NFPA-70E 2018 Changes

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Services We Provide

- Safety, Health and Environmental Consulting, Training and Compliance
- Lockout / Tagout Energy Control Procedures
- Electrical Safety Audits and Training
- Incident Energy Analysis – Arc Flash Labeling
- Confined Space Assessments, Procedures, Training, On-site Services and Rescue Standby
- General Industry and Construction
Objectives of the Program are to gain an understanding of:

- Changes to NFPA 70E
- Concentration on what we all must know – Chapter 1 Safety-Related Work Practices

Need for 70 E-2018?

- OSHA 1910, Subpart S, not revised since 1981
- Subpart S based upon the 1979 version of 70E
- Reflect a need for updating the most current practices and technology
- 70E is nationally recognized for detailed instructions in safeguarding employees from electrical arc exposures
Need for 70 E-2018?

• Provides safe work practices guidelines missing from the National Electrical Code (NEC)

NFPA 70E-2018: Scope

• Revised Version
• “How you work on it approach”
• Goal: To eliminate electrocution
• Able to be read and understood by a Qualified or Un-Qualified Person
NFPA 70E - 2018

- NFPA 70E – three chapters plus appendices
  - Chapter 1 – Applies generally
  - Chapter 2 – Safety-related Maintenance Requirements
  - Chapter 3 – Supplements or modifies Chapter 1 with safety requirements for special equipment.
  - Informative annexes are not part of the standard but are included for informational purposes only.

NFPA 70E - 2018

- Chapter 1 Safety-Related Work Practices
  - Definitions
  - The information all qualified and unqualified persons need to know
  - Considers the most important aspects of working with equipment in an abnormal condition by addressing those aspects first.
Article 90 - Introduction

- Purpose
- Scope – Covered and Not Covered
- Standard Arrangement
- Mandatory Rules, Permissive Rules, and Explanatory Material
- Organization section (90.4) has been deleted
- Informative Annexes 90.5(D) added

NFPA 70E Annexes

- Annex A: Informative Publications: Revised some dates of these documents
- Annex B: is RESERVED
- Annex C: Limits of Approach: Updated Table References
- Annex D: Incident Energy and Arc Flash Boundary Calculation Methods: Revised some of the figures and tables.
- Annex E: Electrical Safety Program
- Annex F: Risk Assessment and Risk Control
- Annex G: Sample Lockout/Tagout Program
NFPA 70E Annexes

- Annex H: Guidance on PPE
- Annex I: Job Briefing and Planning Checklist
- Annex J: Electrical Work Permit
- Annex K: General Categories of Electrical Hazards
- Annex L: Typical Application of Safeguards in the Cell Line Working Zone
- Annex M: Layering of Protective Clothing and Total System Arc Rating
- Annex O: Safety-Related Design Requirements

Article 100

- Definitions
**Article 105 – Application of Safety-Related Work Practices and Procedures**

- For employees who are exposed to an electrical hazard in workplaces covered under the scope of this standard.
- Responsibilities for employer and employee
- Priority - Hazard elimination shall be the first priority in the implementation of safety-related work practices.
- Organization of the standard

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

- Electrical Safety Program
- Training Requirements
- Host and Contract Employer' Responsibilities
- Test Instruments and Equipment
- Portable Cord- and Plug-Connected Electric Equipment
- Ground-Fault Circuit-Interrupter (GFCI) Protection
- Overcurrent Protection
Article 120 – Establishing an Electrically Safe Work Condition

• If possible de-energize an area before attempting work, and the steps on how to do so.

Article 130 – Working On or Near Live Parts

• Steps for working on components not in an electrically safe work condition.
• Only necessary to refer to this if article 110 and 120 have not addressed the electrical hazard.
NFPA 70E - 2018

• Chapter 2 Safety-Related Maintenance Requirements
  o Addresses maintenance of the electrical equipment, which provides for the reliability and predictability necessary for the accurate operation of electrical equipment.
  o (example: substations, switchgear assemblies, switchboards, motor control centers, etc.)

