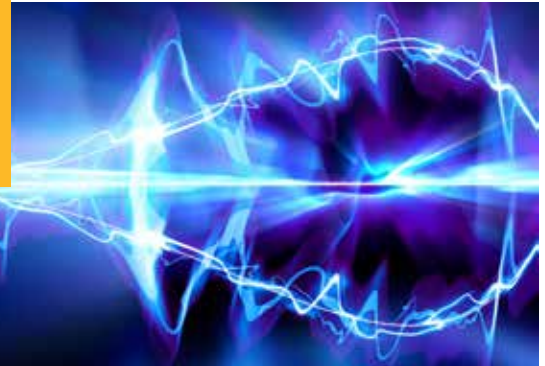


SAFETY CHECKLIST

10 dumb things smart people do when testing electricity

While anyone who works with electricity quickly develops a healthy respect for anything that could possibly be live, even the best of us can make uncharacteristic mistakes when pushed for time. The following is a quick list of **WHAT NOT TO DO** when taking electrical measurements.



DO NOT:

1

Replace the original fuse with a cheaper one. Digital multimeters (DMMs) that meet today's safety standards include a special high-energy fuse designed to pop before an overload hits your hand. Fluke meters use a special sand-filled fuse designed to extinguish an arc within the fuse enclosure. Be sure to replace it with the same kind of authorized fuse.



2

Use a bit of wire or metal to get around the fuse. That may seem like a quick fix if you're caught without an extra fuse, but it won't provide protection against a spike headed your way.



3

Use the wrong test tool for the job. Make sure your test tool holds the correct CAT rating for each job you do, even if it means switching DMMs throughout the day. (See Table 1)



4

Grab the cheapest DMM on the rack. If that cheap test tool doesn't actually have the safety features it advertised, you could end up a victim of a safety accident. Look for independent laboratory testing markings like CSA or UL that ensure the tool meets standards.



DO NOT:

5

Skip out on PPE. They're called "safety" glasses for a reason. Take them out and put them on. The same goes for insulated tools, insulated gloves, ear plugs, your face shield/hood and arc-resistant clothing.



6

Work on a live circuit. De-energize the circuit whenever possible, and verify it's de-energized before starting work. If you have to work on a live circuit, make sure an arc flash risk assessment has been completed, use the NFPA 70E table H.3(b) to select the appropriate PPE, and verify the operation of your test tool by testing a known voltage source first.

! WARNING

**Arc Flash and Shock Hazard
Appropriate PPE Required**

Flash Protection	Shock Protection
Flash Hazard at 18 inches	Shock Hazard when cover is removed 480 VAC
Min. Arc Rating 5.5 cal/cm ²	Limited Approach 42 inches
Flash Protection Boundary 46 inches	Restricted Approach 12 inches
Glove Class 00	

Arc-Rated Clothing:
 Arc-Rated Shirt and Pants min 35 J/cm²
 Arc-Rated Face Shield and Balaclava min 35 J/cm²

Bus: Panel H18 @ E4-4 Prot: X'fmr XMSA-FUSE

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7

Fail to follow lockout/tagout procedures. Lockout/tagout procedures exist to protect you from potentially fatal electric shock—don't risk someone re-energizing your work environment. Review a sample lockout/tagout procedure from the Environmental Safety and Health Group of OSHA at www.shosha.gov.



8

Multi-task while measuring. When working with live circuits, try not to hold the meter in one hand while testing with the other—in a transient situation, that could create a path to ground through your heart. Hang or rest the meter or use a wireless read-out to get the meter out of your hands and the readings at eye level, and use an alligator clip for your ground, so that that you're only using one hand to probe the energized conductor.



DO NOT:

9

Neglect test leads. Test leads are a critical component of DMM safety. Make sure your leads match the CAT level of your job. Look for test leads with double insulation, shrouded input connectors, and test probes with finger guards and a non-slip surface. Test the leads with a known voltage before using. Consider leads with adjustable shrouds. There are even probes with built in fuses!



10

Hang onto an old test tool forever. Today's test tools contain safety features unheard of even a few years ago. These features are worth the cost of an equipment upgrade and a lot less expensive than an emergency room visit. For example new standards restrict the length of metal in the tip of a test probe to 4mm or less in CATIII/IV environments.



Table 1. Measurement Categories IAW IEC/EN 61010-031

Measurement Category	Description	Examples
CAT IV	Three-phase at utility connection, any outdoor conductors. Limited only by the utility transformer feeding the circuit. >>50 kA short circuit current.	<ul style="list-style-type: none"> The "origin of installation"—where low-voltage connection (service entrance cables) is made to utility power. Electricity meters, primary overcurrent protection equipment. Outside and service entrance, service drop from pole to building, run between meter and panel. Overhead line to detached building, underground line to well pump.
CAT III	Three-phase distribution, including single-phase commercial lighting. <50 kA short circuit current.	<ul style="list-style-type: none"> Equipment in fixed installations, such as switchgear and polyphase motors. Bus and feeders in industrial plants. Feeders and short branch circuits, devices fed directly from distribution panels. Lighting systems in larger buildings. Appliance outlets with short connections to service entrance.
CAT II	Single-phase receptacle connected loads. <10 kA short circuit current.	<ul style="list-style-type: none"> Appliances, portable tools, and other household and similar loads. Outlet and long branch circuits. <ul style="list-style-type: none"> – Outlets at more than 10 meters (30 feet) from CAT III source. – Outlets at more than 20 meters (60 feet) from CAT IV source.

Personal protective equipment categories

Always abide by the limits of use and minimum working distance.* The following PPE categories are described by the National Fire Protection Association (NFPA) Standard 70E. The greater the electrical hazard, the higher the personal protective equipment arc rating must be to withstand an arc-flash incident.

