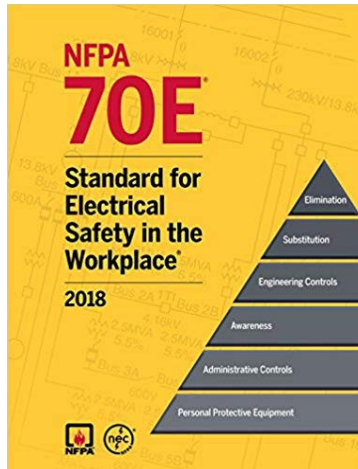


Overview

Occupational Health and Safety Administration (OSHA) provides the legal requirement for employers to ensure a safe work environment, and its regulations are enforceable under federal law. It sets general requirements for safe work practices, personal protective equipment (PPE) and hazard analysis. OSHA is often referred to as the “what must I do” to keep my employees safe in the workplace.

National Fire Protection Association (NFPA) is the world’s leading advocate of fire protection and has published more than 300 consensus codes and standards including the National Electrical Code (NFPA 70) and Standard for Electrical Safety in the Workplace (NFPA 70E).

Together, OSHA and NFPA are working to ensure safe working conditions in the workplace. Where OSHA is the “what”, NFPA 70E is the “how”. How does the employer ensure safety in the workplace. NFPA 70E outlines specific safety procedures and practices when working on live equipment. The standard covers safety-related work practices associated with electrical energy during activities such as installation, inspection, operation, maintenance and demolition of electric equipment.



Many companies believe they have adequately protected their employees by labeling their equipment, yet hundreds of deaths and thousands of injuries still occur each year due to shock, electrocution, arc flash and arc blast. Unfortunately, many of these incidents are caused by unsafe acts—not faulty equipment. NFPA 70E undergoes updates and revisions every three years, and the 2018 edition continues to evolve to address risk assessment and introduces human factors, such as human error, as part of that assessment. Annex Q was also added to provide guidance for Human Performance and Workplace Electrical Safety. While some of the updates are editorial or informational in nature, others require facility managers to once again act to revise and update safety policies.

Key Changes and Significant Content

Tables and text that specify PPE standards have been moved to information tables or notes.

- Section 130.7(C)(14)(b) was added to provide guidance on conformity assessment of PPE.
- Employers are required to verify that appropriate PPE is given to employees.
- Employers must validate PPE manufacturer claims.

Definitions throughout document were standardized for consistency.

Article 120 was rearranged into a logical order of establishing an electrically safe work condition.

Article 320 introduced voltage thresholds for batteries and battery rooms.

Global Changes

- All Mathematical Symbols are replaced with Alphanumeric values
- “Accident” changed to “Incident”.
- “Accidental” is changed to “Unintentional”.
- cal/cm² will be used as primary value.
- “Short Circuit current” is changed to “Available Fault current”.
- DC Voltage threshold in all locations is now 50Vdc.
 - Same as AC Voltage threshold.
 - Exception – Battery Systems See Chapter 3.

Definitions

Electrical Safety Program - A documented system consisting of electrical safety principles, policies, procedures, and processes that directs activities appropriate for the risk associated with electrical hazards.

Electrically Safe Work Condition - A State in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure verify the absence of voltage and, if necessary, temporary protective grounding equipment has been applied temporarily grounded for personnel protection.

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 the hazards and avoid reduce the hazards involved associated risk.

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

Condition of Maintenance - The state of the electrical equipment's condition equipment considering the manufacturer's recommendations and manufacturer's instructions, manufacturer's recommendations, applicable industry codes, standards and standards recommended practices.

Article 105 – application of safety-related work practices and procedures

- **105.3(A) Employer Responsibility.** The employer shall have the following responsibilities:
 1. Establish, document and implement the safety-related work practices and procedures required by this standard.
 2. Provide employees with training in the employer's safety-related work practices and procedures.
- **105.3(B) Employee Responsibility.** The employee shall comply with the safety-related work practices and procedures provided by the employer.
- **105.4 Priority.** Hazard elimination shall be the first priority in the implementation of safety-related work practices.

Informational note: Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.1(H).