NFPA 70E - 2018

• Chapter 3 Safety Requirements for Special Equipment
  o In instances where electrical energy is converted to a form that exposes workers to unique hazards.
  o In these instances, the electrical energy is a process variable and the safe work practices defined in Chapter 1 might become unsafe.
  o Chapter 3 is intended to identify Safety-related work practices for use in these situations.
    • Electrolytic Cells, batteries and battery charging rooms, lasers, power electronic equipment (electric arc welding, radio, radar, television transmission, motor drives, etc.)
    • Research and development laboratories
NFPA 70E 2018

- Changes contained within new edition
- Revisions are in shaded text
- N indicates new text added to edition
- Δ indicates text deletions, also figure or table revisions
- ◼ indicates Section deletions

Changes Throughout NFPA 70E 2018

1. 100 VDC changed to 50 volts
2. The term “Short Circuit Current” is now referred to as “Available Fault Current”
3. “accident” is now “incident”
4. “accidental” is now “unintentional”
5. “accidentally” is now “unintentionally”
Electrical Worker Safety Training

Arc-Flash and Shock Hazards

Definitions

Accessible, Readily (Readily Accessible): Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools [other than keys], to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth. [70:100]
Definitions

Arc Flash Hazard: A source of possible injury or damage to health associated with the release of energy caused by an electric arc.

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained.

Informational Note No. 2: See Table 130.5(C) for examples of tasks that increase the likelihood of an arc flash incident occurring.

Definitions

Boundary, Arc Flash: When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm² (5 J/cm²).

Informational Note: According to the Stoll skin burn injury model, the onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm² (5 J/cm²) for one second.
Definitions

Boundary, Restricted Approach. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.

REMOVED “for personnel working in close proximity to the energized electrical conductor or circuit part.”

Definitions

• Electrical Hazard. A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or arc blast injury.

• 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.
Definitions

• Electrical Safety. **Identifying** hazards associated with the use of electrical energy and taking precautions to reduce the risk associated with those 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 verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

Definitions

• Enclosed. Surrounded by a case, housing, fence, or wall(s) that prevents persons from **unintentionally** contacting energized parts.

• Enclosure. The case or housing of apparatus — or the fence or walls surrounding an installation to prevent personnel from **unintentionally** contacting energized electrical conductors or circuit parts or to protect the equipment from physical damage.
Definitions

• Fault Current. The amount of current delivered at a point on the system during a short-circuit condition.

• Fault Current, Available. The largest amount of current capable of being delivered at a point on the system during a short-circuit condition.

  Informational Note No. 1: A short circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault. See Figure 100.0.

  Informational Note No. 2: If the dc supply is a battery system, the term available fault current refers to the prospective short-circuit current.

• Maintenance, Condition of. The state of the electrical equipment considering the manufacturers’ instructions, manufacturers’ recommendations, and applicable industry codes, standards, and recommended practices.

• 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 reduce the associated risk.
Definitions

- 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.

  Informational Note: As used in this standard, arc flash risk assessment and shock risk assessment are types of risk assessments.

Definitions

- Shock Hazard. A **source of possible injury or damage to health** associated with current **through the body** caused by contact or approach to energized electrical conductors or circuit parts.

  Informational Note: Injury and damage to health resulting from shock is dependent on the magnitude of the electrical current, the power source frequency (e.g., 60 Hz, 50 Hz, dc), and the path and time duration of current through the body. The physiological reaction ranges from perception, muscular contractions, inability to let go, ventricular fibrillation, tissue burns, and death.
Definitions

• Working Distance. The distance between a person's face and chest area and a prospective arc source.

  Informational Note: Incident energy increases as the distance from the arc source decreases. See 30.5(C)(1) for further information.

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.
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 into 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)(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.

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
Article 110 General Requirements for Electrical Safety-Related Work Practices

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.

Job Safety Planning. The job safety plan shall be in accordance with the following:
- Be completed by a qualified person;
- Be documented;
- 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 a 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.

Incident Investigations. The electrical safety program shall include elements to investigate electrical incidents.

Test Instruments and Equipment.
- Testing. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring on electrical equipment operating at voltages equal to or greater than 50 volts.

