Training Solutions, Delivered!

Safe Electrical Work Practices & the 2018 NFPA 70E®

Leader's Guide, Fact Sheet & Quiz

Item Number: 4891

This easy-to-use Leader's Guide is provided to assist in conducting a successful presentation.

PREPARING FOR THE MEETING

Here are a few suggestions for using this program:

a) Review the contents of the Fact Sheet that immediately follows this page to familiarize yourself with the program topic and the training points discussed in the program. The Fact Sheet also includes a list of Program Objectives that details the information that participants should learn from watching the program.

b) If required by your organization, make an attendance record to be signed by each participant to document the training to be conducted.

c) Prepare the area and equipment to be used for the training. Make sure the watching environment is comfortable and free from outside distractions. Also, ensure that participants can see and hear the TV screen or computer monitor without obstructions.

d) Make copies of the Review Quiz included at the end of this Leader's Guide to be completed by participants at the conclusion of the presentation. Be aware that the page containing the answers to the quiz comes *before* the quiz itself, which is on the final page.

CONDUCTING THE PRESENTATION

a) Begin the meeting by welcoming the participants. Introduce yourself and give each person an opportunity to become acquainted if there are new people joining the training session.

b) Introduce the program by its title and explain to participants what they are expected to learn as stated in the Program Objectives of the Fact Sheet.

c) Play the program without interruption. Upon completion, lead discussions about your organization's specific policies regarding the subject matter. Make sure to note any unique hazards associated with the program's topic that participants may encounter while performing their job duties at your facility.

d) Hand out copies of the review quiz to all of the participants and make sure each one completes it before concluding the training session.

4891 Safe Electrical Work Practices & the 2018 NFPA 70E®
FACT SHEET

LENGTH: 27 MINUTES

PROGRAM SYNOPSIS:
This video explains the important changes and updates contained in the 2018 NFPA 70E and discusses how electrical workers can be protected from both the shock hazard and arc-flash hazard presented by exposed energized parts. The 2018 NFPA 70E places an emphasis on controlling risk. As such, the electrical safety program, the shock hazard assessment and the arc-flash hazard assessment must now consider the likelihood as well as the severity of injury related to an electrical hazard. When controlling risk, the 2018 regulation now requires that a specific hierarchy of controls be followed. Another new requirement is that the potential for human error be considered in all risk assessments. Annex Q has been added to help explain how human performance can be applied to workplace electrical safety. The required elements of the electrical safety program have been revised to now include a written job safety plan in addition to a job briefing, inspection of equipment, incident investigation and risk assessment.

Other key revisions include the addition of an additional unit of measure for incident energy, the selection of arc-rated protective equipment and establishing the arc-flash boundary. Key definitions have also been updated, including qualified worker, shock hazard, arc-flash hazard, arc-flash boundary and electrically safe work condition. The 2018 NFPA 70E now includes both employer and employee responsibilities. After viewing this program, electrical workers and supervisors will have an understanding of those responsibilities and be convinced that always following electrical safe work practices and procedures is the only way for electrical workers to stay safe.

PROGRAM OBJECTIVES:
After watching the program, the participant should be able to explain the following:
- What the elements of an electrical safety program are;
- How risk assessment and control procedures are conducted;
- How an electrically safe working condition is established and verified;
- What the two approach boundaries for shock protection are;
- How the Arc-flash Boundary is determined;
- What clothing and protective equipment is required by each of the four arc-flash hazard PPE categories;
- When energized work is allowed and when an energized work permit is required.

PROGRAM OUTLINE:

BACKGROUND
- One of the leading authorities on electrical safety is the National Fire Protection Association, the NFPA. Their document number "70E" is recognized by OSHA and other regulatory authorities as the "best practices" for electrical safety.
- The 2018 NFPA 70E focuses on protecting workers from the two main hazards of electricity: the shock hazard and the arc-flash hazard.
- A shock hazard is defined as "a source of possible injury or damage to health associated with current through the body caused by contact or approach to energized electrical conductors or circuit parts."
- An arc-flash hazard is defined as "a source of possible injury or damage to health associated with the release of energy caused by an electric arc."

