

**ANSWER SHEET • Safe Jobsite Electrical Practices (IRE) • Course No. WA2023-442**

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## SAFE JOBSITE ELECTRICAL PRACTICES (IRE)

### NFPA 70E

#### Standard for Electrical Safety in the Workplace

**90.3 Standard Arrangement.** This standard is divided into the introduction and three chapters; 90.3. Chapter 1 applies generally for safety-related work practices;

**Chapter 2** applies to safety-related maintenance requirements for electrical equipment and installations in workplaces.

**Chapter 3** supplements or modifies Chapter 1 with safety requirements for special equipment.

**90.4 Organization.** This standard is divided into the following 3 chapters and 16 informative annexes:

- (1) Chapter 1, Safety-Related Work Practices
- (2) Chapter 2, Safety-Related Maintenance Requirements
- (3) Chapter 3, Safety Requirements for Special Equipment
- (4) Informative Annex A, Referenced Publications
- (5) Informative Annex B, Informational References
- (6) Informative Annex C, Limits of Approach
- (7) Informative Annex D, Incident Energy and Arc Flash Boundary Calculation Methods
- (8) Informative Annex E, Electrical Safety Program
- (9) Informative Annex F, Risk Assessment Procedure
- (10) Informative Annex G, Sample Lockout/Tagout Procedure
- (11) Informative Annex H, Guidance on Selection of Protective Clothing and Other Personal Protective Equipment
- (12) Informative Annex I, Job Briefing and Planning Checklist
- (13) Informative Annex J, Energized Electrical Work Permit
- (14) Informative Annex K, General Categories of Electrical Hazards
- (15) Informative Annex L, Typical Application of Safeguards in the Cell Line Working Zone
- (16) Informative Annex M, Layering of Protective Clothing and Total System Arc Rating
- (17) Informative Annex N, Example Industrial Procedures and Policies for Working near Overhead Electrical Lines and Equipment
- (18) Informative Annex O, Safety-Related Design Requirements
- (19) Informative Annex P, Aligning Implementation of This Standard with Occupational Health and Safety Management Standards



**Informative annexes** are not part of the requirements of this standard but are included for informational purposes only.

## EXAM QUESTIONS

1. **What part of the NFPA 70E should be used when developing energized electrical work permits?**
  - A. Annex I
  - B. Annex G
  - C. Annex J
  - D. Annex H
2. **What annex of this code would you reference to determine the correct way of performing a Risk Assessment Procedure?**
  - A. 1
  - B. C
  - C. D
  - D. F
3. **What are not part of the requirements of this code, but are included for informational purposes only?**
  - A. Informational notes
  - B. Informative annexes
  - C. Exceptions
  - D. Informative notes
4. **What chapter of this code applies to the Safety-Related Work Practices for electrical equipment and installations in workplaces?**
  - A. 3
  - B. 2
  - C. 1
  - D. 16
5. **What annex of this code would you reference to determine the limits of approach for electrical equipment?**
  - A. C
  - B. F
  - C. D
  - D. 1
6. **Where would you find a job briefing and planning checklist in this code?**
  - A. Annex H
  - B. Annex G
  - C. Annex E
  - D. Annex I
7. **Where would you find information regarding electrical safety programs in this code?**
  - A. Chapter 2
  - B. Annex E
  - C. Chapter 1
  - D. Annex D
8. **Where would you find sample lockout/tagout procedures in this code?**
  - A. Annex D
  - B. Chapter 2
  - C. Annex E
  - D. Annex G
9. **What chapter of this code applies to the safety requirements for special equipment for electrical equipment and installations in workplaces?**
  - A. 3
  - B. 2
  - C. 1
  - D. 16
10. **What annex in this code gives example industrial procedures and policies for working near overhead electrical lines and equipment?**
  - A. Annex G
  - B. Annex N
  - C. Annex I
  - D. Annex J
11. **What chapter of this code applies to the safety-related maintenance requirements for electrical equipment and installations in workplaces?**
  - A. 16
  - B. 1
  - C. 3
  - D. 2
12. **Where does this code list general categories of electrical hazards?**
  - A. Annex G
  - B. Annex K
  - C. Annex I
  - D. Annex J

13. How many chapters is this code organized into?

- A. 12
- B. 19
- C. 16
- D. 3

14. What annex of this code would you reference to review incident energy and arc flash boundary calculation methods?

- A. D
- B. F
- C. C
- D. 1

15. Guidance on the selection of protective clothing and other personal protective equipment can be found in what annex?

- A. Annex G
- B. Annex H
- C. Annex E
- D. Annex D

**Qualified Person.** One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved.

**Risk.** A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard.

**Risk Assessment.** An overall process that identifies hazards, estimates the potential severity of injury or damage to health, estimates the likelihood of occurrence of injury or damage to health, and determines if protective measures are required.

## ARTICLE 105

### Application of Safety-Related Work Practices

**105.3 Responsibility.** The employer shall provide the safety-related work practices and shall train the employee, who shall then implement them.

## ARTICLE 110

### General Requirements for Electrical Safety-Related Work Practices

#### 110.1 Electrical Safety Program.

**(B) Maintenance.** The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.

**(C) Awareness and Self-Discipline.** The electrical safety program shall be designed to provide an awareness of the potential electrical hazards to employees who work in an environment with the presence of electrical hazards. The program shall be developed to provide the required self-discipline for all employees who must perform work that may involve electrical hazards. The program shall instill safety principles and controls.



**(D) Electrical Safety Program Principles.** The electrical safety program shall identify the principles upon which it is based.

**Informational Note:** For examples of typical electrical safety program principles, see Informative Annex E.

**(E) Electrical Safety Program Controls.** An electrical safety program shall identify the controls by which it is measured and monitored.

**Informational Note:** For examples of typical electrical safety program controls, see Informative Annex E.

**(F) Electrical Safety Program Procedures.** An electrical safety program shall identify the procedures to be utilized before work is started by employees exposed to an electrical hazard.

**Informational Note:** For an example of a typical electrical safety program procedure, see Informative Annex E.

## ARTICLE 120

### Establishing an Electrically Safe Work Condition

**120.2 De-energized Electrical Equipment That Has Lockout/Tagout Devices Applied. (B) Principles of Lockout/Tagout Execution. (1) Employee Involvement.** Each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the lockout/tagout process.

**Informational Note:** An example of direct exposure is the qualified electrician who works on the motor starter control, the power circuits, or the motor. An example of indirect exposure is the person who works on the coupling between the motor and compressor.



