ESAO Resource

Information to Assist with the Development of Policies and Procedures
for
Working on Indoor Energized Electrical Systems

Standards for Personal Protection

Classification of Voltages Used for Safety Equipment:

Class 00	– Up to 500 volts
Class 0	– Up to 1000 volts
Class 1	– Up to 7500 volts
Class 2	– Up to 17,000 volts
Class 3	– Up to 26,500 volts
Class 4	– Up to 36,000 volts

Clothing Requirements for Different Classifications of Electrical Hazards

FR – 'fire retardant'

'Arc Rating' – energy released by electrical arcing, which causes burns. Expressed in calories per centimeter squared per second

When is protective clothing required?

Protective clothing is required when a person is within an area around exposed live electrical equipment called the *'flash protection boundary'*. The protection is required to be worn by everyone within the hazardous zones - not just the worker(s). The following distances are the minimum safety zones as specified by NFPA standard 70E:

Flash Protection Boundary		
Voltage	distance	
	meters	feet
50 to 750	0.9	3
750 to 2 000	1.2	4
2000 to 15,000	4.8	16
15,000 to 36,000	5.7	19
Over 36,000	calculate	calculate

Clothing requirements become more stringent as the risk of electrical arc burns (flash) increases either with the different types of work and/or increasing voltages. NFPA 70E requires that the arc rating be calculated for specific operations. The clothing is not intended to protect the worker from shocks but will protect the workers body from the heat (radiation) from flashes.

Protective clothing includes hand, foot and face flash arc protection which is usually incorporated into the specific protective equipment for those areas of the body.

NFPA 70E has a simplified reference for some routine maintenance work:

Hazard/ Risk Category	Required minimum Arc rating of PPE	Examples from NFPA 70
Risk Category **0**	up to 1.2 cal/cm^2	- operating an exposed breaker up to 240 volts - using a meter switch over 1000 volts
Risk Category **1**	1.3 to 4 cal/cm^2	- voltage testing or installing a breaker in a live panel up to 240 volts. - Operating an exposed circuit breaker up to 600 volts
Risk Category **2**	4.1 to 8 cal/cm^2	- work on control circuits above 120 volts changing live breakers up to 600 volts - voltage testing and parts at or above 600 volts
Risk Category **3**	8.1 to 25 cal/cm^2	- starter "buckets at 600volts
Risk Category **4**	25.1 to 49 cal/cm^2	- voltage testing and working on parts at or above 1000 volts

Required minimum standard for clothing or minimum Arc Rating of PPE based on energy protection required (cal/cm). Shirts must be long sleeved and pants must fully cover the workers legs. Electrical protective clothing can not have any part made out of conductive materials. Conductive (metallic and some plastics) buttons, zippers, pins, eyelets and other decorative items must not be present.

Risk Category	Protective Clothing required	Examples
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/yd2.	- 100% cotton shirt - jeans or - !00% cotton slacks
1	FR shirt and FR pants or FR coverall.	- Nomex clothing - FR pants - Denim jeans > 12 oz/yd2
2	Cotton underwear – conventional short sleeve and brief/shorts, plus FR shirt and FR pants Face shield with side protection, chin cups	Flash suits and Flash hoods must be rated above the flash energy levels expected and meet the appropriate ASTM standard.
3	Cotton underwear plus FR Shirt and FR pants plus FR coverall and Flash hood, or cotton underwear plus two FR coveralls and Flash hood. *or* Flash suit and Flash hood.	
4	Cotton Underwear plus FR Shirt and FR Pants plus multilayer flash suit. *or* Flash suit meeting ASTM F1506 and ASTM F2178	

Test Instrument Requirements

Electrical test equipment (multimeters) must be designed to meet the International Electro-technical Commission (IEC) 1010 Category (III) standards.

Note: CAT III are designed to give the user protection when there are electrical spikes.

The test device (multimeter) should have both a CSA International (or equivalent) logo (approval) and a CAT III designation and be rated above any voltage being tested.

Moisture and temperature can affect the meter – see the manufacturer's specifications and limitations.

Tool Requirements

All tools must be insulated and certified for voltages above any voltages expected. Proper/certified fuse pullers and other specialialized electrical tools must be used.

