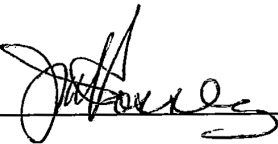


**CALIFORNIA STATE UNIVERSITY  
AT  
LOS ANGELES**

**ELECTRICAL SAFETY PROGRAM**

**SEPTEMBER 2009**

**PROGRAM APPROVAL AND AUTHORIZATION**



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James M. Rosser, President

9-28-09

Date

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## **1.0 PURPOSE**

California State University Los Angeles has adopted a policy to protect employees and the campus community from electrical hazards. It focuses mainly on staff who may encounter electrical hazards during their work routine and specifically for those performing electrical work. Risk Management & Environmental Health and Safety (RM/EHS) will proactively coordinate training, investigative, and corrective measures with specific departments. This program addresses safe work practices, training, and protective equipment. It does not, however, cover all requirements especially related to installation methods and procedures specifically learned through an electrician apprenticeship program.

## **2.0 SCOPE**

This program applies to all Qualified and Non-Qualified Personnel working on or near energized electrical equipment or systems (50 volts or more), their supervisors and managers, Planning and Construction, RM/EHS, and Facilities Services due to their involvement in electrical safety. This Program is not intended to address all of the regulatory requirements or applicable guidelines, which can be found in CCR, Title 8, Electrical Safety Orders.

## **3.0 ORGANIZATIONS AFFECTED**

The following departments are affected by these procedures:

### Facilities Services

- Building Service Engineers

- Plumbers

- Mechanics

- Auto Shop

- Refrigeration

- Electrical Shop

### Facilities Planning and Construction

- Independent Contractors

### Engineering & Technology Maintenance

- Theater Maintenance Personnel

- Housing Maintenance

## 4.0 REFERENCES

California Code of Regulations (CCR), Title 8, §2299 – 2974

Code of Federal Regulations, Title 29, §1910 & 1926

National Fire Protection Association (NFPA), 70E Standard for Electrical Safety in the Workplace, 2004 Edition

## 5.0 DEFINITIONS

**Arc Flash Hazard** – a dangerous condition associated with the possible release of energy caused by an electric arc.

**Arc Flash Hazard Analysis** – a study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash protection boundary, and the appropriate levels of PPE.

**Arc Flash Protection Boundary** – an approach limit (distance) from an energized part within which a person could receive a second degree burn if an arc would occur.

**Arc Flash Suit** – a complete FR clothing and equipment system that covers the entire body, except for the hands and feet. This includes pants and jacket, and beekeeper-type hood fitted with a face-shield.

**Arc Rating** – the value attributed to materials describing their protective performance when exposed to an arc flash (in cal/cm<sup>2</sup>).

**Barricade** – a physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning about and to limit access to a hazardous area

**De-energized** – free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth

**Electrical Equipment or Systems** – equipment or systems operating at 50 volts or more

**Electrical Hazard** – a dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or blast

**Energized Parts** – electrically connected to or having a source of voltage

**Flame Resistant (FR)** – the property of a material which prevents, terminates, or inhibits combustion when a source of ignition is applied

**Flash Protection Boundary** – an approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur

**High Risk Operations** – OSHA considers contact with over 300 volts a high risk operation

**High Voltage Electrical Work** – work on associated electrical conductors and equipment operating at or intended to operate at a sustained voltage of more than 600 volts between conductors

**Limited Approach Boundary** – an approach limit at a distance from an exposed live part within which a shock hazard exists

**Live Parts** – exposed energized electrical conductor or circuit part

**Non-Qualified Personnel** – personnel who may be exposed to electrical hazards or work within limited approach boundaries but who are not authorized as Qualified Personnel or Qualified Electrical Workers

**Personal Protective Equipment (PPE)** – includes, but is not limited to electrically rated or FR head protection, eye and face protection, gloves, sleeves, leather protectors, footwear, work clothing, raingear, hot sticks with fittings, personal safety grounds, barriers, mats, insulated blankets, insulated tools, and face protective products

**Prohibited Approach Boundary** – an approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part

**Qualified Electrical Worker** – a qualified person with a minimum of two years of training and experience with high-voltage circuits and equipment under the supervision of another qualified electrical worker and who has demonstrated by performance familiarity with the work to be performed and the hazards involved. They must be able to distinguish exposed live parts, determine their nominal voltage, maintain approach distances, properly use energy isolation procedures and special precautionary techniques, and properly use PPE, insulating and shielding materials, insulated tools, grounding devices, and test equipment.