**120.2 De-energized Electrical Equipment That Has Lockout/Tagout Devices Applied. (B) Principles of Lockout/Tagout Execution.**

Retraining shall be performed:

**(B) (3) Retraining.**

- (a) When the established procedure is revised
- (b) At intervals not to exceed 3 years

**(B) (4) Training Documentation.**

- (a) The employer shall document that each employee has received the training required by this section.
- (b) The documentation shall be made when the employee demonstrates proficiency in the work practices involved.
- (c) The documentation shall contain the content of the training, each employee's name, and the dates of the training.

**Informational Note:** Content of the training could include one or more of the following: course syllabus, course curriculum, outline, table of contents, or training objectives.



## EXAM QUESTIONS

16. **What article of this code covers the general requirements for electrical safety-related work practices?**
- 110
  - 100
  - 105
  - 120
17. **An overall process that identifies hazards, estimates the potential severity of injury or damage to health, estimates the likelihood of occurrence of injury or damage to health, and determines if protective measures are required is known as?**
- Risk
  - Risk Assessment
  - Job Hazard Analysis
  - Accident
18. **One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify and avoid the hazards involved would be best defined as a?**
- Authority Having jurisdiction
  - Competent Person
  - Qualified Person
  - All listed answers
19. **According to this code, who's responsibility is it to be trained on site specific safety-related work practices?**
- Employee
  - Employer
  - Mutual agreement between worker and employee
  - No requirement
20. **When is an electrical safety program required to be done that identifies the procedures to be utilized by employees exposed to the electrical hazard?**
- During the post job report
  - After the work is started
  - During the work
  - Before the work is started
21. **What is the maximum interval allowed by this code regarding lockout/tagout training?**
- 2 years
  - 3 Years
  - Annually
  - Bi Annually
22. **Who is required by this code to keep records of completed lockout/tagout training?**
- Site superintendent
  - Employee
  - Safety coordinator
  - Employer
23. **A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard would be defined as?**
- Risk Assessment
  - Risk
  - Accident
  - Job Hazard Analysis
24. **Who is required to be involved in a lockout/tagout situation?**
- Each person who could be exposed directly or indirectly to a source of electrical energy.
  - Shop Foreman
  - The Maintenance Electrician
  - The Equipment Operator



**250.1 Maintenance Requirements for Personal Safety and Protective Equipment.** Personal safety and protective equipment such as the following shall be maintained in a safe working condition:

- (1) Grounding equipment
- (2) Hot sticks
- (3) Rubber gloves, sleeves, and leather protectors
- (4) Test instruments
- (5) Blanket and similar insulating equipment
- (6) Insulating mats and similar insulating equipment
- (7) Protective barriers
- (8) External circuit breaker rack-out devices
- (9) Portable lighting units
- (10) Temporary protective grounding equipment
- (11) Dielectric footwear
- (12) Protective clothing
- (13) Bypass jumpers
- (14) Insulated and insulating hand tools



**250.4 Test Instruments.** Test instruments and associated test leads used to verify the absence or presence of voltage shall be maintained to assure functional integrity. The maintenance program shall include functional verification as described in 110.4(A)(5).

## ARTICLE 320

### Safety Requirements Related to Batteries and Battery Rooms

**320.3 Safety Procedures. (A) General Safety Hazards. (1) Battery Risk Assessment.** Prior to any work on a battery system, a risk assessment shall be performed to identify the chemical, electrical shock, and arc flash hazards and assess the risks associated with the type of tasks to be performed.

## ARTICLE 330

### Safety-Related Work Practices for Use of Lasers

#### 330.3 Safety Training.

**(A) Personnel to Be Trained.** Employers shall provide training for all operator and maintenance personnel.

**(B) Scope of Training.** The training shall include, but is not limited to, the following:

- (1) Familiarization with laser principles of operation, laser types, and laser emissions
- (2) Laser safety, including the following:
  - a. System operating procedures
  - b. Risk assessment and risk control procedures
  - c. Need for personnel protection
  - d. Accident reporting procedures
  - e. Biological effects of the laser upon the eye and the skin
  - f. Electrical and other hazards associated with the laser equipment, including the following:
    - i. High voltages (>1 kV) and stored energy in the capacitor banks
    - ii. Circuit components, such as electron tubes, with anode voltages greater than 5 kV emitting X-rays

- iii. Capacitor bank explosions
- iv. Production of ionizing radiation
- v. Poisoning from the solvent or dye switching liquids or laser media
- vi. High sound intensity levels from pulsed lasers

### 330.4 Safeguarding of Employees in the Laser Operating Area.

#### Area.

**(A) Eye Protection.** Employees shall be provided with eye protection as required by federal regulation.

**(B) Warning Signs.** Warning signs shall be posted at the entrances to areas or protective enclosures containing laser products.

**(C) Master Control.** High-power laser equipment shall include a key-operated master control.

**(D) High-Power Radiation Emission Warning.** High power laser equipment shall include a fail-safe laser radiation emission audible and visible warning when it is switched on or if the capacitor banks are charged.

**(E) Beam Shutters or Caps.** Beam shutters or caps shall be used, or the laser switched off, when laser transmission is not required. The laser shall be switched off when unattended for 30 minutes or more.

**(F) Aiming.** Laser beams shall not be aimed at employees.

**(G) Label.** Laser equipment shall bear a label indicating its maximum output.

**(H) Personal Protective Equipment (PPE).** PPE shall be provided for users and operators of high-power laser equipment.



## EXAM QUESTIONS

25. Who is responsible for the training with regards to the safety-related work practices when using lasers?
- A. State code enforcement
  - B. Department of Energy
  - C. City code enforcement
  - D. Employer
26. What section of this code describes the functional verification requirement for test instruments?
- A. 110.5(A)(4)
  - B. 110.4(A)(5)
  - C. 110.4(B)(5)
  - D. 110.4(B)(4)
27. What is a laser equipment label required to indicate?
- A. Its disconnect rating
  - B. Its maximum input
  - C. Its maximum output
  - D. Its disconnect location
28. What does this code require you to do before beginning any work on a battery system?
- A. Install Ground clamps
  - B. Risk assessment
  - C. Disconnect the affected cell
  - D. Open the Primary Connection
29. What is the maximum length of time a laser can be unattended before it must be turned off?
- A. 30 Minutes
  - B. 20 Minutes
  - C. 1 Hour
  - D. No Requirement

30. What safety item(s) is not listed to be maintained in a safe working condition when maintaining personal safety and protective equipment?
- Hot sticks
  - Bypass jumpers
  - Protective barriers
  - Dielectric material
31. A key-operated master control is required to be used for all \_\_\_\_\_.
- Photovoltaic systems
  - Capacitor rectifier banks
  - High-power laser equipment
  - Battery banks of 10 or more
32. How many items does this code list for personal safety and protective equipment that must be maintained in a safe working condition?
- 10
  - 14
  - 20
  - No items are listed
33. What safety-related work practice when using lasers is not required in the scope of training?
- Capacitor bank explosions
  - Need for personnel protection
  - High sound intensity levels from pulsed lasers
  - Biological effects of the laser upon the organs