THE ELECTRICAL SAFETY PROGRAM
- In order to protect workers from the dual hazards of electricity, the 2018 NFPA 70E requires employers to develop an electrical safety program.
- An electrical safety program is defined as "a documented system consisting of electrical safety principles, policies, procedures and processes that directs activities appropriate for the risk associated with electrical hazards."
- The 2018 edition of the NFPA 70E recognizes that electrical safety requires the commitment of both employers and employees.
- As such, Article 105 has been updated to address both the employee and employer's responsibilities regarding the electrical safety program.
- Employers shall establish, document and implement the required safety-related work practices and procedures.
- Employers shall provide employees with training on the employer's safety-related work practices and procedures.
- Employees have the responsibility to comply with the safety-related work practices and procedures provided by the employer.

ELEMENTS OF THE ELECTRICAL SAFETY PROGRAM
- Article 110 lists the required elements of the electrical safety program, which includes the following:

—The electrical safety program should provide employees an awareness of the potential electrical hazards in the work environment;

—The electrical safety program must identify the principles on which it is based; the controls by which it is measured and the procedures it requires;

—The electrical safety program must now include inspection elements to verify that newly installed or modified equipment is in compliance with applicable industry codes and the equipment manufacturer's recommendations.

- Another change for the 2018 edition is the requirement for a job safety plan in addition to a job briefing.
- The electrical safety program must require that a documented job safety plan be completed by a qualified person for each electrical related job task. The job safety plan must include the following:

—A description of the job and the individual tasks;
—Identification of any electrical hazards associated with the tasks;
—A shock risk assessment;
—An arc-flash risk assessment;
—The work procedures involved;
—Any special precautions to be taken and the methods to be used to identify and control the sources of hazardous energy.

- A job briefing must be conducted with all involved employees prior to beginning any job. The job briefing must include all elements of the job safety plan as well as the information contained on an energized electrical work permit if one is required.
- The 2018 regulation also requires that the electrical safety program include elements to investigate electrical incidents.
- An electrical incident is defined as "an event or occurrence that results in or could have resulted in a fatality, an injury or damage to health."
- A proper investigation will determine the root causes of an electrical incident so preventative measures can be devised and implemented to prevent a similar incident from occurring in the future.
- The electrical safety program must also include an auditing program. The electrical safety program, field work and the lockout/tagout program each have specific auditing requirements.
- The electrical safety program itself must be audited at least every three years to verify that its principles and procedures are in compliance with the most current NFPA 70E standard.
- Field work must be audited at least annually to verify that the requirements of the electrical safety program are being followed.
- The lockout/tagout program and its procedures must be audited by a qualified person at least annually. The audit must include at least one lockout tagout in progress.
- The lockout/tagout audit must be designed to identify and correct deficiencies in the lockout tagout program, its procedures, worker training and worker execution of the procedures.

RISK ASSESSMENT & CONTROL

- The 2018 NFPA 70E also requires that a risk assessment procedure be part of the electrical safety program.
- The NFPA 70E defines "risk" as the combination of two components: one is the likelihood of an occurrence of injury or damage to health; the other is the severity of injury or damage to health that results from a hazard.
- The risk assessment process must include:

—Hazard identification;
—An estimate of the potential "severity of injury" or "damage to health" which may occur;
—An estimate of the likelihood of occurrence of injury or damage to health;
—A determination if protective measures are required;
—The potential for human error.

- The negative consequences of human error on people, processes, the work environment and equipment must be taken into account as part of the electrical safety program's risk control procedure.
- Commonly called "Human Performance" or "HU" for short, this aspect of risk management addresses the various factors that lead to or prevent human errors and their related events.
- The 2018 NFPA 70E has added Annex Q to introduce the concept of human performance and how it can be applied to workplace electrical safety and error prevention.
- Also new for 2018 is the requirement that the electrical safety program must follow a specific "hierarchy of controls" when controlling risk.
- This hierarchy prioritizes the elimination of the hazard as the first priority.
- For electrical hazards, this typically means removing unnecessary equipment or eliminating the need to expose energized parts. It can also mean de-energizing equipment and creating an electrically safe condition which also eliminates electrical hazards.
- When hazard elimination is not possible, the next priority is substitution. For example, this may mean replacing older electrical equipment with newer equipment designed to reduce risk.
- The third risk control method in the hierarchy of controls is engineering controls. For electrical hazards, engineering controls may be the addition of cover plates or shielding to prevent exposure to energized parts.
- The fourth risk control method in the hierarchy is awareness and administrative controls. Examples of awareness and administrative controls may be written procedures, signage and training used to restrict access to hazard areas.
- Finally, the least effective risk control method and the last choice in the hierarchy of controls to reduce risk is to protect the worker with personal protective equipment.