**Qualified Personnel** – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved

**Restricted Approach Boundary** – an approach limit from an exposed live part exposing Qualified Personnel to increased risk of shock

## 6.0. RESPONSIBILITY

### 6.1. RM/EHS shall:

- 6.1.1. Develop and implement a written electrical safety program with Facilities Services consultation.
- 6.1.2. Implement a permit program for all work on live parts (other than testing, troubleshooting and voltage measuring by Qualified Personnel) with Facilities Services.
- 6.1.3. Develop baseline training for Non-Qualified Personnel with Facilities Services.
- 6.1.4. Ensure that the program elements are incorporated into contractor safety requirements in consultation with Facilities Services and Planning & Construction.

### 6.2. Facilities Services shall:

- 6.2.1. Identify Qualified Personnel, Qualified Electrical Workers, and Non-Qualified Personnel.
- 6.2.2. Identify high risk operations and locations where work on energized parts could occur over 300 volts.
- 6.2.3. Complete a written electrical safety program with RM/EHS.
- 6.2.4. Implement a permit program for work on live parts over (other than testing, troubleshooting, and voltage measuring by qualified personnel) with RM/EHS.
- 6.2.5. Provide baseline training for Qualified Personnel, Qualified Electrical Workers, and Non-Qualified Personnel with RM/EHS.
- 6.2.6. Identify and provide appropriate personal protective equipment (PPE) for Qualified Personnel and Qualified Electrical Workers, and require its use.
- 6.2.7. Provide for and monitor the use of PPE and other protective safety devices.
- 6.2.8. Complete an arc flash hazard analysis and update as the system requires.
- 6.2.9. Ensure that Program elements are incorporated into the contractor safety requirements, in consultation with RM/EHS.

- 6.2.10. Label all equipment and components on campus.
- 6.2.11. Identify limited, flash protection, prohibited and restricted approach boundaries.
- 6.2.12. Ensure that consultants provide training on arc flash hazard analysis to all electrical workers.
- 6.2.13. Determine the frequency for reassessing electrical equipment and components.
- 6.2.14. Provide surveillance of the Program elements including training, hazard assessment and labeling on an ongoing basis.

6.3. Qualified Personnel and Qualified Electrical Workers shall:

- 6.3.1. Ensure that Qualified Electrical Workers are the only employees who may perform high voltage work (600 volts or more).
- 6.3.2. Ensure that two Qualified Electrical Workers are present during high voltage work (600 volts or more).
- 6.3.3. Establish limited approach boundaries with barricades, which establishes flash protection boundaries.
- 6.3.4. Establish prohibited approach boundaries.
- 6.3.5. Establish restricted approach boundaries.

6.4. Non-Qualified Personnel shall:

- 6.4.1. Avoid limited approach boundaries unless supervised by Qualified Personnel or a Qualified Electrical Worker, and, always wear flash protection, while maintaining prohibited, and restricted approach boundaries.

6.5. Project Managers (Planning & Construction and Facility Services) shall:

- 6.5.1. Instruct contract employers of known hazards covered by Cal/OSHA and NFPA 70E related to their work on campus and that their employees might not recognize.
- 6.5.2. Provide contract employers with information on CSULA electrical installations so they can adequately assess Cal/OSHA and NFPA safety requirements [Complete Appendix "A" High Voltage Switching Procedures].

- 6.5.3. Report safety violations to contract employer.
- 6.5.4. Ensure contract employers doing electrical work have electrical safety programs addressing high voltage work, lockout/tag-out, and performing live work on/near energized parts.
- 6.5.5. Require a subcontractor pre-qualification. Examine Injury and Illness Prevention Programs, insurance loss runs, and three-year history of Cal OSHA citations.
- 6.5.6. Provide a copy of the High Voltage Switching Procedures & Acknowledgement of Receipt [See Appendix "A"].
- 6.5.7. Contractors will return/submit updated changes to any and all drawing(s) at completion of the job.
- 6.5.8. Require at the completion of the job that all impacted panels will be recalibrated and panel markings revised to reflect changes. Notification to Facilities Services of any changes should occur.