Article 110 – General Requirements for Electrical Safety-Related Work Practices

- **110.1(B) Inspection.** The electrical safety program shall include elements to verify that newly installed or modified electrical equipment or systems have been inspected to comply with applicable installation codes and standards prior to being placed in service.
- **110.1(H) Risk Assessment Procedure.** The electrical safety program shall include a risk assessment procedure and shall comply with 110.1(H)(1) through 110.1(H)(3).
 - **110.1(H)(1) Elements of a Risk Assessment Procedure.** The risk assessment procedure shall address employee exposure to electrical hazards and shall identify the process to be used by the employee before work is started to carry out the following:
 1. Identify hazards.
 2. Assess risks.
 3. Implement risk control according to the hierarchy of risk control methods.
 - **110.1(H)(2) Human Error.** The risk assessment procedure shall address the potential for human error and its negative consequences on people, processes, the work environment and equipment.

Informational note: The potential for human error varies with factors such as tasks and the work environment. See Informative Annex Q.

- **110.1(H)(3) Hierarchy of Risk Control Methods.** The risk assessment procedure shall require that preventive and protective risk control methods be implemented in accordance with the following hierarchy:
 1. Elimination.
 2. Substitution.
 3. Engineering controls.
 4. Awareness.
 5. Administrative controls.
 6. PPE.
- **110.1(I) Job Safety Planning and Job Briefing.** Before starting each job that involves exposure to electrical hazards, the employee in charge shall complete a job safety plan and conduct a job briefing with the employees involved.

- **110.1(I)(1) Job Safety Planning.** The job safety plan shall be in accordance with the following:
 1. Be completed by a qualified person.
 2. Be documented.
 3. Include the following information:
 - A description of the job and the individual tasks.
 - Identification of the electrical hazards associated with each task.
 - A shock risk assessment in accordance with 130.4 for tasks involving shock hazard.
 - An arc flash risk assessment in accordance with 130.5 for tasks involving an arc flash hazard.
 - Work procedures involved, special precautions, and energy source controls.

- **110.1(I)(2) Job Briefing.** The job briefing shall cover the job safety plan and the information on the energized electrical work permit, if a permit is required.

- **110.1(I)(3) Change in Scope.** Additional job safety planning and job briefings shall be held if changes occur during the course of the work that might affect the safety of employees.

Informational Note: For an example of a job briefing form and planning checklist, see NFPA 70E 2018 Informative Annex I, Figure I.1.

- **110.1(J) Incident Investigations.** The electrical safety program shall include elements to investigate electrical incidents.

Informative Note: Electrical incidents include events or occurrences that result in, or could have resulted in, a fatality, an injury, or damage to health. Incidents that do not result in fatality, injury, or damage to health are commonly referred to as a “close call” or “near miss.”

- **110.1(K) Auditing**

1. Electrical Safety Program Audit.
2. Field Work Audit.
3. Lockout/Tagout Program and Procedure Audit.
4. Documentation.
5. The audits required by 110.1(K) shall be documented.

- **110.2(A) Electrical Safety Training**

- **110.2(A)(5) Electrical Safety Training Documentation.** The employer shall document that each employee has received the training required by 110.2(A). This documentation shall be in accordance with the following:

1. Be made when the employee demonstrated proficiency in the work practices involved.
2. Be retained for the duration of the employee's employment.
3. Contain the content of the training, each employee's name, and dates of training.

Informational Note No 1: Content of the training could include one or more of the following: course syllabus, course curriculum, outline, table of contents, or training objectives.

Informational Note No 2: Employment records that indicate that an employee has received the required training are an acceptable means of meeting this requirement.

- **110.2(B) Lockout/Tagout Procedure Training**

- **110.2(B)(1) Initial Training.** Employees involved in or affected by the lockout/tagout procedures required by 120.2 shall be training in the following:

1. The lockout/tagout procedures.
2. Their responsibility in the execution of the procedures.

- **110.2(B)(2) Retraining.** Retraining in the lockout/tagout procedures shall be performed as follows:

1. When the procedures are revised.
2. At intervals not to exceed 3 years.
3. When supervision or annual inspections indicate that the employee is not complying with the lockout/tagout procedures.

- **110.2(C) Emergency Response Training**

- **110.2(C)(1): Contact Release.** Employees exposed to shock hazards and those responsible for the safe release of victims from the contact with energized electrical conductors or circuit parts shall be trained in methods of safe release. Training shall occur annually.