Eyewear / Face Protection Requirements

Use CSA standard Z94.3-00 (Eye protection that meets or exceeds American National Standards Institute (ANSI) standards Z87.1-89 and Z87.1A-91 may not meet Canadian impact-protection standards).

When working on live electrical equipment, non-conducting frames with scratch resistant clear polycarbonate lenses or CR-39 (plastic) lenses with ultraviolet (UV400) protection are acceptable. Shaded lenses with ultraviolet protection to a maximum shade rating of 1.7 may only be worn when the work area is bright.

Face shields must be arc rated to at least 8 cal/cm^2 and be worn with safety glasses which have side shields. To achieve full-face protection a chin cup must be worn if the chin is not fully protected by the design of the face shield.

Footwear Protection Requirements

Electrically rated steel toed footwear

Use CSA standards: Canadian Standards Association (CSA), Z195-M92: *Protective Footwear*
Must have an external rectangular patch colour with Greek letter omega (Ω) in orange, denoting electrical shock resistant soles.

Head Protection Requirements

Loose hair mist be fully restrained using a non-conductive hairnet, cap or hard hat.

In hazardous or construction areas where a hard hat is required use a CSA approved hard hat:

CSA standards: Canadian Standards Association (CSA) Standard Z94.1-92 (R2003), *'Industrial Protective Headwear'*.

There are three electrical classifications for hard hats:

Class 'E' (Electrical): tested using 20,000 volts
Class 'G' (General): tested using 2,200 volts
Class 'C' (Conductive): not tested for electrical insulation

Personal Protective Equipment Standards for Energized Electrical Work (ASTM standards):

Note The ASTM standards below refer to Rubber. The items do not have to be made of rubber as long as the material used has similar (or better) electrical resistance as rubber.

1. **Gloves:**

   Standard: ASTM D120-95 *'Standard Specification for Rubber Insulating Gloves*'

   - Must be of seamless manufacture and clearly marked for electrical use and class.
   - The gloves used must be rated for the maximum voltage the worker could make contact with.

   Voltage classes and identifier colour codes:

Class 00	- beige
Class 0	- red
Class 1	- white
Class 2	- yellow
Class 3	- green
Class 4	- orange

   Types – I – not ozone resistant
   II – ozone resistant

   Electrical protective gloves are generally soft and easily subject to mechanical and chemical damage. For general work when dexterity is not required they should be used with leather protectors to provide mechanical protection.

   Leather Protectors:

   Standard: ASTM F696-97 *'Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens*'

2. **Sleeves**

   Standard: ASTM D1051-95 *'Standard Specification for Rubber Insulating Sleeves*'

   - Same as gloves

3. **Blankets**

   Standard: ASTM D1048-99 *'Standard Specification for Rubber Insulating Blankets'*

   - Blanket should be labelled with the rating.
   - Damaged or frayed edges of blankets should be trimmed.

4. **Insulating Covers**

   Standard: ASTM D1049-98 *'Standard Specification for Rubber Insulating Covers'*

   - Same as gloves

5. **Insulating matting**

   Standard: ASTM D178-93 (1998) "*Standard Specification for Rubber Insulating Matting*'

   - Same as gloves

6. **Insulator in tools**

   Standard: ASTM F711-97 *'Standard Specification for Fiberglass Reinforced Plastic (FRP) Rod and Tube used in Live Line Tools*'

   - Statement of standard and voltage met should be embedded in the tubing or on a permanent label attached to a tool manufactured using the tubing.

Testing Requirements for personal protective equipment

Wear, tears, cracks, dents and chemicals or metal embedded in the surface can make protective equipment ineffective. Some items can be checked by the user; however many items should only be checked by a qualified person. Check the manufacturer's recommendations. The following list indicates how often personal protective equipment should be checked.

General insulating	- when there is any indication that insulating value is suspect
Insulating covers	- when there is any indication that insulating value is suspect
Insulating blankets	- before first issue and every 12 months
Insulating gloves	- before first issue and every 6 months
Insulating sleeves	- before first issue and every 12 months
Others	- the user must visually inspect each item each day before use