## ARTICLE 340

### Safety-Related Work Practices: Power Electronic Equipment.

#### 340.7 Specific Measures for Personnel Safety.

(A) **Employer Responsibility.** The employer shall be responsible for the following:

- Proper training and supervision by properly qualified personnel, including the following:
  - Identification of associated hazards
  - Strategies to reduce the risk associated with the hazards
  - Methods of avoiding or protecting against the hazard
  - Necessity of reporting any incident that resulted in, or could have resulted in, injury or damage to health
- Properly installed equipment
- Proper access to the equipment
- Availability of the correct tools for operation and maintenance
- Proper identification and guarding of dangerous equipment
- Provision of complete and accurate circuit diagrams and other published information to the employee prior to the employee starting work (The circuit diagrams should be marked to indicate the components that present an electrical hazard.)
- Maintenance of clear and clean work areas around the equipment to be worked on
- Provision of adequate and proper illumination of the work area



#### 340.7 Specific Measures for Personnel Safety.

(B) **Employee Responsibility.** The employee shall be responsible for the following:

- Understanding the hazards associated with the work
- Being continuously alert and aware of the possible hazards
- Using the proper tools and procedures for the work

- (4) Informing the employer of malfunctioning protective measures, such as faulty or inoperable enclosures and locking schemes
- (5) Examining all documents provided by the employer relevant to the work, especially those documents indicating the location of components that present an electrical hazard
- (6) Maintaining good housekeeping around the equipment and work space
- (7) Reporting any incident that resulted in, or could have resulted in, injury or damage to health
- (8) Using and appropriately maintaining the PPE and tools required to perform the work safely



**350.1 Scope.** The requirements of this article shall apply to the electrical installations in those areas, with custom or special electrical equipment, designated by the facility management for research and development (R&D) or as laboratories.

**350.2 Definitions.**

**Field Evaluated.** A thorough evaluation of non-listed or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction. The evaluation approval ensures that the equipment meets appropriate codes and standards, or is similarly found suitable for a specified purpose.

**Laboratory.** A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnostics, product testing, or use of custom or special electrical components, systems, or equipment.

**350.4 Specific Measures and Controls for Personnel Safety.** Each laboratory or R&D system application shall be assigned a competent person as defined in this article to ensure the use of appropriate electrical safety-related work practices and controls.

**350.5 Listing Requirements.** The equipment or systems used in the R&D area or in the laboratory shall be listed or field evaluated prior to use.

## EXAM QUESTIONS

34. Equipment used in a R&D facility is required to be \_\_\_\_\_ prior to use.
  - A. Approved
  - B. Field evaluated
  - C. Listed
  - D. All listed answers
35. How many provisions are listed regarding the employee's responsibility for safety-related work practices around power electronic equipment?
  - A. 8
  - B. 5
  - C. 6
  - D. 12
36. How many provisions are listed regarding the employer's responsibility for safety-related work practices around power electronic equipment?
  - A. 6
  - B. 5
  - C. 8
  - D. 12
37. What does article 350 of this code cover?
  - A. Development Facilities
  - B. Laboratories
  - C. Research Facilities
  - D. All listed answers

38. A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnostics, product testing, or use of custom or special electrical components, systems, or equipment would best be defined as?
- Server Room
  - Laboratory
  - Control space
  - Think tank
39. A thorough evaluation of non-listed or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction is known as?
- UL Listed
  - Field Listed
  - UL Standard
  - Field Evaluated
40. R&D facilities are required to have a \_\_\_\_\_ to ensure the use of appropriate electrical safety-related work practices and controls.
- Competent Person
  - General Journeyman
  - Maintenance Electrician
  - Construction Management Company

### Informative Annex C Limits of Approach

**C.1 Preparation for Approach.** Observing a safe approach distance from exposed energized electrical conductors or circuit parts is an effective means of maintaining electrical safety. As the distance between a person and the exposed energized conductors or circuit parts decreases, the potential for electrical accident increases.

**C.1.2.1** Determine the arc flash boundary and, if the boundary is to be crossed, appropriate arc-rated protective equipment must be utilized.

**C.1.2.2** For a person to cross the limited approach boundary and enter the limited space, a person should meet the following criteria:

- Be qualified to perform the job/task
- Be able to identify the hazards and associated risks with the tasks to be performed

**C.1.2.3** To cross the restricted approach boundary and enter the restricted space, qualified persons should meet the following criteria:

- Have an energized electrical work permit authorized by management
- Use personal protective equipment (PPE) that is rated for the voltage and energy level involved
- Minimize the likelihood of bodily contact with exposed energized conductors and circuit parts from inadvertent movement by keeping as much of the body out of the restricted space as possible and using only protected body parts in the space as necessary to accomplish the work
- Use insulated tools and equipment



**C.2.1.1 Column 1.** The voltage ranges have been selected to group voltages that require similar approach distances based on the sum of the electrical withstand distance and an inadvertent movement factor. The value of the upper limit for a range is the maximum voltage for the highest nominal voltage in the range, based on ANSI C84.1, Electric Power Systems and Equipment— Voltage Ratings (60 Hz). For singlephase systems, select the range that is equal to the system’s maximum phase-to-ground voltage multiplied by 1.732.

**C.2.1.2 Column 2.** The distances in column 2 are based on OSHA’s rule for unqualified persons to maintain a 3.05 m (10 ft) clearance for all voltages up to 50 kV (voltage to ground), plus 100 mm (4.0 in.) for each 10 kV over 50 kV.

#### Informative Annex: D Incident Energy and Arc Flash Boundary Calculation Methods

**D.1 Introduction.** Informative Annex D summarizes calculation methods available for calculating arc flash boundary and incident energy. It is important to investigate the limitations of any methods to be used. The limitations of methods summarized in Informative Annex D are described in Table D.1.

**D.2.1 Basic Equations for Calculating Arc Flash Boundary Distances.** The clearing time for a current-limiting fuse is approximately 1/4 cycle or 0.004 second if the arcing fault current is in the fuse’s current-limiting range. The clearing time of a 5-kV and 15-kV circuit breaker is approximately 0.1 second or 6 cycles if the instantaneous function is installed and operating. This can be broken down as follows: actual breaker time (approximately 2 cycles), plus relay operating time of approximately 1.74 cycles, plus an additional safety margin of 2 cycles, giving a total time of approximately 6 cycles. Additional time must be added if a time delay function is installed and operating.



**D.4.5 Arc Flash Boundary.** The arc flash boundary is the distance at which a person is likely to receive a second degree burn. The onset of a second-degree burn is assumed to be when the skin receives 5.0 J/cm<sup>2</sup> of incident energy.