6.6. Contract Employer shall:

- 6.6.1. Instruct their employees of hazards reported by CSULA.
- 6.6.2. Enforce safe work practice requirements, as required by regulation and by CSULA program guidelines.
- 6.6.3. Advise the CSULA Project Manger of:
  - 6.6.3.1. Unique hazards presented by contract employer's work.
  - 6.6.3.2. Unanticipated hazards found during the contract employer's work.
  - 6.6.3.3. Corrective actions taken to correct safety violations.

## **7.0 TRAINING**

Training represents one of the most important aspects of any safety program. Electrical safety training should occur as either classroom or on-the-job training. However, the specialized nature of the field requires that an electrician or someone working in the electrical field conduct a large portion of the training. RM/EHS can assist in coordinating the training with the specialist and can cover many non-specialty training elements, such as: regulatory requirements, injury potential, emergency procedures, Non-Qualified Personnel training, and basic elements of training for Qualified Personnel and Qualified Electrical Workers. Any organizations conducting this training must



document all employees' training and maintain those records throughout their employment.

#### 7.1. Non-Qualified Personnel Training Elements.

- Limited approach boundaries; See table (#1).
- Types of electrical injuries.
- Recognition of electrical hazards.

#### 7.2 Qualified Personnel Training Elements.

- Completion of all training elements for Non-Qualified Personnel.
- Specific hazards associated with electrical energy and how they relate to injury potential and injury types.
- Safety-related work practices.
- Procedural requirements to determine voltage of exposed live parts and to differentiate them from other parts.
- Selection of appropriate voltage detectors, demonstration of their use to verify the absence of voltage, and information on their limitations.
- Barricade requirements.
- Limited approach, flash protection, prohibited and restricted approach boundaries requirements.
- Lockout/Tagout procedures.
- Emergency procedures.
- Methods to release victims from contact with exposed energized electrical conductors or circuit parts.
- Recognizing signs and symptoms of electric shock, heart fibrillation, electric burns, and proper first aid protocols for these conditions.
- CPR training.
- Task specific hazards, precautions, and arc flash potential. Tasks performed less than once per year require re-training prior to performing the task. Refer to Job Safety Analysis (JSA) for specific task.
- Use of PPE, insulating and shielding materials, and insulated tools and test equipment based on the hazard.

#### 7.3. Qualified Electrical Worker Training Elements.

- Completion of all training elements for Qualified Personnel.
- Minimum of two years of training and experience with high-voltage circuits and equipment.
- Demonstration by performance familiarity with the work to be performed and the hazards involved. Tasks performed less than once per year require re-training prior to performing the task.

#### 7.4. Retrain employees on any required element when:

- They are not complying with safety-related work practices.
- Changing work conditions require safety-related work practices different than those that are normally used.
- The employee must use safety-related work practices not normally used during regular job duties.

7.5. Completion of arc flash analysis triggers the following training:

- A two-day training session for Qualified Personnel and Qualified Electrical Workers, supervisors, and safety personnel.
- A half-day session for Non-Qualified Personnel and management.

## **8.0 PROGRAM ELEMENTS**

8.1. Hazard/Risk Evaluation – Employees shall identify the hazards through a risk evaluation process before they work within Limited Approach Boundaries or with any electrical hazards.

8.2. Electrical Safety Auditing – Management shall audit all elements of the electrical safety program at a risk-based frequency to ensure that the principles and procedures are being followed. Management shall make the appropriate program revisions based on those observations and/or conclusions.

8.3. Operation Verification – Employees performing work under these standards shall verify operation of the test instrument before and after test instruments are used for the testing of voltage on conductors or circuit parts operating at 50 volts or more.

8.4. Lockout/Tagout (LOTO) - Hazardous energy appears in the workplace in the form electrical, mechanical, pneumatic, hydraulic and thermal energy and includes chemical, water, steam and gaseous energy systems. LOTO procedures prevent the unexpected energizing, start up or release of stored energy that could cause injury to employees working on said equipment. The University has established a LOTO Program to safeguard employees from hazardous energy while they are performing service or maintenance on machines and equipment. The purpose of this program is to identify the practices and procedures necessary to shut down and LOTO machines and equipment. It requires that employees receive training in the LOTO program and requires that periodic inspections be conducted to maintain and enhance the program.

