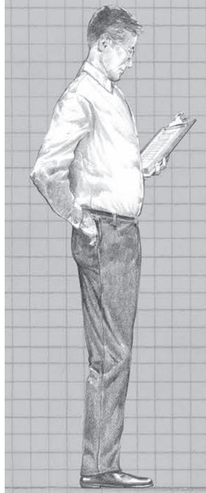
Approach limit boundaries for Arc Flash and Shock Based on NFPA 70E-2015 Standard Editions

1.2 cal/cm² onset of 2nd degree skin burn

Arc flash boundary

Higher risk of shock



Unqualified personnel + Arc-rated PPE, awareness & continuously escorted by a qualified person

Arc flash boundary

Qualified person
Plus competent for work task
Plus risk assessment procedure
Plus arc flash risk assessment (incident energy calculations or arc flash PPE category table method)
Plus approved work procedure
Plus EEWP if required
Plus arc-rated PPE appropriate & suitable for the work task

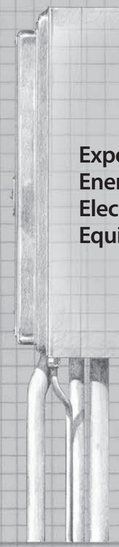
LIMITED approach boundary for shock

Qualified person
Plus competent for work task
Plus risk assessment procedure
Plus shock risk assessment

No unqualified personnel allowed!

RESTRICTED approach boundary for shock

Qualified person
Plus competent for work task
Plus contact work justification
Plus risk assessment procedure
Plus arc flash risk assessment
Plus shock risk assessment
Plus approved work procedure
Plus EEWP is required
Plus shock PPE, tools & equipment appropriate & suitable for the work task



Exposed Energized Electrical Equipment

Arc rated PPE required

⚠ WARNING

Arc Flash & Shock Hazard

ARC FLASH PROTECTION		SHOCK PROTECTION	
Working Distance	**18 inches**	Shock Hazard when covers removed	**600 VAC**
Incident Energy	**5.0 cal/cm²**	Limited Approach	**42 inches**
Arc Flash Boundary	**43 inches**	Restricted Approach	**12 inches**
<Company> PPE Level=	**2**	Rubber Insulating Glove Class	**0**
Refer to <Company>'s Electrical Safety Program for Arc Flash PPE requirements			

Location: MCC #1 Building
Equipment: LOAD SIDE of **MCC #1 MAIN BREAKER**
Report #: ATS-XXX-YYY-AHA-ZZZ Rev 1.0

Study provided by: ATS
Date: **2015-01-08**
Label#: 1

Detailed arc flash and shock warning label example

Approach boundaries to energized electrical conductors or circuit parts for shock protection for AC systems

System Voltage	Limited Approach Boundary	Restricted Approach Boundary
< 50V	Not specified	Not specified
120V	3 ft. 6 in. / 1.0 m	Avoid contact
208V - 600V	3 ft. 6 in. / 1.0 m	1 ft. 0 in. / 0.3 m
4,160V	5 ft. 6 in. / 1.5 m	2 ft. 2 in. / 0.7 m
13,800V	5 ft. 6 in. / 1.5 m	2 ft. 2 in. / 0.7 m

This material is not all-inclusive and users shall refer to the Standard for requirements

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Arc Flash

What you need to know...

Here are the facts...

The Federal Government (OSHA requires that all "Non-Dwelling" facilities have an Arc Flash Hazard Analysis done to determine:

- The Arc Flash Boundary
- The Level of PPE Required
- The Presence of a Flash Hazard

NFPA 70E 130.7(E) says this:
"Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of ANSI Z535…"

NFPA 70 110.16 says this:
"Electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that are in other than dwelling occupancies, and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment…"

NFPA 70E 130.3 says this:
"An arc flash hazard analysis shall determine the Arc Flash Protection Boundary and the personal protective equipment that people within the Arc Flash Protection Boundary shall use..."

Refer to:
OSHA 29 CFR Part 1910.302-308 & 1910.331-335

US Department of Labor, occupational Safety & Health Admin

National Fire Protection Association, NFPA 70 & NFPA 70E

What is an arc flash?
An arc flash is a current flowing through air that flashes from one exposed live conductor to another conductor or to ground. When an arc flash happens, the temperatures can reach up to 35,000 degrees Fahrenheit. This is four times the temperature on the surface of the sun. The result can be destruction of equipment, fire, and injury.

What causes an arc flash?
An arc flash occurs when electrical clearances are reduced or compromised by deteriorating insulation or human error. The arc flash follows a conductive path between two hot (energized) wires or between a hot wire and ground.

How can I protect employees from arc flashes?
The recommended way to protect employees is to de-energize equipment prior to working on it. When de-energizing is not feasible per code, enforce safe work practices. Require your employees to be properly suited in conjunction with a recent arc flash study. Actions that require PPE include, but are not limited to, operating a breaker with the dead-front cover removed, voltage testing, working on energized equipment, and racking in or out draw-out units.

Are the generic PPE recommendations of the National Fire Protection Association (NFPA) 70E sufficient?
Following NFPA 70E guidelines is highly recommended, however, the actual field conditions can be more hazardous than the NFPA 70E guidelines. An arc flash study can reveal equipment with elevated hazard levels. This will help you protect your employees.