- Operation Verification. When test instruments are used for testing the absence of voltage on conductors or circuit parts operating at voltages equal to or greater than 50 volts, the operation of the test instrument shall be verified on any known voltage source before and after an absence of voltage test is performed.
**Article 110 General Requirements for Electrical Safety-Related Work Practices**

110.1(K) Auditing

(1) Electrical Safety Program Audit: 3 years
(2) Field Work Audit: 1 Year
(3) Lockout/Tagout Program and Procedure Audit. The lockout/tagout program and procedures required by Article 120 shall be audited by a qualified person at intervals not to exceed 1 year.
(4) Documentation: shall be documented

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

110.2(A)(3) Retraining. Retraining in safety-related work practices... intervals not to exceed 3 years...or if...

(1) The supervision or annual inspections indicate the employee is not complying with the safety-related work practices.
(2) New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices different from those that the employee would normally use.
(3) The employee needs to review tasks that are performed less often than once per year.
(4) The employee needs to review safety-related work practices not normally used by the employee during regular job duties.
(5) The employee's job duties change.
Article 110 General Requirements for Electrical Safety-Related Work Practices

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 demonstrates 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

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.2(B) Lockout/Tagout Procedure Training.

1. Initial Training. Employees involved in or affected by the lockout/tagout procedures required by 120.2 shall be trained in the following:
   1. The lockout/tagout procedure
   2. Their responsibility in the execution of the procedures
Article 110 General Requirements for Electrical Safety-Related Work Practices

Lockout/Tagout Procedure

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

Article 110 General Requirements for Electrical Safety-Related Work Practices

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

110.2(C)(2) First Aid, Emergency Response, and Resuscitation...Training shall occur at a frequency that satisfies the requirements of the certifying body.
Article 110 General Requirements for Electrical Safety-Related Work Practices

110.2(C)(3) Training Verification. Employers shall verify at least annually that employee training required by 110.2(C) is current.

110.2(C)(4) Documentation. The employer shall document that the training required by 110.2(C) has occurred.

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.4(A) Testing. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring on electrical equipment operating at voltages equal to or greater than 50 volts.
Article 120 Establishing an Electrically Safe Work Condition

Reorganized to provide a more logical sequence for the overall process.

(1) Lockout/Tagout Program
(2) Lockout/Tagout Principles
(3) Lockout/Tagout Equipment
(4) Lockout/Tagout Procedures
(5) Process for Establishing and Verifying an Electrically Safe Work Condition

120.1 Lockout/Tagout Program
(1) Applicable to the experience and training of the workers and conditions in the workplace
(2) Meet requirements of Article 120
(3) Apply to fixed, permanently installed equipment, temporarily installed equipment and portable equipment
Article 120 Establishing an Electrically Safe Work Condition

120.1(B) Employer Responsibilities
(1) Provide equipment to execute Lockout/Tagout procedures
(2) Provide Lockout/Tagout training in accordance with Article 110.2
(3) Audit the Lockout/Tagout Program (Article 110.1)
(4) Audit execution of the Lockout/Tagout Program in accordance with Article 110.1

Article 120 Establishing an Electrically Safe Work Condition

120.5 Process for Establishing and Verifying an Electrically Safe Work Condition.
• Use an adequately rated **portable** test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.
• (See Next 2 slides for exceptions)
Article 120 Establishing an Electrically Safe Work Condition

- 120.2 Lockout/Tagout Principles
- 120.2(A) General - Meet requirements of Article 120
- 120.2(B) 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”
- 120.2(C) Lockout/Tagout Procedure – language relocated from 120.2(B)(5) Plan. “A lockout/tagout procedure” shall be developed and “suitable documentation including” up-to-date drawings and diagrams was added.

Article 120 Establishing an Electrically Safe Work Condition

- 120.3 Lockout/Tagout Equipment – Relocated 120.2(E) and covers the requirements of lock application, LOTO device, lockout device and tagout device.
- 120.4 Lockout/Tagout Procedures – Derived from relocating other sections.
- 120.5 Process for Establishing and Verifying an Electrically Safe Work Condition – This was 120.1 and relocated and retitled. Two additional steps were added:
  - (4) Release stored electrical energy
  - (5) Release or block stored mechanical energy
Article 120 Establishing an Electrically Safe Work Condition

120.5 Process for Establishing and Verifying an Electrically Safe Work Condition.

• Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source.