**D.5.3 Short Circuit Current.** The determination of short circuit current is necessary in order to use Table 130.7(C)(15) (B). The arcing current is calculated at 50 percent of the dc short-circuit value. The current that a battery will deliver depends on the total impedance of the short-circuit path. A conservative approach in determining the short-circuit current that the battery will deliver at 25°C is to assume that the maximum available short-circuit current is 10 times the 1 minute ampere rating (to 1.75 volts per cell at 25°C and the specific gravity of 1.215) of the battery. A more accurate value for the short-circuit current for the specific application can be obtained from the battery manufacturer.

## EXAM QUESTIONS

41. What is the minimum safe distance unqualified persons need to maintain from voltages of up to 50 kV to ground?
- 12 feet
  - 6 feet
  - 10 feet
  - 20 feet
42. What must be used if an arc flash boundary is to be crossed?
- Leather gloves
  - Arc-rated protective equipment
  - Zone barrier tape
  - Energized work permit
43. What does the short circuit current that a battery will deliver depend on?
- The total impedance of the short-circuit path
  - The total capacitance of the short-circuit path
  - The total power factor of the circuit path
  - The total of the dielectric material storage charge
44. How many criteria must be met for a person to cross the limited approach boundary and enter the limited space?
- 1
  - 3
  - 7
  - 2

45. Column 1 voltage ranges have been selected to group voltages that require similar approach distances based on an inadvertent movement factor and what additional criteria?
- The arc Blast radius
  - The sum of the electrical withstand distance
  - The arc flash distance
  - The zone of protection perimeter
46. Which item is NOT required when crossing the restricted approach boundary and entering the restricted space?
- The use of rated PPE
  - Use of insulated tools and equipment
  - Have an energized electrical work permit
  - 100 KVA rated hot stick
47. What type of burn is a person likely to receive at the arc flash boundary?
- A first degree burn
  - A third degree burn
  - A second degree burn
  - No Burns likely
48. What table summarizes the limitations of methods summarized in informative annex D?
- Table E.1
  - Table B.1
  - Table C.1
  - Table D.1
49. What is the clearing time of a 15-kV circuit breaker if the instantaneous function is installed and operating?
- 3 cycles
  - 4 cycles
  - 6 cycles
  - 8 cycles
50. As the distance between a person and the exposed energized conductors or circuit parts decreases, the potential for electrical accident \_\_\_\_\_.
- Is mitigated
  - Decreases
  - Increases
  - Is underscored
51. What is the clearing time for a current-limiting fuse if the arcing fault current is in the fuse's current-limiting range?
- 1/4 cycle
  - 3/4 cycle
  - 1/2 cycle
  - 1 cycle

## Informative Annex: E Electrical Safety Program

**E.1 Typical Electrical Safety Program Principles.** Electrical safety program principles include, but are not limited to, the following:

- Inspecting and evaluating the electrical equipment
- Maintaining the electrical equipment's insulation and enclosure integrity
- Planning every job and document first-time procedures
- De-energizing, if possible (see 120.1)
- Anticipating unexpected events
- Identifying the electrical hazards and reduce the associated risk
- Protecting employees from shock, burn, blast, and other hazards due to the working environment
- Using the right tools for the job
- Assessing people's abilities
- Auditing the principles



**E.2 Typical Electrical Safety Program Controls.** Electrical safety program controls can include, but are not limited to, the following:

- (1) The employer develops programs, including training, and the employees apply them.
- (2) Employees are to be trained to be qualified for working in an environment influenced by the presence of electrical energy.
- (3) Procedures are to be used to identify the electrical hazards and to develop plans to eliminate those hazards or to control the associated risk for those hazards that cannot be eliminated.
- (4) Every electrical conductor or circuit part is considered energized until proved otherwise.
- (5) De-energizing an electrical conductor or circuit part and making it safe to work on is, in itself, a potentially hazardous task.
- (6) Tasks to be performed on or near exposed energized electrical conductors and circuit parts are to be identified and categorized.
- (7) Precautions appropriate to the working environment are to be determined and taken.
- (8) A logical approach is to be used to determine the associated risk of each task.

**E.3 Typical Electrical Safety Program Procedures.** Electrical safety program procedures can include, but are not limited to determination and assessment of the following:

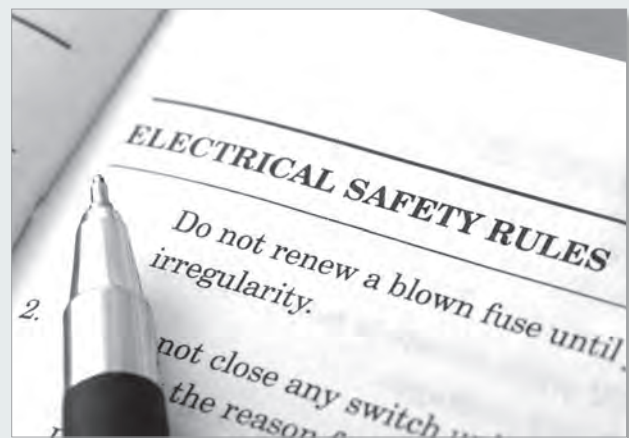
- (1) Purpose of task
- (2) Qualifications and number of employees to be involved
- (3) Identification of hazards and assessment of risks of the task
- (4) Limits of approach
- (5) Safe work practices to be used
- (6) Personal protective equipment (PPE) involved
- (7) Insulating materials and tools involved
- (8) Special precautionary techniques
- (9) Electrical single-line diagrams
- (10) Equipment details
- (11) Sketches or photographs of unique features
- (12) Reference data

### Informative Annex: F Risk Assessment Procedure

**F.2.2 Parameters Used in Risk Estimation.** In preparation for the risk assessment, parameters are estimated and can be entered into Table F.2.5. These parameters should be based on worst-case considerations for the electrical system. Different risk reduction strategies can be implemented for each hazard. The risk estimation stage is the only one at which hazards can be eliminated, thus avoiding the need for additional protective measures, such as safeguarding or complementary protective measures.

### F.2.3 Severity of the Possible Injury or Damage to Health (Se).

Severity of injuries or damage to health can be estimated by taking into account reversible injuries, irreversible injuries, and death. Typically, the types of hazards to be considered include, but are not limited to, shock and electrocution, burns, and impact. Choose the appropriate value of severity from Table F.2.3, based on the consequences of an injury, as follows:





- (1) 8: a fatal or a significant irreversible injury, such that it will be very difficult to continue the same work after healing, if at all
- (2) 6: a major or irreversible injury, in such a way that it can be possible to continue the same work after healing and can also include a severe major but reversible injury such as broken limbs
- (3) 3: a reversible injury, including severe lacerations, stabbing, and severe bruises, that requires attention from a medical practitioner
- (4) 1: a minor injury, including scratches and minor bruises that require attention by first aid.