Article 120 – Establishing an Electrically Safe Work Condition

• 120.1 Lockout/Tagout Program

- **120.1(A) General.** Each employer shall establish, document, and implement a lockout/tagout program. The lockout/tagout program shall specify lockout/tagout procedures to safeguard workers from exposure to electrical hazards. The lockout/tagout program and procedures shall also incorporate the following:

1. Be applicable to the experience and training of the workers and conditions in the workplace.
2. Meet the requirements of Article 120.
3. Apply to fixed, permanently installed equipment, temporarily installed equipment and portable equipment.

- **120.1(B) Employer Responsibilities.** The employer shall be responsible for the following:

1. Providing the equipment necessary to execute lockout/tagout procedures.
2. Providing lockout/tagout training to workers in accordance with 110.2.
3. Auditing the lockout/tagout program in accordance with 110.1.
4. Auditing execution of the lockout/tagout procedures in accordance with 110.1.

Informational Note: For an example of a lockout/tagout program, see Informative Annex G.

• 120.2 Lockout/Tagout Principles

- **120.2(A) General.** Electrical conductors and circuit parts shall not be considered in an electrically safe work condition until all the requirements of Article 120 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used in accordance with Article 130 until such time that electrical conductors and circuit parts are in an electrically safe work condition.

Informational Note: See 120.5 for the steps to establish and verify an electrically safe work condition.

• 120.5(7) Process for Establishing and Verifying a Safe Work Condition

- Exception No 1: An adequately rated permanently mounted test device shall be permitted to be used to verify the absence of voltage.
- Exception No 2: On electrical systems over 1000 volts, noncontact test instruments shall be permitted to be used to test each phase conductor.

Article 130 – Work Involving Electrical Hazards

- **130.2 (A)(4) Normal Operating Operation.** Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

1. The equipment is properly installed.
2. The equipment is properly maintained.
3. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
4. The equipment doors are closed and secured.
5. All equipment covers are in place and secured.
6. There is no evidence of impending failure.

Informational Note: The phrase properly installed means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase properly maintained means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase evidence of impending failure means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

• 130.2(B)(2) Elements of a Work Permit

2. Description of the work to be performed.
5. PPE for shock protection identified.
6. PPE for Arc protection identified.

- **130.4 Shock Risk Assessment**

- **130.4(B) Additional Protective Measures.** If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.1(H). When the additional protective measures include the use of PPE, the following shall be determined:

1. The voltage to which personnel will be exposed.
2. The boundary requirements.
3. The personal and other protective equipment required by the standard to protect against the shock hazard.

- **130.4(C) Documentation.** The results of the shock risk assessment shall be documented.

- **130.5 Arc Flash Risk Assessment**

- **130.5(A) General.** An arc flash risk assessment shall be performed:

1. To identify arc flash hazards.
2. To estimate the likelihood of occurrence of injury or damage to health and potential severity of injury or damage to health.
3. To determine if additional protective measures are required, including the use of PPE.

- **130.5(B) Estimate of Likelihood and Severity.** The estimate of the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration the following:

1. The design of the electrical equipment, including its overcurrent protective device and its operating time.
2. The electrical equipment operating condition and condition of maintenance.

- **130.5(C) Additional Protective Measures.** If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.1(H). When the additional protective measures include the use of PPE, the following shall be determined:

1. Appropriate safety-related work practices.
2. The arc flash boundary.
3. The PPE to be used within the arc flash boundary.

Table 130.5(C) shall be permitted to be used to estimate the likelihood of occurrence of an arc flash event to determine if additional protective measures are required.

- **130.5(E) Arc Flash Boundary**

1. The arc flash boundary shall be the distance at which the incident energy equals 1.2 cal/cm² (5 J/cm²).
Informational Note: For the information on estimating the arc flash boundary, see Informative Annex D.
2. The arc flash boundary shall be permitted to be determined by Table 130.79(C)(15)(a) or Table 130.7(C)(15)(b) when the requirements of these tables apply.

- **130.5(F) Arc Flash PPE. One of the following methods shall be used for the selection of arc flash PPE:**

1. The incident energy analysis method in accordance with 130.5(G).
2. The arc flash PPE category method in accordance with 130.7(C)(15).

Either, but not both, methods shall be permitted to be used on the same piece of equipment. The results of an incident energy analysis to specify an arc flash PPE category in Table 130.7(C)(15)(c) shall not be permitted.

- **130.5(G) Incident Energy Analysis Method.** The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the working distance at which the incident energy was determined.

The incident energy analysis shall take into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance.

