Electrical Safety-Related Work Practices and the 2021 NFPA® 70E®
for Supervisors and Managers

LENGTH: 36 MINUTES

PROGRAM SYNOPSIS:
This program provides supervisors and managers of electrical workers a clear understanding of the requirements of the 2021 NFPA 70E. Included in these requirements and outlined in this program are the hierarchy of controls to eliminate electrical hazards, the required elements of the electrical safety program, worker training requirements, program audits, risk assessments and the proper labeling of electrical equipment for shock and arc flash hazards. The dual hazards of electric shock and arc flash are explained in this program as well as the factors that contribute to the severity of injury, including an explanation of the incident energy associated with an arc flash and how this is used to establish the Arc Flash Boundary distance.

Also explained are the conditions that require an electrically safe work condition to be established as well as the step-by-step process of creating and verifying an electrically safe work condition. In addition, the program describes those limited instances when energized work is allowed as well as the safe work practices and procedures that are required for work involving electrical hazards. This includes the Energized Electrical Work Permit, shock and arc flash risk assessments, job planning and job briefing, the establishment of approach boundaries and the selection of arc-rated clothing and PPE.

The definition of a qualified electrical worker is explained as well as the knowledge and skills required for a qualified electrical worker to cross the Restricted Approach Boundary. Also included are the restrictions and exceptions for unqualified workers related to the various approach boundaries.

To assist supervisors and managers in seeking out additional information, this program provides the regulation's article and section numbers for the referenced information as well as the specific numbers of the look-up tables used to determine approach boundaries and the selection of personal protective equipment.

PROGRAM OBJECTIVES:
After watching the program, the participant should be able to explain the following:
- What the two hazards of electricity are and what factors contribute to the amount of damage they can cause;
- Which circumstances permit the performance of energized work;
- How the risks of exposure to electrical hazards are assessed and controlled;
- What the elements of the Electrical Safety Program are, including incident investigation, auditing and training;
- What the requirements for a qualified person are;
- How to create and verify an electrically safe work condition;
- What the requirements for the two approach boundaries and the Arc Flash Boundary are;
- Which clothing and personal protective equipment is required for each of the four Arc Flash PPE Categories.

PROGRAM OUTLINE:

INTRODUCTION
- There are a wide variety of electrical equipment and electrical-related tasks that workers may be exposed to as they perform their job duties each day.
- Protecting electrical workers from the hazards of electricity is the purpose of your organization's Electrical Safety Program and its safe work practices and procedures.
- One of the leading authorities on electrical safety is the National Fire Protection Association, the NFPA. Their standard for electrical safety in the workplace, "70E", is recognized by many regulatory authorities as the "best practices" for electrical safety and has been incorporated by reference into many safety and health regulations.
- In this program, we will review Chapter One of the 2021 NFPA 70E, titled, "Safety-Related Work Practices." This section of the regulation is commonly used as the blueprint for creating an Electrical Safety Program in the workplace. Being familiar with its requirements is critical for understanding, implementing and following safe electrical work practices.

ARTICLE 105
- The 2021 edition of the NFPA 70E recognizes that electrical safety requires the commitment of both employers and employees. As such, article 105 includes both the employee and the employer's responsibilities regarding the Electrical Safety Program.
- Employers shall establish, document and implement the safety-related work practices and procedures required by the 2021 NFPA 70E and provide employees with training on the established work practices and procedures.
- Employees have the responsibility to comply with the safety-related work practices and procedures provided by the employer.

TWO HAZARDS OF ELECTRICITY

- The 2021 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 exposed energized electrical conductors or circuit parts."
- There are several factors that contribute to the amount of damage caused by an electric shock, including:

—The amount of electric current,
—The frequency of the power source,
—The current's path through the body,
—The time duration of the shock event.

- The other main hazard associated with electricity is an arc flash. 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."
- There are several factors that contribute to the amount of damage that may be caused by an arc flash, including:

—The amount of fault current,
—The duration of the arc event,
—The distance of a worker from an electric arc source,
—The protective equipment worn by the worker.