**F.2.4.1 Frequency and Duration of Exposure (Fr).** The following aspects should be considered to determine the level of exposure:

- (1) Need for access to the hazard zone based on all modes of use; for example, normal operation and maintenance
- (2) Nature of access, for example, examination, repair, and troubleshooting It should then be possible to estimate the average interval between exposures and, thus, the average frequency of access.

This factor does not include consideration of the failure of the short-circuit interruption device(s) or the failure to use the appropriate PPE. Select the appropriate row for frequency and duration of exposure (Fr) from Table F.2.4.1. Insert the appropriate number under the Fr column in Table F.2.5.

## EXAM QUESTIONS

- 52. What value of severity is a major or irreversible injury, in such a way that it can be possible to continue the same work after healing and can also include a severe major but reversible injury such as broken limbs?
  - A. 1
  - B. 8
  - C. 3
  - D. 6
- 53. How many typical electrical safety program controls are listed in annex E?
  - A. 12
  - B. 8
  - C. 5
  - D. 10
- 54. What are the parameters used in risk estimation based on for the electrical system?
  - A. Unsafe working distances from the source
  - B. Best-case considerations
  - C. Safe working distance
  - D. Worst-case considerations
- 55. What value of severity is a minor injury, including scratches and minor bruises that require attention by first aid?
  - A. 1
  - B. 8
  - C. 6
  - D. 3
- 56. What value of severity is a reversible injury, including severe lacerations, stabbing, and severe bruises, that requires attention from a medical practitioner?
  - A. 6
  - B. 8
  - C. 3
  - D. 1
- 57. How many typical electrical safety program principles are listed in annex E?
  - A. 12
  - B. 10
  - C. 5
  - D. 8
- 58. What value of severity is a fatal or a significant irreversible injury, such that it will be very difficult to continue the same work after healing, if at all?
  - A. 8
  - B. 6
  - C. 3
  - D. 1
- 59. How many aspects are listed to consider when determining the frequency and duration of exposure to electrical systems?
  - A. 2
  - B. 8
  - C. 6
  - D. 3

60. How many typical electrical safety program procedures are listed in annex E?

- A. 10
- B. 8
- C. 5
- D. 12

### Table F.2.4.2 Likelihood of a Hazardous Event (Pr) Classification

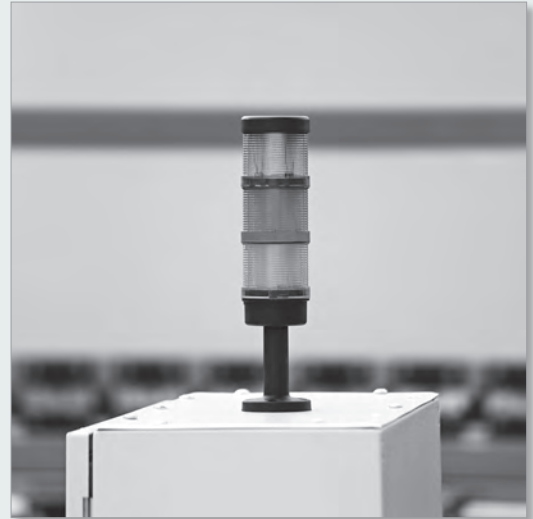
Likelihood of a Hazardous Event Pr Value

|            |   |
|------------|---|
| Very high  | 5 |
| Likely     | 4 |
| Possible   | 3 |
| Rare       | 2 |
| Negligible | 1 |

**F.2.4.3 Likelihood of Avoiding or Limiting Injury or Damage to Health (Av).** This parameter can be estimated by taking into account aspects of the electrical system design and its intended application that can help to avoid or limit the injury or damage to health from a hazard, including the following examples:

- (1) Sudden or gradual appearance of the hazardous event; for example, an explosion caused by high fault values under short-circuit conditions.
- (2) Spatial possibility to withdraw from the hazard.
- (3) Nature of the component or system; for example, the use of touch-safe components, which reduce the likelihood of contact with energized parts. Working in close proximity to high voltage can increase the likelihood of personnel being exposed to hazards due to approach to live parts.
- (4) Likelihood of recognition of a hazard; for example, as an electrical hazard, a copper bar does not change its appearance, whether it is under voltage or not. To recognize the presence of the hazard, an instrument is needed to establish whether or not electrical equipment is energized; thus, both inadvertent and intentional contact need to be considered.

Select the appropriate row for likelihood of avoiding or limiting injury or damage to health (Av) from Table F.2.4.3. Insert the appropriate value for risk level in the Av column in Table F.2.5.



**F.3.1.2 Awareness Devices.** Awareness means can be used to complement the effects of engineering controls with regard to risk reduction. They should be chosen based on the design configuration for each specific application and their potential effectiveness during foreseen interaction. Each design and configuration can require unique awareness devices in order to have the desired impact on risk.

Typically, awareness means take the form of signs, visual alarms, audible alarms, and so forth.

**F.3.1.5 Personal Protective Equipment (PPE).** The electrical system must be analyzed in order to determine the appropriate PPE. Once the appropriate PPE has been determined, personnel must maintain and use it as required in order to ensure that residual risk remains at the desired level.

### F.4.1.2 Design — Use of Engineering Controls.

- (a) Greatest impact on the likelihood of a hazardous event(s) under certain circumstances

(b) No impact on severity of injury or damage to health

Failure mode(s) examples:

- (1) Incorrect application of construction or manufacturing specification
- (2) Unanticipated tasks
- (3) Incentive to circumvent or reduce effectiveness
- (4) Excessive production pressure
- (5) Protective system failure

#### F.4.1.3 Use of Systems that Increase Awareness of Potential Hazards.

- (a) Potential impact on avoiding or limiting injury or damage to health
- (b) Potential impact on inadvertent exposure
- (c) Minimal or no impact on severity of injury or damage to health

Failure mode(s) examples:

- (1) Too many warning signs
- (2) Depreciation of effect over time
- (3) Lack of understanding



## EXAM QUESTIONS

61. How many examples are listed as a likely cause that can help to avoid or limit the injury or damage to health from an electrical hazard?
  - A. 4
  - B. 8
  - C. 2
  - D. 3
62. What numeric value is listed for the likelihood of a hazardous event Pr value in the "Very high" range?
  - A. 2
  - B. 8
  - C. 5
  - D. 3
63. What type of potential drawback(s) could occur if using systems that increase awareness of potential hazards?
  - A. Too many warning signs
  - B. Depreciation of effect over time
  - C. Lack of understanding
  - D. All listed answers
64. What does each design and configuration of awareness device hope to impact?
  - A. Risk
  - B. Efficiency
  - C. Production
  - D. All listed answers
65. What numeric value is listed for the likelihood of a hazardous event Pr value in the "Rare" range?
  - A. 2
  - B. 8
  - C. 5
  - D. 3
66. Once the risk of an electrical system is analyzed, what will this hope to determine?
  - A. The appropriate signage
  - B. The appropriate zone barriers
  - C. The appropriate PPE
  - D. The appropriate work permits