8.5. Personal Protective Equipment (PPE)

8.5.1. PPE used for electrical work shall comply with the standards given in Table 130.7 (C) (8) of NFPA 70 E, Standard for Electrical Safety in the Workplace [See Table (2)].

8.5.2. A flash hazard analysis shall form the basis of PPE selection or NFPA 70E Table 130.7 (C) (10) [See Table (2)].

8.5.3. Qualified Personnel normal work clothing shall include:

- FR long-sleeve shirt (minimum arc rating of 4) worn over an untreated cotton T-shirt with FR pants (minimum arc rating of 8);
- or, FR coveralls (minimum arc rating of 4) worn over untreated cotton T-shirt (or an untreated natural fiber long sleeve-shirt) with untreated natural fiber pants.

8.5.4. Qualified Personnel and Qualified Electrical Workers shall not wear non-FR clothing that will ignite or melt when exposed to an arc flash.

8.6. Approach Boundaries to Live Parts (NFPA 70E, 130.2)

8.6.1. A properly trained employee shall not approach or take any conductive object closer to exposed live parts (operating at 50 volts or more) than the Restricted Approach Boundary listed in table 1 (below) unless ANY of the following apply:

- The properly trained employee is insulated or guarded from the live parts operating at 50 volts or more and no un-insulated part of the employee's body crosses the Prohibited Approach Boundary listed in Table (#1)., or
- The live part operating at 50 volts or more is insulated from the employee and from any other conductive object at a different potential.

8.6.2. Approach by untrained persons: When an untrained person is working at or close to the Limited Approach Boundary, the supervisor in charge of the job shall advise the untrained person of the electrical hazard.

**TABLE 1****Approach Boundaries to Live Parts for Shock Protection**

Nominal System Voltage Range, Phase to Phase	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary
	For Exposed Movable Conductor	For Exposed Fixed Circuit Part		
Less Than 50	None	None	None	None
50 to 300	10 ft. 0 in.	3 ft. 6 in.	Avoid Contact	Avoid Contact
301 to 750	10 ft. 0 in.	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.
751 to 15kV	10 ft. 0 in.	5 ft. 0 in.	2 ft. 2 in.	0 ft. 7 in.

**TABLE 2****Hazard / Risk Category Classifications**

<b>Task (Assumes Equipment Is Energized, and Work Is Done Within the Flash Protection Boundary)</b>	<b>Hazard / Risk Category</b>	<b>V-rated Gloves</b>	<b>V-rated Tools</b>
<b>Panelboards Rated 240 V and Below – Notes 1 and 3</b>			
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
<b>Panelboards or Switchboards Rated &gt;240 V and up to 600 V (with molded case or insulated case circuit breakers) — Notes 1 and 3</b>			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
<b>600 V Class Motor Control Centers (MCCs) — Notes 2 (except as indicated) and 3</b>			
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter “buckets” from MCC — Note 4	3	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N

TABLE 2 (CONTINUED)

Task (Assumes Equipment Is Energized, and Work Is Done Within the Flash Protection Boundary)	Hazard / Risk Category	V-Rated Gloves	V-Rated Tools
<b>600 V Class Switchgear (with power circuit breakers or fused switches) — Notes 5 and 6</b>			
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2*	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open	3	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	3	N	N
Opening hinged covers (to expose bare, energized parts)	2	N	N
<b>Other 600 V Class (277 V through 600 V, nominal) Equipment — Note 3</b>			
<i>Lighting or small power transformers (600 V, maximum)</i>	--	--	--
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
<i>Revenue meters (kW-hour, at primary voltage and current)</i>	--	--	--
Insertion or removal	2*	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N

TABLE 2 (CONTINUED)

Task (Assumes Equipment Is Energized, and Work Is Done Within the Flash Protection Boundary)	Hazard / Risk Category	V-Rated Gloves	V-Rated Tools
<b>NEMA E2 (fused contactor) Motor Starters, 2.3 Kv Through 7.2 kV</b>			
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2*	N	N
Work on energized parts, including voltage testing	3	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	3	Y	Y
Insertion or removal (racking ) of starters from cubicles, doors open	3	N	N
Insertion or removal (racking) of starters from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
<b>Metal Clad Switchgear, 1 kV and Above</b>			
CB or fused switch operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	4	N	N
Work on energized parts, including voltage testing	4	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized parts >120 V, exposed	4	Y	Y
Insertion or removal (racking ) of CBs from cubicles, doors open	4	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized parts)	3	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N