THE QUALIFIED PERSON

- One important safety principle contained in the NFPA 70E is that an electrical worker must be "qualified" for the work to be performed. A qualified person is defined as follows: "A qualified person is one who has demonstrated skills and knowledge related to the construction

and operation of the electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risks."

- Some skills that a qualified electrical worker should be able to demonstrate include:

—Distinguish exposed energized conductors and circuit parts from other parts of the equipment;

—Determine the nominal voltage of exposed energized conductors and circuit parts;

—Determine the Approach Boundary distances;

—Demonstrate the decision making process necessary to perform job safety planning, hazard identification, risk assessment and the selection of appropriate risk control methods including personal protective equipment.

ESTABLISHING AND VERIFYING AN ELECTRICALLY SAFE WORK CONDITION

- The 2018 version of 70E has reorganized the requirements of the lockout/tagout program and its principles, equipment and procedures in article 120.1 thru 120.4.
- Article 120.5 then explains the process for establishing and verifying an electrically safe work condition. An electrically safe work condition is defined as "a state in which an electrical conductor or circuit part has been disconnected from energized parts, locked and tagged in accordance to established standards, tested to ensure the absence of voltage and temporarily grounded for personnel protection if determined necessary."
- To create an electrically safe working condition, first determine all possible sources of electrical supply to the equipment.
- Next, disconnect any active loads.
- Then open the disconnecting device for each source of electrical supply.
- Visually verify if possible, that all blades of disconnecting devices are fully open and that draw-out type circuit breakers are withdrawn to the fully disconnected position.
- Next, release any stored electrical energy such as that found in capacitors and release or block any stored mechanical energy such as springs under tension or items that could be impacted by gravity.
- Then apply company approved locks and tags to the open disconnecting devices in accordance with your facility's lockout tagout procedures.
- Finally, no electrical lockout is complete without testing for the absence of voltage and applying grounds when necessary.
- It's critical that testing for an absence of voltage be done using an adequately rated test instrument.
- For voltages over 1,000 volts, a non-contact test instrument is permitted.
- The test instrument must be verified to be working properly by measuring a known voltage source immediately prior to voltage testing.
- When testing to confirm an absence of voltage, test each phase conductor or circuit part both phase to ground and to phase, for all phases.
- Once voltage testing is complete, immediately verify the test instrument again on a known voltage source.
- Until you have verified the existence of an electrically safe work condition and all other provisions of Article 120 have been met, the electrical conductors and circuit parts are not considered to be in an electrically safe condition and all safe work practices applicable to the circuit voltage and energy level must be used.
- Once the electrical conductors and circuit parts are verified to be in an electrically safe work condition, then no electrical hazards exist.
- This means that shock and arc-flash protection are no longer necessary and may be removed. This also means that other workers who are not qualified electrical workers may enter the area as needed.

APPROACH BOUNDARIES

- Remember, until you have verified the existence of an electrically safe work condition, all safe work practices applicable to the circuit voltage and energy level must be used. This includes establishing approach boundaries for shock protection and arc-flash protection and wearing appropriate PPE for both shock and arc-flash protection.
- There are two approach boundaries for shock protection: the Limited Approach Boundary and the Restricted Approach Boundary.
- The Limited Approach Boundary is the shock protection boundary farthest away from exposed energized electrical conductors or circuit parts and is established to keep unqualified persons a safe distance from exposed energized parts.
- Unqualified workers may not cross the Limited Approach Boundary unless briefed on the hazards and continuously escorted by a qualified person.
- The Restricted Approach Boundary is the shock protection boundary closest to the exposed energized parts and may only be crossed by qualified electrical workers following safe electrical work-practices which include wearing appropriate shock protection PPE and using insulated tools.
- Shock protection PPE must include voltage rated gloves anytime the nominal voltage is greater than 50 volts.
- The distance from an energized part or conductor to each of these shock protection boundaries increases as the nominal voltage increases. One of the required skills of a qualified electrical worker is determining the nominal voltage of the equipment on which they intend to work.
- Once this information is known, the shock protection approach boundaries may be looked up in Table 130.4(D)(a) for alternating current or "AC" systems and in table 130.4(D)(b) for direct current or "DC" systems.

THE ARC-FLASH BOUNDARY

- A qualified electrical worker must also be able to determine the Arc-flash Boundary and the required Arc-flash PPE for the job task they intend to perform.