67. What numeric value is listed for the likelihood of a hazardous event Pr value in the “Possible” range?

- A. 2
- B. 8
- C. 5
- D. 3

68. What is NOT a failure mode with regards to risk evaluation and the use of engineering controls?

- A. Unanticipated tasks
- B. Excessive production pressure
- C. Inadequate procurement control
- D. Protective system failure

### Informative Annex G: Sample Lockout/Tagout Procedure

Lockout is the preferred method of controlling personnel exposure to electrical energy hazards. Tagout is an alternative method that is available to employers. To assist employers in developing a procedure that meets the requirement of 120.2 of NFPA 70E, the sample procedure that follows is provided for use in lockout and tagout programs. This procedure can be used for a simple lockout/tagout, or as part of a complex lockout/tagout. A more comprehensive plan will need to be developed, documented, and used for the complex lockout/tagout.

**1.0 Purpose.** This procedure establishes the minimum requirements for lockout/tagout of electrical energy sources. It is to be used to ensure that conductors and circuit parts are disconnected from sources of electrical energy, locked (tagged), and tested before work begins where employees could be exposed to dangerous conditions. Sources of stored energy, such as capacitors or springs, shall be relieved of their energy, and a mechanism shall be engaged to prevent the reaccumulation of energy.

**2.0 Responsibility.** All employees shall be instructed in the safety significance of the lockout/tagout procedure. All new or transferred employees and all other persons whose work operations are or might be in the area shall be instructed in the purpose and use of this procedure. [Name(s) of the person(s) or the job title(s) of the employee(s) with responsibility] shall ensure that appropriate personnel receive instructions on their roles and responsibilities. All persons installing a lockout/tagout device shall sign their names and the date on the tag [or state how the name of the individual or person in charge will be available].

**3.4** Provide an adequately rated test instrument to test each phase conductor or circuit part to verify that they are deenergized (see Section 11.3). Provide a method to determine that the test instrument is operating satisfactorily.

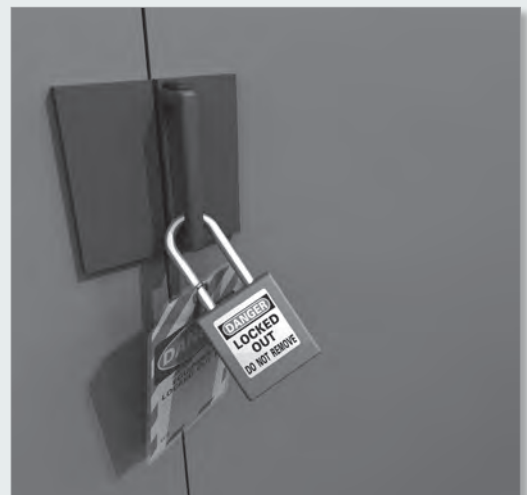
**5.4** Lockout/tagout all disconnecting means with lockout/tagout devices.

**6.1** After the job or task is complete, visually verify that the job or task is complete.

**6.6 Remove lockout/tagout devices.** The person who installed the devices is to remove them.

**9.0 Complex Lockout/Tagout.** A complex lockout/tagout plan is required where one or more of the following exist:

- (1) Multiple energy sources (more than one)
- (2) Multiple crews
- (3) Multiple crafts



- (4) Multiple locations
- (5) Multiple employers
- (6) Unique disconnecting means
- (7) Complex or particular switching sequences
- (8) Lockout/tagout for more than one shift; that is, new shift workers

**9.2** A person in charge shall be involved with a complex lockout/tagout procedure. The person in charge shall be at the procedure location.

**9.5** The person in charge can install locks/tags or direct their installation on behalf of other employees.

**13.0 Lockout/Tagout Training.** Recommended training can include, but is not limited to, the following:

- (1) Recognition of lockout/tagout devices
- (2) Installation of lockout/tagout devices
- (3) Duty of employer in writing procedures
- (4) Duty of employee in executing procedures
- (5) Duty of person in charge
- (6) Authorized and unauthorized removal of locks/tags
- (7) Enforcement of execution of lockout/tagout procedures
- (8) Simple lockout/tagout
- (9) Complex lockout/tagout
- (10) Use of single-line and diagrammatic drawings to identify sources of energy
- (11) Alerting techniques
- (12) Release of stored energy
- (13) Personnel accounting methods
- (14) Temporary protective grounding equipment needs and requirements
- (15) Safe use of test instruments



## EXAM QUESTIONS

- 69.** True or false? The person in charge of a complex lockout/tagout procedure can install the personal locks on behalf of other employees.
- A. True
  - B. False
- 70.** The 70E sample lockout/tagout procedure establishes the \_\_\_\_\_ requirements for the lockout/tagout of electrical energy sources.
- A. Procedural
  - B. Maximum
  - C. Minimum
  - D. Listed
- 71.** After the lockout/tagout work is complete, what needs to be done?
- A. Energize the system
  - B. Take a break
  - C. Visually verify that the job or task is complete
  - D. There is no special requirement
- 72.** In what part of this code could you reference a sample Lockout/Tagout procedure?
- A. Article 120.2
  - B. Article 110.3
  - C. Annex D
  - D. Annex G

73. What is an adequately rated test instrument provided to test for during the lockout/tagout period?
- A. Each phase conductor is deenergized
  - B. Continuity of each phase conductor
  - C. Continuity of each phase conductor to ground
  - D. The load side of the disconnect is deenergized
74. Who should be instructed on the safety significance of the lockout/tagout procedure?
- A. The employees
  - B. The managers
  - C. The electricians
  - D. All listed answers
75. What do disconnecting means need installed during the lockout/tagout period?
- A. Yellow label
  - B. Lockout/tagout devices
  - C. Red label
  - D. Red and white colored lock box
76. Who needs to remove the lockout/tagout devices?
- A. The fire watch individual
  - B. The shift foreman
  - C. The safety operator
  - D. The person who installed the devices
77. How many separate recommended items are listed to cover during lockout/tagout training?
- A. 5
  - B. 10
  - C. 15
  - D. 12
78. How many different conditions can lead to a complex lockout/tagout plan being required?
- A. 6
  - B. 8
  - C. 10
  - D. 4
79. What is the preferred method of controlling personnel exposure to electrical energy hazards?
- A. Lockout/Tagout
  - B. Site badge
  - C. Area work permit
  - D. All listed answers
80. Where is the person in charge of a complex lockout/tagout procedure supposed to be?
- A. At the designated break area
  - B. At the job shack
  - C. At the procedure location
  - D. In the operations control room

**Informative Annex H: Guidance on Selection of Protective Clothing and Other Personal Protective Equipment (PPE)**

**H.3 Arc-Rated Clothing and Other Personal Protective Equipment (PPE) for Use with Risk Assessment of Electrical Hazards.** Table H.3(a) provides a summary of specific sections within the NFPA 70E standard describing PPE for electrical hazards. Table H.3(b) provides guidance on the selection of arc-rated and other PPE for users who determine the incident energy exposure (in cal/cm<sup>2</sup>).