What steps can help protect employees from arc flash?
1. Work while system is de-energized
2. Have a professional engineer calculate the short circuits
3. Perform a Protective Device Coordination Study
4. Perform an arc flash calculation
5. Document the findings
6. Determine specifics of unsafe work locations
7. Eliminate hazards through system changes or operational procedures
8. Apply hazard labels describing required PPE and boundaries for equipment use
9. Establish safe work practice procedures

Why is an arc flash study important?
Without an arc flash study you will not know the actual level of danger or the appropriate personal protective equipment (PPE) required for employees. Electrical systems are dynamic and change over time. Internal changes, such as adding new equipment can affect the level of arc flash energy. A study must be updated every time the system changes. External changes, such as a utility changing transformers or changes at your utility's closest sub-station can severely impact your level of arc flash energy.

Your OSHA Compliance Checklist:

- ✓ Conduct Arc Flash Analysis
- ✓ Place Labels/Signs on Panel
- ✓ Obtain PPE
- ✓ Train Workers on Safety/Hazards

Call for a Free Consultation
832.467.4446
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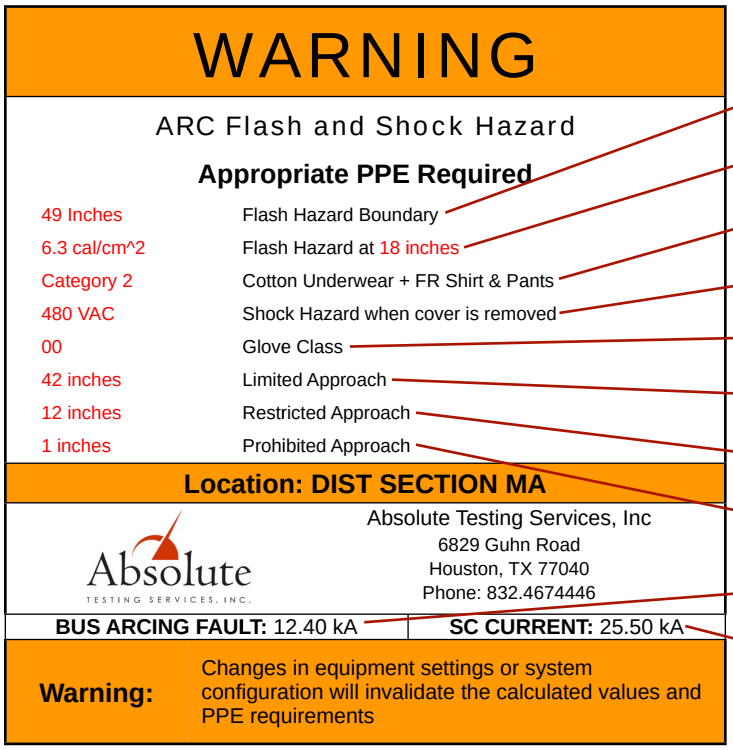

DATA REQUIRED TO BE ON THE NEW ARC FLASH WARNING LABELS

1. Flash Protection Boundary
This boundary is the closest that anyone may approach without the use of PPE. The available short circuit current, predicted fault duration and the voltage are all needed to determine the flash protection boundary.

According to NFPA 70E 2009 Edition, there are three ways in which this boundary can be calculated:
- Simplified Table 130.7(C)(9), 130.7(C)(10)
- Analysis based on NFPA 70E Annex D
- Analysis based on IEEE 1584

2. Incident Energy at 18" (cal/cm2)
This is the energy per unit area on a surface located 18 in. from the potential arc source. The incident energy is measured in units of calories per square centimeter. Second-degree burns occur at an energy level of approximately 1.2 calories/cm2.

3. PPE Required
The Personal Protective Equipment required is dependent on the incident energy at every point a person may perform work on energized equipment. An electrical engineer or other qualified person should perform the calculations that determine the incident energy. The appropriate PPE should cover all parts of the body that may be exposed to an arc flash. This could include shoes, gloves, flame resistant clothing, safety glasses, etc.

4. Voltage Shock Hazard
The hazard based on the voltage of a system that is used to determine the glove rating when working on that system. NFPA 70E has a table for glove ratings based on the voltage shock hazard.

6. Limited Shock Approach Boundary
This boundary may only be crossed by an "unqualified" person when they are accompanied by a "qualified" person.

5. Glove Class
This class is based on the voltage level. The following Glove Class table comes from ASTM D 120-95.

Glove Class	Voltage
00	500 V
0	1,000 V
1	7,500 V
2	17,000 V
3	26,500 V
4	36,000 V

7. Restricted Shock Approach Boundary
This boundary may only be crossed by a "qualified" person that uses adequate shock prevention equipment and techniques.

8. Prohibited Shock Approach Boundary
This boundary may only be crossed by a "qualified" person that has the same level of protection as if they are planning on direct contact with live parts

9. Bus Arcing Fault
The arc fault calculations assume that there is a physical gap between conductors that was bridged by something resulting in the formation of an arc. Once the arc is formed and plasma is produced, the arc current should closely approximate the calculated fault levels. The Arc Fault calculations are an approximation based upon research and testing similar to the short circuit analysis methods.

10. Available Short-Circuit Current
The magnitudes of the prospective currents flowing through the power system at various time intervals after a fault occurs are determined by short-circuit studies. The resulting data is used to determine the bolted three-phase short circuit current, which allows for the calculation of the arcing fault current.