HAZARD ELIMINATION/ELECTRICALLY SAFE WORK CONDITION

- Article 110 of the 2021 NFPA 70E contains the "General Requirements for Electrical Safety-Related Work Practices." The regulation requires that, when safety-related work practices are implemented, hazard elimination must be the first priority.
- One method that can be used to eliminate electrical hazards is to create 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 verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection."
- The requirement to create an electrically safe work condition is listed in Article 110.3, which states that energized conductors or circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work if any of the following conditions exist:

—The employee is within the Limited Approach Boundary;
—The employee interacts with equipment, where conductors or circuit parts are not exposed, but an increased likelihood of injury from an exposure to an arc flash hazard exists.

- It's important to note that an electrically safe work condition is not a procedure, but rather a temporary state wherein all electrical conductors or circuit parts to which a worker may be exposed are maintained in a de-energized state.
- The process of creating an electrically safe work condition is commonly referred to as the "control of hazardous energy" and also as "lockout/tagout."
- The 2021 NFPA 70E lists the requirements for creating an electrically safe work condition in Article 120 as well as listing the overall requirements of the Lockout/Tagout Program.
- All electrical workers must understand that electrical conductors and circuit parts are not considered to be in an electrically safe work condition until all of the requirements of Article 120 have been met.
- This requires that all safe work practices, including shock protection and arc flash protection appropriate for the circuit voltage and energy level, must be used until an electrically safe work condition has been established.

ENERGIZED WORK

- In Article 110.4, the 2021 NFPA 70E outlines the limited circumstances where performing energized work is permitted.
- Energized work is permitted when it can be demonstrated that de-energizing introduces additional or increased hazards. Examples of additional hazards include the interruption of life support equipment, deactivation of emergency alarm systems or the shutdown of hazardous location ventilation equipment.
- Energized work is permitted when the electrical conductors and circuit parts operate at less than 50 volts and it is determined that there will be no increased exposure to electric burns or to explosion due to electric arcs. When making this determination, the capacity of the energy source and the overcurrent protection that exists between the source and the worker must be considered.
- Energized work is permitted 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.
- Examples of work that may be infeasible in a de-energized state include testing, troubleshooting, voltage measuring and thermography.
- The normal operation of energized equipment is also permitted as long as "normal operating conditions" exist. 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.

THE ELECTRICAL SAFETY PROGRAM

- The regulation also requires employers to implement and document 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."
- Article 110.5 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 and be developed to provide the self-discipline required for employees to follow safe work practices while performing work that may involve electrical hazards.
—The Electrical Safety Program must identify the principles on which it is based, the controls by which it is measured and the procedures that must be utilized before work is started by employees exposed to an electrical hazard.
—The Electrical Safety Program must include an electrically safe work condition policy that complies with the requirements of 110.3.
—The Electrical Safety Program must also include elements to inspect and verify that newly installed or modified equipment is in compliance with applicable industry codes and standards prior to being put into service.

- In addition, the program must also consider the condition and maintenance of electrical equipment and systems.

THE RISK ASSESSMENT PROCEDURE

- The 2021 NFPA 70E includes a requirement that the Electrical Safety Program include a risk assessment procedure. 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 procedure must address employee exposure to electrical hazards and identify the process to be used to identify hazards, assess risks and implement risk control measures.
- The 2021 NFPA 70E recognizes that the potential for human error is an important factor in assessing risk. The standard requires that the risk assessment procedure address the potential for human error and its negative consequences on people, processes, the work environment and equipment relative to the electrical hazards in the workplace.
- 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 2021 NFPA 70E includes Annex Q to provide more information on the concept of human performance and also Annex F to provide more information on risk assessment and control.

THE HIERARCHY OF RISK CONTROL METHODS

- The Electrical Safety Program required by Article 110.5 must include a specific "hierarchy of controls" that must be followed when risk control methods are implemented.
- 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 and fifth risk control methods in the hierarchy are 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 control risk is to protect the worker with personal protective equipment.

JOB SAFETY PLAN AND JOB BRIEFING

- Article 110 also requires that a job safety plan be completed and a job briefing be conducted by the employee in charge prior to starting any job that involves exposure to electrical hazards.
- The job safety plan must be documented and 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 each task,
—A shock risk assessment for tasks involving a shock hazard,
—An arc flash risk assessment for tasks involving an arc flash hazard,
—The methods to be used to identify and control the sources of hazardous energy,
—The work procedures involved,
—Any special precautions to be taken.