**Informative Annex K: General Categories of Electrical Hazards**

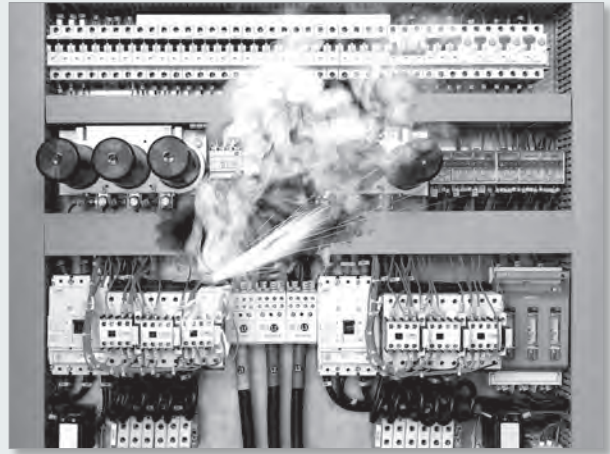
**K.1 General Categories.** There are three general categories of electrical hazards: electrical shock, arc flash, and arc blast.

**K.2 Electric Shock.** Approximately 30,000 nonfatal electrical shock accidents occur each year. The National Safety Council estimates that about 1000 fatalities each year are due to electrocution, more than half of them while servicing energized systems of less than 600 volts. Electrocution is the fourth leading cause of industrial fatalities, after traffic, homicide, and construction accidents. The current required to light a 71/2-watt, 120-volt lamp, if passed across the chest, is enough to cause a fatality. The most damaging paths through the body are through the lungs, heart, and brain.



**K.3 Arc Flash.** When an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors, the temperatures can reach 35,000°F. Exposure to these extreme temperatures both burns the skin directly and causes ignition of clothing, which adds to the burn injury. The majority of hospital admissions due to electrical accidents are from arc flash burns, not from shocks. Each year more than 2000 people are admitted to burn centers with severe arc flash burns. Arc flashes can and do kill at distances of 3 m (10 ft).

**K.4 Arc Blast.** The tremendous temperatures of the arc cause the explosive expansion of both the surrounding air and the metal in the arc path. For example, copper expands by a factor of 67,000 times when it turns from a solid to a vapor. The danger associated with this expansion is one of high pressures, sound, and shrapnel. The high pressures can easily exceed hundreds or even thousands of pounds per square foot, knocking workers off ladders, rupturing eardrums, and collapsing lungs. The sounds associated with these pressures can exceed 160 dB. Finally, material and molten metal are expelled away from the arc at speeds exceeding 1120 km/hr (700 mph), fast enough for shrapnel to completely penetrate the human body.



#### Informative Annex L: Typical Application of Safeguards in the Cell Line Working Zone

**L.2 Electrical Power Receptacles.** Power supply circuits and receptacles in the cell line area for portable electric equipment should meet the requirements of 668.21 of NFPA 70, National Electrical Code. However, it is recommended that receptacles for portable electric equipment not be installed in electrolytic cell areas and that only pneumatic-powered portable tools and equipment be used.

## EXAM QUESTIONS

81. What temperature can be reached when an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors?
- 25,000°F
  - 35,000°F
  - 65,000°F
  - 45,000°F
82. How many general categories of electrical hazards are listed in the 70E?
- 5
  - 2
  - 3
  - 4
83. Power supply circuits and receptacles in the cell line area for portable electric equipment should meet the requirements of what listed article in the NEC?
- 668.21
  - 712
  - 667.9
  - 686.21
84. What is the approximate number of fatal electrical shock accidents that occur each year?
- 500
  - 5,000
  - 3,000
  - 1,000
85. At what distance can arc flashes kill?
- 15 feet
  - 12 feet
  - 10 feet
  - 20 feet
86. What is the approximate number of nonfatal electrical shock accidents that occur each year?
- 3,000
  - 30,000
  - 10,000
  - 25,000

87. How many times does copper expand when it turns from a solid to a vapor?

- A. 67,000 times
- B. 7,000 times
- C. 6,000 times
- D. 76,000 times

88. What table in the 70E provides guidance on the selection of arc-rated and other PPE for users who determine the incident energy exposure (in cal/cm<sup>2</sup>)?

- A. H.3(a)
- B. H.3(b)
- C. H.2
- D. H.5

### Informative Annex: M Layering of Protective Clothing and Total System Arc Rating

**M.1.1** Layering of arc-rated clothing is an effective approach to achieving the required arc rating. The use of all arc-rated clothing layers will result in achieving the required arc rating with the lowest number of layers and lowest clothing system weight. Garments that are not arc rated should not be used to increase the arc rating of a garment or of a clothing system.

### Informative Annex N: Example Industrial Procedures and Policies for Working Near Overhead Electrical Lines and Equipment

**N.2 Overhead Powerline Policy (OPP).** This Informative annex applies to all overhead conductors, regardless of voltage, and requires the following:

- (1) That employees not place themselves in close proximity to overhead power lines. "Close proximity" is within a distance of 3 m (10 ft) for systems up to 50 kV, and should be increased 100 mm (4 in.) for every 10 kV above 50 kV.
- (2) That employees be informed of the hazards and precautions when working near overhead lines.
- (3) That warning decals be posted on cranes and similar equipment regarding the minimum clearance of 3 m (10 ft).
- (4) That a "spotter" be designated when equipment is working near overhead lines. This person's responsibility is to observe safe working clearances around all overhead lines and to direct the operator accordingly.
- (5) That warning cones be used as visible indicators of the 3 m (10 ft) safety zone when working near overhead power lines.

