style="float: right;">Prepared on: 01/25/10</span>
<b>Arc Flash and Shock Hazard Appropriate PPE Required</b>	
<p><b>79 inches</b> <b>14 cal/cm<sup>2</sup></b></p> <p><b>Category 3</b></p>	<p>Flash Hazard Boundary Flash Hazard at 18 inches</p> <p><b>FR Shirt &amp; Pant + FR Coverall + Approved Face Shield + Appropriate Gloves + Leather Work Shoes + Hearing Protection</b></p>
Shock Hazard Information	
<p><b>480 VAC</b> <b>00</b> <b>42 inches</b> <b>12 inches</b> <b>1 inches</b></p>	<p>Shock Hazard when cover is removed</p> <p>Glove Class</p> <p>Limited Approach</p> <p>Restricted Approach</p> <p>Prohibited Approach</p>
<b>BUS: Example Bus 3</b>	

 <h1 style="margin: 0;">DANGER</h1>	
	<p>SKM Modeled      Prepared on: 01/25/10</p> <h2 style="margin: 0;">Arc Flash and Shock Hazard Appropriate PPE Required</h2>
<p><b>117 inches</b> <b>26 cal/cm<sup>2</sup></b></p> <p><b>Category 4</b></p>	<p>Flash Hazard Boundary Flash Hazard at 18 inches</p> <p><b>FR Shirt &amp; Pant + Multi Layer Flash Suit + Appropriate Gloves + Leather Work Shoes + Hearing Protection</b></p>
Shock Hazard Information	
<p><b>480 VAC</b> <b>00</b> <b>42 inches</b> <b>12 inches</b> <b>1 inches</b></p>	<p>Shock Hazard when cover is removed</p> <p>Glove Class</p> <p>Limited Approach</p> <p>Restricted Approach</p> <p>Prohibited Approach</p>
<p><b>BUS: Example Bus 4</b></p>	

 <h1 style="margin: 0;">DANGER</h1>	
	<p>SKM Modeled      Prepared on: 01/25/10</p> <h2 style="margin: 0;">Arc Flash and Shock Hazard Appropriate PPE Required</h2>
<p><b>196 inches</b> <b>60 cal/cm<sup>2</sup></b></p> <p><b>Dangerous!</b></p>	<p>Flash Hazard Boundary Flash Hazard at 18 inches</p> <p><b>No FR Category Found</b></p>
Shock Hazard Information	
<p><b>480 VAC</b> <b>00</b> <b>42 inches</b> <b>12 inches</b> <b>1 inches</b></p>	<p>Shock Hazard when cover is removed</p> <p>Glove Class</p> <p>Limited Approach</p> <p>Restricted Approach</p> <p>Prohibited Approach</p>
<p><b>BUS: Example Bus 5</b></p>	