TABLE 2 (CONTINUED)

Task (Assumes Equipment Is Energized, and Work Is Done Within the Flash Protection Boundary)	Hazard / Risk Category	V-Rated Gloves	V-Rated Tools
<b>Other Equipment 1 kV and Above</b>			
<i>Metal clad load interrupter switches, fused or unfused</i>	--	--	--
Switch operation, doors closed	2	N	N
Work on energized parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	N	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

Note:

*V-rated Gloves* are gloves rated and tested for the maximum line-to-line voltage upon which work will be done.

*V-rated Tools* are tools rated and tested for the maximum line-to-line voltage upon which work will be done.

2\* means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category 2 requirements of Table 130.7(C)(10).

Y = yes (required)

N = no (not required)

Notes:

1. 25 kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
2. 65 kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
3. For  $\leq$  10 kA short circuit current available, the hazard/risk category required may be reduced by one number.
4. 65 kA short circuit current available, 0.33 second (20 cycle) fault clearing time.
5. 65 kA short circuit current available, up to 1.0 second (60 cycle) fault clearing time.
6. For  $\geq$  25 kA short circuit current available, the hazard/risk category required may be reduced by one number.



TABLE 3

## PROTECTIVE CLOTHING AND PERSONAL PROTECTIVE EQUIPMENT (PPE) MATRIX

Protective Clothing and Equipment	Protective Systems for Hazard / Risk Category						
	Hazard / Risk Category Number	-1 (Note 3)	0	1	2	3	4
<b>Non-melting (according to ASTM F 1506-00) or Untreated Natural Fiber</b>							
a. T-shirt (short-sleeve)	X				X	X	X
b. Shirt (long-sleeve)		X				X	
c. Pants (long)	X	X	X (Note 4)		X (Note 6)	X	X
<b>FR Clothing (Note 1)</b>							
a. Long-sleeve shirt			X	X		X (Note 9)	X
b. Pants			X (Note 4)	X (Note 6)	X (Note 9)	X (Note 9)	X
c. Coverall			X (Note 5)	X (Note 7)	X (Note 9)	X (Note 9)	X (Note 5)
d. Jacket, parka, or rainwear			AN	AN	AN	AN	AN
<b>FR Protective Equipment</b>							
a. Flash suit jacket (multilayer)							X
b. Flash suit pants (multilayer)							X
c. Head protection	--	--	--	--	--	--	--
1. Hard hat			X	X	X	X	X
2. FR hard hat liner						AR	AR
d. Eye protection	--	--	--	--	--	--	--
1. Safety glasses	X	X	X	AL	AL	AL	AL
2. Safety goggles				AL	AL	AL	AL
e. Face and head area protection	--	--	--	--	--	--	--
1. Arc-rated face shield, or flash suit hood				X (Note 8)			
2. Flash suit hood					X	X	X
3. Hearing protection (ear canal inserts)				X (Note 8)	X	X	X
f. Hand protection	--	--	--	--	--	--	--
Leather gloves (Note 2)			AN	X	X	X	X
g. Foot protection	--	--	--	--	--	--	--
Leather work shoes			AN	X	X	X	X

AN = As needed

AL = Select one in group

AR = As required

X = Minimum required

Notes:

1. See Table 130.7(C)(11). Arc rating for a garment is expressed in cal/cm<sup>2</sup>.

2. If voltage-rated gloves are required, the leather protectors worn external to the rubber gloves satisfy this requirement.

3. Hazard/Risk Category Number "-1" is only defined if determined by Notes 3 or 6 of Table 130.7(C)(9)(a).

4. Regular weight (minimum 12 oz/yd<sup>2</sup> fabric weight), untreated, denim cotton blue jeans are acceptable in lieu of FR pants. The FR pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 4.
5. Alternate is to use FR coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
6. If the FR pants have a minimum arc rating of 8, long pants of non-melting or untreated natural fiber are not required beneath the FR pants.
7. Alternate is to use FR coveralls (minimum arc rating of 4) over non-melting or untreated natural fiber pants and T-shirt.
8. A faceshield with a minimum arc rating of 8, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, a flash suit hood), is required.
9. Alternate is to use two sets of FR coveralls (the inner with a minimum arc rating of 4 and outer coverall with a minimum arc rating of 5) over non-melting or untreated natural fiber clothing, instead of FR coveralls over FR shirt and FR pants over non-melting or untreated natural fiber clothing.