**N.4.3.1 Heavy Mobile Equipment.** Prior to the start of each workday, a high-visibility marker (orange safety cones or other devices) shall be temporarily placed on the ground to mark the location of overhead wires. The supervisors shall discuss electrical safety with appropriate crew members at on-site tailgate safety talks. When working in the proximity of overhead lines, a spotter shall be positioned in a conspicuous location to direct movement and observe for contact with the overhead wires. The spotter, equipment operator, and all other employees working on the job location shall be alert for overhead wires and remain at least 3 m (10 ft) from the mobile equipment. All mobile equipment shall display a warning decal regarding electrical contact. Independent truck drivers delivering materials to field locations shall be cautioned about overhead electrical lines before beginning work, and a properly trained on-site or contractor employee shall assist in the loading or off-loading operation. Trucks that have emptied their material shall not leave the work location until the boom, lift, or box is down and is safely secured.





**N.4.5 Vehicles with Loads in Excess of 4.25 m (14 ft) in Height.** This policy requires that all vehicles with loads in excess of 4.25 m (14 ft) in height use specific procedures to maintain safe working clearances when in transit below overhead lines.

### **Informative Annex O: Safety-Related Design Requirements**

**O.2.1** Employers, facility owners, and managers who have responsibility for facilities and installations having electrical energy as a potential hazard to employees and other personnel should ensure that electrical hazards risk assessments are performed during the design of electrical systems and installations.

**O.2.2** Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:

- (1) Reducing the likelihood of exposure
- (2) Reducing the magnitude or severity of exposure
- (3) Enabling achievement of an electrically safe work condition

**O.2.3 Incident Energy Reduction Methods.** The following methods have proved to be effective in reducing incident energy:

- (1) Zone-selective interlocking. A method that allows two or more circuit breakers to communicate with each other so that a short circuit or ground fault will be cleared by the breaker closest to the fault with no intentional delay. Clearing the fault in the shortest time aids in reducing the incident energy.
- (2) Differential relaying. The concept of this protection method is that current flowing into protected equipment must equal the current out of the equipment. If these two currents are not equal, a fault must exist within the equipment, and the relaying can be set to operate for a fast interruption. Differential relaying uses current transformers located on the line and load sides of the protected equipment and fast acting relay.
- (3) Energy-reducing maintenance switching with a local status indicator. An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to operate faster while the worker is working within an arc flash boundary, as defined in NFPA 70E, and then to set the circuit breaker back to a normal setting after the work is complete.

### **O.2.4 Other Methods.**

- (1) Energy-reducing active arc flash mitigation system. This system can reduce the arcing duration by creating a low impedance current path, located within a controlled compartment, to cause the arcing fault to transfer to the new current path, while the upstream breaker clears the circuit. The system works without compromising existing selective coordination in the electrical distribution system.
- (2) Arc flash relay. An arc flash relay typically uses light sensors to detect the light produced by an arc flash event. Once a certain level of light is detected the relay will issue a trip signal to an upstream overcurrent device.
- (3) High-resistance grounding. A great majority of electrical faults are of the phase-to-ground type. High resistance grounding will insert an impedance in the ground return path and will typically limit the fault current to 10 amperes and below (at 5 kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level. High resistance grounding will not affect arc flash energy for line-to-line or line-to-line-to-line arcs.



- (4) **Current-limiting devices.** Current-limiting protective devices reduce incident energy by clearing the fault faster and by reducing the current seen at the arc source. The energy reduction becomes effective for current above the current-limiting threshold of the current-limiting fuse or current limiting circuit breaker.

### **Informative Annex P: Aligning Implementation of This Standard with Occupational Health and Safety Management Standards**

**P.1 General.** Injuries from electrical energy are a significant cause of occupational fatalities in the workplace in the United States. This standard specifies requirements unique to the hazards of electrical energy. By itself, however, this standard does not constitute a comprehensive and effective electrical safety program. The most effective application of the requirements of this standard can be achieved within the framework of a recognized health and safety management system standard. ANSI/AIHA Z10, American National Standard for Occupational Health and Safety Management Systems, provides comprehensive guidance on the elements of an effective health and safety management system Management Systems - Requirements with Guidance for Use; and BS OSHAS 18001, Occupational Health and Safety Management Systems. Some companies and other organizations have proprietary health and safety management systems that are aligned with the key elements of ANSI/AIHA Z10, and is one recognized standard. ANSI/AIHA Z10 is harmonized with other internationally recognized standards, including CAN/CSA Z1000, Occupational Health and Safety Management; ANSI/ISO 14001, Environmental

## EXAM QUESTIONS

89. **True or False? Annex P constitutes a comprehensive and effective electrical safety program.**
- True
  - False
90. **How do the design option decisions facilitate the ability to eliminate hazards or reduce risk?**
- Reducing the magnitude or severity of exposure
  - Enabling achievement of an electrically safe work condition
  - Reducing the likelihood of exposure
  - All listed answers
91. **What uses current transformers located on the line and load sides of the protected equipment and fast acting relay?**
- Zone-selective interlocking
  - Energy-reducing maintenance switching with a local status indicator
  - Differential relaying
  - Zone-selective status indicator
92. **True or False? Layering of arc-rated clothing is not an effective approach to achieving the required arc rating.**
- True
  - False
93. **What method allows two or more circuit breakers to communicate with each other so that a short circuit or ground fault will be cleared by the breaker closest to the fault with no intentional delay?**
- Zone-selective interlocking
  - Energy-reducing maintenance switching with a local status indicator
  - Differential relaying
  - Zone-selective status indicator
94. **What best defines an energy-reducing maintenance switch that allows a worker to set a circuit breaker trip unit to operate faster while the worker is working within an arc flash boundary?**
- Zone-selective status indicator
  - Differential relaying
  - Zone-selective interlocking
  - Energy-reducing maintenance switching with a local status indicator
95. **What system can reduce the arcing duration by creating a low impedance current path, located within a controlled compartment, to cause the arcing fault to transfer to the new current path, while the upstream breaker clears the circuit?**
- High-resistance grounding
  - Current-limiting devices
  - Energy-reducing active arc flash mitigation system
  - Arc flash relay

96. What is the minimum distance heavy mobile equipment should be from overhead power lines?
- A. 10 feet
  - B. 14 feet
  - C. 12 feet
  - D. 20 feet
97. A great majority of electrical faults are of what type?
- A. The phase-to-fault
  - B. The phase-to-phase type
  - C. The instantaneous ground type
  - D. The phase-to-ground type
98. At what height do vehicle loads need to use specific procedures to maintain safe working clearances when in transit below overhead lines?
- A. 12 feet
  - B. 10 feet
  - C. 14 feet
  - D. 20 feet
99. What type of devices reduce incident energy by clearing the fault faster and by reducing the current seen at the arc source?
- A. Inverse time circuit devices
  - B. Current-limiting protective devices
  - C. Intermittent duty devices
  - D. Instantaneous time device
100. What does an arc flash relay typically use to detect the light produced by an arc flash event?
- A. Heat sensors
  - B. Light sensors
  - C. Arc sensors
  - D. Wave sensors