- During an arc-flash event, a large amount of thermal energy or “heat energy” is released. The amount of thermal energy at a given distance from an arc source is referred to as the “incident energy.”
- The 2018 NFPA 70E recognizes two units of measure for incident energy: calories and joules. The arc-flash boundary is placed at the approach limit distance where the incident energy is equal to 1.2 calories per square centimeter or five joules per square centimeter.
- These values were chosen because this is the amount of thermal energy which may result in the onset of a second-degree burn on unprotected skin. A second degree burn, while painful, is a curable burn which typically has no lasting damage.
- To protect against thermal burns, arc-rated clothing and protective equipment must be selected to meet or exceed the predicted incident energy of a potential arc-flash at the “working distance” of the task to be performed. The working distance is the distance of a worker’s face and chest area from a potential arc source while performing a specific task.
- One method that electrical workers can use to determine both the arc-flash boundary and the appropriate arc-flash hazard PPE is to utilize the tables contained in the 2018 NFPA 70E for common electrical systems.
- Table 130.7(C)(15)(a) may be used for common AC systems and Table 130.7(C)(15)(b) may be used for common for DC systems.
- Before using these tables, you must ensure that the circuit and equipment on which you intend to work match the available fault current and fault clearing times noted in the table.
- If your equipment does not match these specifications, you may not use these tables to determine the Arc-flash Boundary distance or the appropriate arc-flash hazard PPE. An incident energy analysis must be performed instead.
- An incident energy analysis is a calculation based on the specific design and condition of the electrical system in question. The incident energy analysis is used to predict the incident energy of a potential arc-flash.
- Two of the critical factors used during an incident energy analysis are the available fault current and the speed of any over-current protection. NFPA 70E Annex D contains detailed information on performing an incident energy analysis.
- The arc-flash boundary is typically the outermost of all approach boundaries and must be marked with barricading and hazard signage.
- One method used to meet this requirement is using red "Danger High Voltage” barricade tape, which serves the dual purpose of being both a barricade and a danger sign.
- Workers may not cross the Arc-flash Boundary unless they are briefed on the hazards and are wearing appropriate arc-rated clothing and protective equipment.

ARC-RATED CLOTHING

- Arc-rated clothing is designed to withstand both the intense heat and force of an arc blast without breaking open or bursting into flames.
- When unprotected workers cross the arc-flash protection boundary without arc-rated clothing and protective equipment, they place themselves at risk of serious burn injury. These burns are often made much worse by the ignition of flammable clothing.
- Clothing that is not arc-rated, such as 100 percent cotton or wool, can burst into flames and continue to burn even after the arc is extinguished. Other fabrics such as polyester or nylon will also melt into the skin, making a burn even worse.
- The survival rate of serious burn injury is largely dependent on the percentage of body burned. Preventing your clothing from igniting during an arc-flash incident is often the difference between life and death.

ARC-FLASH HAZARD PPE CATEGORIES

- The Arc-flash Hazard PPE tables in the 2018 70E standard list the required arc-flash protection as being in one of four arc-flash PPE categories.
- Each arc-flash PPE Category requires a specific level of arc rated protection, measured in calories per square centimeter or joules per square centimeter.
- Category One requires arc-rated clothing of at least four calories per square centimeter or 16.75 joules per square centimeter. This must include arc-rated long sleeves and long pants or arc-rated coveralls. Also required is an arc-rated face shield or an arc-rated flash suit hood.
- Category Two requires arc-rated clothing of at least eight calories per square centimeter or 33.5 joules per square centimeter. This must include arc-rated long sleeves and long pants or arc-rated coveralls. Also required is an arc-rated face shield combined with an arc-rated balaclava or an arc-rated flash suit hood.
- Category Three requires a system of arc-rated clothing that provides a minimum of 25 calories per square centimeter or 104.7 joules per square centimeter.
- This system of arc-rated clothing may consist of any combination of the following provided that the chosen combination has been tested and verified to provide the required level of arc-flash protection: arc-rated long sleeves, arc-rated long pants, arc-rated coveralls, arc-rated flash suit pants and arc-rated flash suit jacket. Also required is an arc-rated flash suit hood.
- Category Four requires a system of arc-rated clothing that provides a minimum of 40 calories per square centimeter or 167.5 joules per square centimeter.
- This system of arc-rated clothing may consist of any combination of the following provided that the chosen combination has been tested and verified to provide the required level of arc-flash protection: arc-rated long sleeves, arc-rated long pants, arc-rated coveralls, arc-rated flash suit pants and arc-rated flash suit jacket. Also required is an arc-rated flash suit hood.
- Each of the four arc-flash PPE categories also requires the following protective equipment: voltage-rated hardhat, safety glasses or safety goggles, ear canal insert-type hearing protection, leather footwear and leather gloves or voltage-rated gloves with leather protectors.
- Category three and four require that gloves be arc-rated.