- The job briefing must be conducted with all involved employees prior to beginning any job with exposure to electrical hazards. 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.
- It's important to understand that additional job safety planning and job briefings must occur if changes to the scope of work take place during the course of work that might affect the safety of employees.

INCIDENT INVESTIGATION

- Article 110 of the 2021 NFPA 70E also requires that the Electrical Safety Program include elements to investigate electrical incidents.
- Electrical incidents include events or occurrences that result 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.

AUDITING

- The Electrical Safety Program must also include an auditing program that includes audits of the Electrical Safety Program itself, all field work and the Lockout/Tagout Program.
- 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 and its procedures, the worker's lockout/tagout training and the worker's execution of the lockout/tagout procedures.

TRAINING REQUIREMENTS

- Article 110.6 specifies the training requirements for electrical safety training. Employees exposed to an electrical hazard shall be trained to understand the specific hazards associated with electrical energy, which includes the shock hazard and the arc flash hazard.
- These employees must also be trained in the safe electrical work practices and procedures, as necessary, to provide protection from the electrical hazards associated with the job or task and they must be trained to identify and understand the relationship between electrical hazards and possible injury.

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.
- A qualified person must be trained and knowledgeable in the construction and operation of equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method.
- The training requirements also require that a qualified person be familiar with insulated tools and shielding materials, test equipment and PPE.
- A qualified person must also be trained in the selection of an appropriate test instrument to verify the absence of voltage and be able to demonstrate its use and understand its limitations.
- It's important to understand that a person may be qualified with respect to certain equipment and tasks, but still be unqualified for others.
- Before a qualified person is permitted to work within the Limited Approach Boundary, they must, at a minimum, be additionally trained on and able to demonstrate the following:

—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 and the corresponding voltages to which they will be exposed,
—Demonstrate the decision-making process necessary to perform job safety planning, identify electrical hazards, risk assessment and the selection of appropriate risk control methods including personal protective equipment.

- Those workers who are considered "unqualified" are not permitted to perform work on electrical systems that have not been placed in an electrically safe work condition.

OTHER REQUIRED TRAINING

- Unqualified workers must be trained in and be familiar with any electrical safety-related practices necessary for their safety.
- The training requirements listed in Article 110.6 also include training specific to the Lockout/Tagout Program, as well as Emergency Response Training.
- Employees involved in the Lockout/Tagout Program must be trained in the lockout/tagout procedures as well as their responsibilities in the execution of those procedures.
- Lockout/tagout re-training must take place at least every three years, anytime a procedure is revised or when an employee is found to be in non-compliance.
- Emergency Response Training must include annual "contact release" training for all employees exposed to electric shock hazards. Contact release refers to the safe release of workers who are in contact with energized parts.
- When a person is being shocked, a potential rescuer must not touch the shock victim because of the risk of also being shocked.
- When possible, the power source for the conductor or equipment should be interrupted or opened in order to safely release the victim. If this is not possible, a non-conductive object can be used to push the victim away from the energized conductor or circuit part.
- In addition, any employees responsible for responding to medical emergencies must be trained in first aid, cardiopulmonary resuscitation (CPR) and the use of an automated external defibrillator (AED) when one is provided as part of the emergency response plan.

CREATING AN ELECTRICALLY SAFE WORK CONDITION

- With limited exceptions, an electrically safe work condition is required before beginning work on electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts. The process for establishing and verifying an electrically safe work condition is listed in Article 120.5.
- To create an electrically safe work condition, first, determine all possible sources of electrical supply to the equipment. Next, interrupt the load current by disconnecting 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 "test" position or to the "fully disconnected" position.
- Next, release any stored electrical energy, such as that found in capacitors. Block or relieve any stored nonelectrical energy in devices so that circuit parts cannot be unintentionally energized by their movement.
- Then, apply lockout/tagout devices in accordance with a documented and established procedure.
- After the lockout/tagout devices have been applied, the next step is to test each phase conductor or circuit part for an absence of voltage.
- Testing for an absence of voltage must be done using an adequately rated, portable test instrument. For voltages over 1,000 volts, a non-contact, capacitive 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 phase to phase, for all phases.
- Once voltage testing is complete, immediately verify the test instrument again on a known voltage source.
- When there is a possibility of induced voltages or stored energy, all circuit conductors and parts should be grounded before touching them.
- Temporary protective grounds should be installed when the possibility exists that the conductors or circuit parts could come in contact with other exposed energized parts or conductors.
- Remember, 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 work condition and all safe work practices applicable to the circuit voltage and energy level must be used.
- However, 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.