PPE Category 1:

- Panelboards or other equipment rated 240 V ac and below
 - Limits of use: Maximum 25 kA available short circuit current and 2 cycle (0.03 sec) fault clearing time
 - Minimum working distance: 18 inches (457 mm)
- Storage batteries, dc switchboards, and other dc supply sources
 - 100 V dc to 250 V dc, short-circuit current < 4 kA
 - 250 V dc to 600 V dc, short-circuit current of 1.5 kA
 - Maximum arc duration: 2 seconds
 - Minimum working distance: 18 inches (457 mm)

Arc-rated clothing, minimum arc rating of 4 cal/cm²

- Arc-rated long-sleeve shirt and pants or arc-rated coverall
- Arc-rated face shield or arc flash suit hood
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)

Protective equipment

- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves
- Leather footwear (as needed)
- No metal-framed eyeglasses, cell phones or radios, jewelry, rings, keys or watches
- Insulated hand tools

PPE Category 2:

- Panelboards or other equipment rated > 240 V ac to 600 V ac
- Other 600 V ac class (277 V through 600 V, nominal) equipment
 - Limits of use: Maximum 25 kA available short circuit current and 2 cycle (0.03 sec) fault clearing time
 - Minimum working distance: 18 inches (457 mm)
- 600-VAC class motor control centers (MCCs)
 - Limits of use: Maximum 65 kA available short circuit current and 2 cycle (0.03 sec) fault clearing time
 - Minimum working distance: 18 inches (457 mm)
- Storage batteries, dc switchboards, and other dc supply sources
 - 100 V dc to 250 V dc, 4 kA ≤ short-circuit current < 7 kA
 - 250 V dc to 600 V dc, 1.5 kA ≤ short-circuit current < 3 kA
 - Maximum arc duration: 2 seconds
 - Minimum working distance: 18 inches (457 mm)

Arc-rated clothing, minimum arc rating of 8 cal/cm²

- Arc-rated long-sleeve shirt and pants or arc-rated coverall
- Arc-rated face shield or arc flash suit hood and arc-rated balaclava
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)

Protective equipment

- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Heavy duty leather gloves
- Leather footwear
- No metal-framed eyeglasses, cell phones or radios, jewelry, rings, keys or watch
- Insulated hand tools

PPE Category 3:

- Storage batteries, dc switchboards, and other dc supply sources
 - 100 V dc to 250 V dc, 7 kA <= short-circuit current < 15 kA
 - 250 V dc to 600 V dc, 3 kA <= short-circuit current < 7 kA
 - Maximum arc duration: 2 seconds
 - Minimum working distance: 18 inches (457 mm)

Arc-rated clothing, minimum arc rating of 25 cal/cm²

- Arc-rated long-sleeve shirt (as required)
- Arc-rated pants (as required)
- Arc-rated coverall (as required)
- Arc-rated arc flash suit jacket (as required)
- Arc-rated arc flash suit pants (as required)
- Arc-rated arc flash suit hood
- Arc-rated gloves
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)

Protective equipment

- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Leather footwear
- No metal-framed eyeglasses, cell phones or radios, jewelry, rings, keys or watch
- Insulated hand tools

PPE Category 4:

- 600 V class motor control centers (MCCs)
 - Limits of use: Maximum 42 kA available short circuit current and max. 20 cycles (0.33 sec) fault clearing time
 - Minimum working distance: 18 inches (457 mm)
- 600 V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards
 - Limits of use: Maximum 35 kA available short circuit current and max. 30 cycles (0.5 sec) fault clearing time
 - Minimum working distance: 18 inches (457 mm)
- NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV
- Metal-clad switchgear, 1 kV through 15 kV
- Other equipment 1 kV through 15 kV
 - Limits of use: Maximum 35 kA available short circuit current and maximum 15 cycles (0.24 sec) fault clearing time
 - Minimum working distance: 36 inches (914 mm)
- Storage batteries, dc switchboards, and other dc supply sources
 - 250 V dc to 600 V dc, 7 kA <= short-circuit current < 10 kA

Arc-rated clothing, minimum arc rating of 40 cal/cm²

- Arc-rated long-sleeve shirt (as required)
- Arc-rated pants (as required)
- Arc-rated coverall (as required)
- Arc-rated arc flash suit jacket (as required)
- Arc-rated arc flash suit pants (as required)
- Arc-rated arc flash suit hood
- Arc-rated gloves
- Arc-rated jacket, parka, rainwear, or hard hat liner (as needed)

Protective equipment

- Hard hat
- Safety glasses or safety goggles (selection required)
- Hearing protection (ear canal inserts)
- Leather footwear
- No metal-framed eyeglasses, cell phones or radios, jewelry, rings, keys or watch
- Insulated hand tools

Reference: NFPA (National Fire Protection Association) Standard 70E 2015 Edition, Tables 130.7 (C)(15)(A)(b), (C)(15)(B), (C)(16).

*The user of this information is required to estimate the available short circuit current and the fault clearing time of the circuit or equipment to be worked on. These limits, as given in the table ensure the arc-rated clothing and PPE specified in the table will be adequate. There is a risk of minor injury from an arc flash even if the specified arc-rated clothing and PPE is used, as stated by NFPA 70E Article 130.5. The working distance must also be estimated, as incident energy increases rapidly as the distance is reduced. Working distance is the distance from the potential arc source to the chest and face area of the worker. Always be aware of body position when working and maintain the minimum working distance specified in the table. The user of this table must also be aware that the hands will always be closer to the potential arc source and must be protected accordingly. Rubber insulated gloves and leather protectors, when worn together have been shown to provide very good protection to the hands.

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Printed in U.S.A. 4/2015 2071940d_en

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