The incident energy analysis shall be updated when changes occur in the electrical distribution system that could affect the results of the analysis. The incident energy analysis shall also be reviewed for accuracy at intervals not to exceed 5 years.

- **Table 130.5(G) Selection of Arc-Rated Clothing and Other PPE When the Incident Energy Analysis Method Is Used**

Incident energy exposures equal to 1.2 cal/cm² up to 12 cal/cm²

Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy^a.

Long-sleeve shirt and pants or coverall or arc flash suit (SR).

Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR)^b.

Arc-rated outerwear (e.g. jacket, parka, rainwear, hard hat liner) (AN).

Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)^c.

Hard hat.

Safety glasses or safety goggles (SR).

Hearing protection.

Leather footwear.

Incident energy exposures greater than 12 cal/cm²

Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy^a.

Long-sleeve shirt and pants or coverall or arc flash suit (SR).

Arc-rated arc flash suit hood.

Arc-rated outerwear (e.g. jacket, parka, rainwear, hard hat liner) (AN).

Arc-rated gloves or rubber insulating gloves with leather protectors (SR)^c.

Hard hat.

Safety glasses or safety goggles (SR).

Hearing protection.

Leather footwear.

- **130.5(H) Equipment Labeling**

- Exception No 1: Unless changes in electrical distribution system(s) render the label inaccurate, labels applied prior to the effective date of this edition of the standard shall be acceptable if they complied with the requirements for equipment labeling in the standard in effect at the time the labels were applied.

- Exception No 2: In supervised industrial installations where conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system, the information required in 130.5(H)(1) through 130.5(H)(3) shall be permitted to be documented in a manner that is readily available to persons likely to perform examination, servicing, maintenance, and operation of the equipment while energized.

- This Exception No. 2 indicates that label content including system voltage, AF boundary, IE or PPE category, and working distance does is not required but can be maintained via available documentation.

- The method of calculating and the data to support the information for the label shall be documented. The data shall be reviewed for accuracy at intervals not to exceed 5 years. Where the review of the data identifies a change that renders the label inaccurate, the label shall be updated.

The owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the marked label.

- **130.7(E) Alerting Techniques**

- **130.7(E)(1) Safety Signs and Tags.** Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note No 1: Safety signs, tags and barricades used to identify energized “look-alike” equipment can be employed as an additional preventive measure.

Informational Note No 2: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on safety signs and tags.

Miscellaneous Applicable Changes

Article 310 Safety-Related Work Practices for Electrolytic Cells

- Emphasis added for “exposed” energized surfaces and parts
 - **310.4(A)(1) Employee Training.** Qualified persons shall be trained and knowledgeable in the operation of cell line working zone equipment and specific work methods and shall be trained to avoid the electrical hazards that are present. Such persons shall be familiar with the proper use of precautionary techniques and PPE. Training for a qualified person shall include the following:
 1. Skills and techniques to avoid a shock hazard:
 - a. Between exposed energized surfaces, which might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts.
 - b. Between exposed energized surfaces and grounded equipment, other grounded objects, or the earth itself, that might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts.
 2. Method of determining the cell line working zone area boundaries.

Article 320 – Safety Requirements Related to Batteries and Battery Rooms

- **320.3(A)(1) Energy Thresholds.** Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented:
 1. AC: 50 volts and 5 milliamperes.
 2. DC: 100 volts.

Informational Note: This information is extracted for the Department of Energy (DOE) Electrical Safety Handbook, DOE-HDBK-1092.

Annex O.2.3 Incident Energy Reduction Methods

Recognized Energy Reduction Methods:

1. Zone-Selective Interlocking.
2. Differential Relaying.
3. Energy-reducing maintenance switching.
4. Energy-reducing active arc flash mitigation systems.
5. Arc flash relay.
6. High resistance grounding.
7. Current limiting fuses.
8. Shunt-trip.

Annex O.2.4 Safety Related Design Requirements

Additional Safety-by Design Methods:

1. Finger safe components.
2. Disconnects within site of motors.
3. Install current limiting devices.
4. Inspection windows.
5. Single service fused disconnects.
6. Metering for remote monitoring.
7. Install current limiting to motor controllers.
8. Install adjustable instantaneous trip.
9. Arc resistant equipment.
10. Remote racking.
11. Provisions for remote opening/closing.
12. Class C, D and E SPGFCI's.

Annex Q Human Performance and Workplace Electrical Safety

- Introduces the concept of human performance and how this concept can be applied to workplace electrical safety.