WORK INVOLVING ELECTRICAL HAZARDS

- Article 130 of the 2021 NFPA 70E, titled "Work Involving Electrical Hazards", lists the requirements for work involving electrical hazards when an electrically safe work condition has not been established.
- Some of the items addressed in this section include the Energized Electrical Work Permit, Approach Boundaries and Shock and Arc Flash Risk Assessments.
- Recall that Article 110.4 outlines the limited circumstances where performing energized work is permitted. When energized work is performed in accordance with Article 110.4, the following requirements shall apply:

—Only qualified workers are permitted to work on electrical conductors or circuit parts that have not been placed in an electrically safe work condition;

—An Energized Electrical Work Permit shall be completed when the work to be performed is within the Restricted Approach Boundary or the worker interacts with the equipment when conductors or circuit parts are not exposed, but an increased likelihood of injury from exposure to an arc flash hazard exists;

—A shock risk assessment shall be performed and an arc flash risk assessment shall be performed.

- Article 130 provides exceptions to the requirement for an Energized Electrical Work Permit. A qualified person who is following appropriate safe work practices and using required PPE may perform the following work without an Energized Electrical Work Permit:

—Testing, troubleshooting or voltage measuring,

—Thermography, ultrasound or visual inspections if the Restricted Approach Boundary is not crossed,

—Access to and egress from an area with energized electrical equipment if no electrical work is performed and the Restricted Approach Boundary is not crossed,

—General housekeeping and non-electrical tasks, provided that the Restricted Approach Boundary is not crossed.

SHOCK RISK ASSESSMENT/APPROACH BOUNDARIES

- Prior to performing work on energized conductors or circuit parts, Article 130.4 requires a shock risk assessment be performed.
- The shock risk assessment must Identify the shock hazards, estimate the likelihood of the occurrence of injury or damage to health related to a potential shock event, estimate the potential severity of injury or damage to health related to a potential shock event and determine if additional protective measures are required, including the use of PPE.
- The estimate of likelihood and severity must consider the design of the electrical equipment, its operating condition and its condition of maintenance.
- If it is determined that the use of personal protective equipment or other additional protective measures are required, then the voltage to which personnel will be exposed must also be determined and the two shock protection approach boundaries must be determined.

- The Limited Approach Boundary is the shock protection boundary farthest away from the 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.
- There are no circumstances which would allow an unqualified person to cross the Restricted Approach Boundary.
- Once the nominal voltage is determined, the shock protection approach boundaries may be looked up in Table 130.4(E)(a) for alternating current, or AC, systems and in Table 130.4(E)(b) for direct current, or DC, systems.

ARC FLASH RISK ASSESSMENT/ARC FLASH BOUNDARY/ARC FLASH PPE

- Article 130.5 requires an arc flash risk assessment be performed prior to performing work on energized conductors or circuit parts.
- The arc flash risk assessment must identify the arc flash hazards, estimate the likelihood of the occurrence of injury or damage to health related to a potential arc flash event, estimate the potential severity of injury or damage to health related to a potential arc flash event and determine if additional protective measures are required, including the use of personal protective equipment.
- The estimate of likelihood and severity must consider the design of the electrical equipment, its overcurrent protective equipment and its operating time. The equipment's operating condition and its condition of maintenance must also be considered.
- The 2021 NFPA 70E provides Table 130.5(C) as a means to estimate the likelihood of an arc flash event and help determine if additional protective measures are required.
- If it is determined that the use of personal protective equipment or other additional protective measures are required, then the following must be determined: appropriate safety-related work practices, the Arc Flash Boundary and the personal protective equipment to be used within the Arc Flash Boundary.
- 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 amount of incident energy is greatest closest to the arc source and decreases with distance away from the arc source.
- The regulation requires that the Arc Flash Boundary be 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.
- The outermost approach boundary, typically the Arc Flash Boundary, must be marked with barricading and hazard signage. One method commonly 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.
- To protect against thermal burns when working inside the Arc Flash Boundary, 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 PPE is to utilize the tables provided in Article 130.
- First, use Table 130.5(C) to determine the likelihood of an arc flash occurrence. If an arc flash occurrence is likely, then 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 DC systems to determine the Arc Flash Boundary and the required Arc Flash PPE Category.
- Before using these tables, you must ensure that the circuit and equipment upon which you intend to work match the available fault current and fault clearing times noted in the table.