FIELD LABELS

- The 2018 NFPA 70E requires that the owner of electrical equipment install field-labels on equipment. These labels must display the nominal system voltage, the arc-flash boundary and at least one of the following two items: the arc-flash hazard PPE category and/or the

minimum arc rating of clothing and PPE.

- If an incident energy calculation was used to determine the appropriate arc-flash hazard PPE, then the incident energy level and corresponding working distance may be substituted on the label for the arc-flash PPE category.
- Having this critical information readily available on the equipment label makes the selection of proper arc-rated clothing and PPE much easier for electrical workers.

NORMAL OPERATION OF ENERGIZED ELECTRICAL EQUIPMENT

- The 2018 NFPA 70E allows for the normal operation of energized electrical equipment, provided that a normal operating condition exists.
- For a normal operating condition to exist:

—The equipment must be properly installed and maintained;

—The equipment must be used in accordance with instructions included in the listing and labeling and in accordance with the manufacturer's instructions;

—The equipment doors are closed and secured;

—All equipment covers are in place and secured;

—There is no "evidence of impending failure." Evidence of impending failure includes evidence of arcing, overheating, loose or bound equipment parts or deterioration.

ENERGIZED WORK AND THE ENERGIZED WORK PERMIT

- The 2018 NFPA 70E requires an Energized Electrical Work Permit anytime work is performed within the Restricted Approach Boundary and/or anytime a worker interacts with equipment when an increased likelihood of injury or damage to health from an exposure to an arc-flash hazard exists.
- Always remember that energized work is only allowed in the following limited circumstances:

—When it can be demonstrated that de-energizing introduces additional or increased hazards. Examples include life support equipment, emergency alarm systems or hazardous location ventilation equipment;

—When the electrical conductors and circuit parts operate at less than 50 volts and it is determined that there is no increased exposure to electric burns or arcs;

—When it can be demonstrated that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

- An Energized Electrical Work Permit is not required under the following conditions: testing, troubleshooting and voltage measuring, thermography, ultrasound or visual inspections if the restricted approach boundary is not crossed.
- An Energized Electrical Work Permit is not required for general housekeeping and non-electrical tasks provided that the restricted approach boundary is not crossed.

ANSWERS TO THE REVIEW QUIZ

1. a
2. b
3. c
4. a
5. b
6. a
7. a
8. c
9. b
10. c

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REVIEW QUIZ

The following questions are provided to determine how well you understand the information presented in this program.

Name_____Date_____

A qualified worker must be able to determine Approach Boundary distances.

a. True
b. False

2. What is the first step in creating an electrically safe working condition?

a. Disconnecting any active loads
b. Determining all possible sources of electrical supply to the equipment
c. Opening the disconnecting device for each source of electrical supply

3. When should a voltage test instrument be verified to be working properly?

a. Immediately prior to testing
b. Immediately after testing
c. Both immediately prior to testing and immediately after testing

Which approach boundary is the closest to the exposed energized parts?

a. The Restricted Approach Boundary
b. The Limited Approach Boundary

5. Shock protection PPE that includes voltage rated gloves is not required unless the nominal voltage is greater than 120 volts.

a. True
b. False

6. If your equipment does not match the available fault current and fault clearing times noted in the 2018 NFPA 70E tables, you may NOT use these tables to determine the Arc-Flash Boundary distance or the appropriate arc-flash hazard PPE.

a. True
b. False

7. The arc-flash boundary is typically the outermost of all approach boundaries and must be marked with barricading and hazard signage.

a. True
b. False

8. Arc-flash PPE _____ requires a system of arc-rated clothing that provides a minimum of 25 calories per square centimeter or 104.7 joules per square centimeter.

a. Category 1
b. Category 2
c. Category 3
d. Category 4

9. The installation of field labels on electrical equipment is NOT required by the 2018 NFPA 70E.

a. True
b. False

10. An energized electrical work permit is not required to perform general housekeeping and non-electrical tasks provided that the _____ boundary is not crossed.

a. Arc-flash
b. Limited approach
c. Restricted approach