

## SAFE ELECTRICAL TESTING & MEASUREMENT

- GOALS:
1. Electricians should have an awareness of the hazards involved in testing live electrical power sources.
  2. Electricians should understand the various markings that show maximum power, voltage and current ratings on the test and measurement equipment.
  3. Electricians should know what safety equipment (PPE) is available for the various hazardous categories present in their work environment and understand the 4 categories and Arc Flash classifications based on calories per centimeter squared.
  4. Electricians should know what precautions they should take for themselves and those working with or near them to avoid and/or minimize electrical hazards.
- I. An Initial Review of the NFPA 70E Document, the Arc Flash Hazard and the Categories of Power electricians are exposed to in their daily work. (30 Minutes)
1. Category One: low or limited voltage control circuits
  2. Category Two: branch circuits
  3. Category Three: Distribution Panels and Motor Control Centers
  4. Category Four: Utility Power and Underground Feeders.
- II. Proper Planning for each of the categories: (15 Minutes)
1. Fill out an Energized Work Permit
  2. Clearance of the area to work safely
  3. Identify the nearest Exit
  4. Proper light and ventilation
  5. A knowledgeable helper nearby
  6. Notify others where you are
- III. Review common misunderstandings about test and measurement devices and explain the various markings and ratings on the devices. Also review the testing agencies which may or may not have examined the devices. Explain the

symbols for voltage, current, resistance and other values on test equipment. (30 Minutes)

IV. Examine the construction of miscellaneous devices and explain the purpose of shrouding and fusing, “safe” probes, arcing potential, “flashover” or “creepage” possibilities between components on a circuit board, case composition, etc. (15 Minutes)

V. Review the proper testing methods: voltage in parallel, current in series or by clamp-on (magnetic field/ AC or DC), continuity in de-energized circuits. Explain fusing requirements. (30 Minutes)

VI. Review of Safety Standards organizations and their purposes: NFPA, OSHA, ANSI, IEC, IEEE, NEMA. (15 Minutes)

VII. Stress again Arc Flash and its destructive potential and how it could occur in any test or measurement activity. Know how to understand the warning labels on switchboards and motor control centers and the boundaries involved. (30 Minutes)

VIII. Review the safe testing methods for single phase and three phase circuits from convenience outlets to motor control centers and central distribution panels. (30 Minutes)

1. De-energize the circuit whenever possible
2. If circuit must be live, use the proper insulated tools, follow NFPA 70E PPE requirements, remove watches or other jewelry, stand on an insulated mat and wear the required personal protective gear.
3. Don't have both hands near the power source if at all possible.
4. Hang or secure the meter away from hands to avoid the exposure to transients.
5. Consider Bluetooth/WiFi devices to work with doors/panels closed.

IX. How to maintain and safeguard one's own test and measurement equipment, what problems to look for and how and when to replace parts. (15 Minutes)

Quizzes: There will be four quizzes on the material. Quizzes will be spaced evenly through the class. (30 Minutes)

Learning Outcome:

The class is tailored to journeymen electricians, apprentice electricians, limited maintenance electricians and general maintenance personnel—workers most likely to use test and measurement devices.

Instructor is Ralph Bliquez who is approved for this code cycle.

## SAFETY IN TEST AND MEASUREMENT QUIZ ONE

Matching: Place the description next to the following word or phrase.

\_\_\_\_\_ Codes

\_\_\_\_\_ Standards

\_\_\_\_\_ Induction

\_\_\_\_\_ Capacitance

\_\_\_\_\_ Breaker

\_\_\_\_\_ Metric System

\_\_\_\_\_ Fuse

\_\_\_\_\_ Voltage

\_\_\_\_\_ Ampacity

\_\_\_\_\_ AIC

1. The magnetic transfer of energy through space
2. The current carrying capacity of the conductor
3. The electrostatic storage of energy
4. A chemical link that should interrupt overloads and short circuits
5. Has the force of law
6. A mechanical device to interrupt over currents and short circuits
7. The force that drives electrical current
8. A measurement of objective performance
9. The maximum current a device can withstand without failure
10. The use of Base 10 and Exponents for measurements

## SAFETY IN TEST AND MEASUREMENT QUIZ TWO

### TRUE-FALSE

- \_\_\_\_\_ 1. According to NFPA 70E, the difference between Cat III and Cat IV is Cat IV devices are exposed to the Utility power.
- \_\_\_\_\_ 2. An Energized Work Permit is issued by the local Authority Having Jurisdiction.
- \_\_\_\_\_ 3. All voltage and current testing devices meant for voltages above 50 volts must be U.L. certified.
- \_\_\_\_\_ 4. Voltage always should be tested in series.
- \_\_\_\_\_ 5. A Clamp-on testing device for current reacts to the magnetic field surrounding the conductor.
- \_\_\_\_\_ 6. "Flashover" is a phenomenon in testing devices that is a short circuit between components.
- \_\_\_\_\_ 7. NEMA is a government agency.
- \_\_\_\_\_ 8. The Limited Approach Boundary is a shock hazard boundary.
- \_\_\_\_\_ 9. The value used to judge an Arc Flash hazard is calories per centimeter squared.
- \_\_\_\_\_ 10. Digital multimeters should not be fused.

## SAFETY IN TESTING AND MEASUREMENT QUIZ THREE

### TRUE-FALSE

- \_\_\_\_\_1. Current terminals have very high resistance and can withstand any power.
- \_\_\_\_\_2. Continuity measurements in a DMM have minimal resistance.
- \_\_\_\_\_3. "Ghost Voltages" can be caused by high impedance.
- \_\_\_\_\_4. An Energized Work Permit is always required on any work over 50 volts.
- \_\_\_\_\_5. The NEC lists U.S. measurements only.
- \_\_\_\_\_6. When making test measurement connections, connect the power probe first.
- \_\_\_\_\_7. ANSI is a code panel.
- \_\_\_\_\_8. Overcurrent protection is either thermal or magnetic but not both.
- \_\_\_\_\_9. A fuse is a chemical device to interrupt excessive current.
- \_\_\_\_\_10. The "Hall Effect" permits DC current to be tested by a clamping meter.

**SAFETY IN  
TESTING AND MEASUREMENT  
QUIZ 4**

\_\_\_\_\_ 1. The Code of Federal Regulations that applies to Electrical Safety in work related practices (CFR 1926, sub K) is enforced by:

- a. Local Police
- b. OSHA
- c. Electrical Inspectors
- d. U.S. Marshals

\_\_\_\_\_ 2. The NEC designates hazardous voltages and currents to be above:

- a. 120v/15amp
- b. 24v/1amp
- c. 50v/.006amp
- d. 50v/.06amp

\_\_\_\_\_ 3. To verify that the fuse in a meter is working:

- a. plug test leads into any two ports and short the leads
- b. simply turn the meter on to see if there is a display
- c. connect one test lead in V/Ohm, select Ohm and put probe in A
- d. there is no fuse in a meter

\_\_\_\_\_ 4. A breaker in a typical service panel is:

- a. a mechanical device for interrupting current
- b. an electronic device to interrupt transients
- c. a mechanical device for protection from short circuits only
- d. a sensing device for unbalanced loads

\_\_\_\_\_ 5. A fuse in a typical electrical circuit is:

- a. rated only in current
- b. a chemical device to interrupt short circuits/overload currents
- c. a mechanical device to interrupt transient voltages
- d. a link to blow up if too hot