ARC FLASH PPE CATEGORIES

- Table 130.7(C)(15)(c) contains the PPE requirements for each Arc Flash PPE Category.
- Arc Flash PPE 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 are an arc-rated face shield or an arc-rated flash suit hood and heavy leather gloves, arc-rated gloves or voltage-rated gloves with leather protectors.
- Arc Flash PPE 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 are arc-rated face shield combined with an arc-rated balaclava or an arc-rated flash suit hood and heavy leather gloves, arc-rated gloves or voltage-rated gloves with leather protectors.
- Arc Flash PPE 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.
- Also required are an arc-rated flash suit hood and arc-rated gloves or voltage-rated gloves with leather protectors.
- Arc Flash PPE 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.
- Also required are an arc-rated flash suit hood and arc-rated gloves or voltage-rated gloves with leather protectors.
- In addition, each of the four arc-flash PPE categories also requires the following protective equipment: a voltage-rated hard hat,

safety glasses or safety goggles, ear canal insert-type hearing protection and leather footwear.

INCIDENT ENERGY ANALYSIS

- It's important to understand that if your equipment does not match the specifications noted in Table 130.7(C)(15)(a) or 130.7(C)(15)(b), then you may not use these tables to determine the Arc Flash Boundary distance or the appropriate arc flash PPE.
- An incident energy analysis must be performed instead. When using the incident energy analysis method to determine appropriate arc flash PPE, Table 130.5(G) must be used to select arc-rated clothing and other PPE.
- 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.

EQUIPMENT LABELS

- The 2021 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 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 PPE, then the incident energy level and corresponding working distance should 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.

CLOSING

- In this program, we have provided an overview of the safety-related work practices and requirements listed in Chapter One of the 2021 NFPA 70E.
- Keep in mind that we have not covered the entirety of the 70E regulation in this program, nor have we explained all aspects of electrical safety. Each worker and employer has a responsibility to become familiar with all aspects of the NFPA 70E, other applicable electrical and safety regulations as well as your facility's Electrical Safety Program.
- Never forget that the ultimate goal of the Electrical Safety Program is for all electrical workers to make it home safely at the end of each day.

ANSWERS TO THE REVIEW QUIZ

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

Electrical Safety-Related Work Practices and the 2021 NFPA® 70E® for Supervisors and Managers
REVIEW QUIZ

Name_____Date_____

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

1. _____ of the 2021 NFPA 70E includes both the employee and the employer's responsibilities regarding the Electrical Safety Program.

a. Article 105
b. Article 110
c. Article 120

2. Which of the following is NOT a factor that contributes to the amount of damage caused by an electric shock?

a. The amount of electric current
b. The time duration of the shock event
c. The ambient temperature
d. The current's path through the body

3. The amount of incident energy is greatest, closest to the arc source and decreases with distance away from the arc source.

a. True
b. False

4. According to the hierarchy of controls, which risk control method must be the first priority?

a. Substitution
b. Elimination
c. PPE
d. Engineering Controls

5. The risk assessment procedure is NOT required to address the potential for human error.

a. True
b. False

6. The Electrical Safety Program itself must be audited at least every _____ to verify that its principles and procedures are in compliance with the most current NFPA 70E standard.

a. Year
b. 3 years
c. 5 years

7. Only qualified workers are permitted to work on electrical conductors or circuit parts that have not been placed in an electrically safe work condition.

a. True
b. False

8. Which Arc Flash PPE Category requires arc-rated clothing that provides a minimum of 8 calories per square centimeter or 33.5 joules per square centimeter?

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

9. When must an incident energy analysis be used to determine the Arc Flash Boundary distance and appropriate arc flash PPE?

a. When the nominal voltage exceeds 10,000 volts
b. When the fault current is unknown
c. When the equipment does <u>not</u> meet the specifications of table 130.7(C)(15)
d. Always

10. Which of the following is NOT required to be listed on a field label?

a. Nominal System Voltage
b. Maximum Fault Current
c. Arc Flash Boundary
d. Arc Flash PPE Category