TABLE 4

PROTECTIVE CLOTHING CHARACTERISTICS

TYPICAL PROTECTIVE CLOTHING SYSTEMS		
Hazard / Risk Category	Clothing Description (Typical number of clothing layers is given in parentheses)	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/yz <sub>2</sub> (1)	N/A
1	FR shirt and FR pants or FR coverall (1)	16.74 (4)
2	Cotton underwear — conventional short sleeve and brief/shorts, plus FR shirt and FR pants (1 or 2)	33.47 (8)
3	Cotton underwear plus FR shirt and FR pants plus FR coverall, or cotton underwear plus two FR coveralls (2 or 3)	104.6 (25)
4	Cotton underwear plus FR shirt and FR pants plus multilayer flash suit (3 or more)	167.36 (40)

Note: Arc rating is defined in Article 100 and can be either ATPV or E<sub>arc</sub>. ATPV is defined in ASTM F 1959-99 as the incident energy on a fabric or material that results in sufficient heat transfer through the fabric or material to cause the onset of a second-degree burn based on the Stoll curve. E<sub>arc</sub> is defined in ASTM F 1959-99 as the average of the five highest incident energy exposure values below the Stoll curve where the specimens do not exhibit breakopen. E<sub>arc</sub> is reported when ATPV cannot be measured due to FR fabric breakopen.

**TABLE 5**

**Electric Shop Tasks with Potential Electrical Hazards**

- Replacing a 15 or 20 amp 110V receptacle or switch
- Disconnecting/reconnecting utilization equipment, 0-240V
- Disconnecting/reconnecting utilization equipment, rated at 240 V to 600V.
- Voltage testing at utilization equipment rated less than 240V.
- Voltage testing at utilization equipment rated less then (?)V.

Using NFPA 70E Table 130.7(C)(9)(a) Hazard/risk Category Classification the following guide lines will be maintained:

1. 110V – Hazard Level 1; work on energized parts including voltage testing requires “V” rated gloves and tools.
2. 240V – Hazard Level 1; work on energized parts including voltage testing requires “V” rated gloves and tools.
3. 277V – Hazard Level 2; work on energized parts including voltage testing requires “V” rated gloves, tools and double layer switching hood and hearing protection.
4. 480V - H Hazard Level 2; work on energized parts including voltage testing requires “V” rated gloves, tools and double layer switching hood and hearing protection.
5. 12kv – Hazard Level 4; Insulated cable examination in manhole – Do Not enter or work in manholes unless feeder is verified de-energized and locked out.

In addition to the above mentioned PPE and other PPE required for the associated hazard levels are:

- Insulating Blanket – for work on energized equipment in wet areas.
- Personal voltage meter (training in proper care and use) to verify equipment is de-energized.
- LOTO kit – to lock out equipment once it is verified de-energized
- GFIs – for working with corded equipment/power tools in wet conditions.
- Flash blanket/panel board cover – with “high voltage” warning label on it.

## TABLE 6

### Plumbing shop Task with Potential Electrical Hazards

- Manhole entry in proximity of high voltage (up to 12kv)
- 110, 240 and 480v pump maintenance
- 110, 277 and 480v water heater or heat exchange maintenance
- 110 v solenoid valve maintenance
- Core drilling and corded equipment in wet areas
- Use of snake in sump pits (possible entanglement in pump electrical lines)
- Pipe fuse sealing equipment – around energized wires at 110v or above
- Extension cords in wet areas

## TABLE 7

### HVAC Shop Tasks with Potential Electrical Hazards

- Manhole entry in proximity of high voltage (9 upto 12kv)
- 110, 240 and 440v motor maintenance
- 110, 277 and 480v MCC maintenance
- 110, 240 and 480v refrigeration unit maintenance
- 110v solenoid valve maintenance
- 440v. refrigeration compressor maintenance
- Use of extension cords and corded equipment in wet areas