• (See Next 2 slides for exceptions)

Article 120 Establishing an Electrically 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 of the conductors or circuit parts at the work location, provided it meets the all following requirements:

(1) It is permanently mounted and installed in accordance with the manufacturer’s instructions and tests the conductors and circuit parts at the point of work;

(2) It is listed and labeled for the purpose of verifying the absence of voltage;

(3) It tests each phase conductor or circuit part both phase-to-phase and phase-to-ground;

(4) The test device is verified as operating satisfactorily on any known voltage source before and after verifying 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.

130.2(A)(4) Normal Operating Condition. 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.
**Article 130 Work Involving Electrical Hazards**

130.2 (B) Energized Electrical Work Permit.

(1) When Required. When work is performed as permitted in accordance with 130.2(A), an energized electrical work permit shall be required and documented under the any of following conditions...

130.2(B)(2) Added requirement to describe the work to be done

130.2(B)(3) Added ultrasound to the work permit exemptions.

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**130.4 Shock Risk Assessment**

- 130.4 Revised section title to “Shock Risk Assessment” and revised parent text for clarity and usability. Reorganized subsections to capture all of the prescriptive steps of a shock risk assessment.

- 130.4(B) Added requirement to apply risk controls (including PPE) to a shock risk assessment:
  - (voltage to which personnel will be exposed
  - Boundary requirements
  - Personal and other protective equipment required to protect against shock hazard
**Article 130 Work Involving Electrical Hazards**

- 130.4(C) Documentation – Results of the shock risk assessment
- 130.4(C)(a) and Table 130.4(C)(b) Added requirement to document shock risk assessment.
- Table 130.4(D)(a) shall be used for the distances associated with various ac system voltages.
- Table 130.4(D)(b) shall be used for the distances associated with various dc system voltages.

### Table 130.4(D)(a) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating-Current Systems

<table>
<thead>
<tr>
<th>Nominal System Voltage Range, Phase to Phase(^4)</th>
<th>Limited Approach Boundary(^6)</th>
<th>Restricted Approach Boundary(^6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exposed Non-Safe Conductor(^5)</td>
<td>Exposed Non-Safe Circuit Part</td>
</tr>
<tr>
<td>Low than 50 V</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>50 V–100 V</td>
<td>0.5 m (1.6 ft. in.)</td>
<td>1.0 m (3.3 ft. in.)</td>
</tr>
<tr>
<td>100 V–208 V</td>
<td>0.9 m (3.2 ft. in.)</td>
<td>1.6 m (5.2 ft. in.)</td>
</tr>
<tr>
<td>208 V–351 V</td>
<td>1.6 m (5.2 ft. in.)</td>
<td>3.5 m (11.5 ft. in.)</td>
</tr>
<tr>
<td>351 V–600 V</td>
<td>3.7 m (12.1 ft. in.)</td>
<td>7.3 m (24.0 ft. in.)</td>
</tr>
</tbody>
</table>

Sources:
1. For all field boundaries, see 100.8(A).
2. All distances are distance from exposed energized electrical conductors or circuit parts to employee.
3. For single-phase systems above 120 volts, select the range that is equal to the system’s minimum phase-ground voltage multiplied by 1.732.
4. For definition of 351 V–600 V, see 356(A)(2) and Information Annex C for elaboration.
5. Exposed non-safe conductor is defined as the distance between the conductor and a person is not under the control of the person.
6. The term “exposed” is normally applied to overhead live conductors supported by poles.
Table 130.4(D)(b) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct Current Voltage Systems

<table>
<thead>
<tr>
<th>Nominal Potential Difference</th>
<th>Limited Approach Boundary</th>
<th>Restricted Approach Boundary Include Indirect Contact Adder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 50 V</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>50 V-200 V</td>
<td>5.0 m (16 ft 6 in.)</td>
<td>1.0 m (3 ft 3 in.)</td>
</tr>
<tr>
<td>300 V-1 kV</td>
<td>3.0 m (9 ft 10 in.)</td>
<td>1.5 m (5 ft 0 in.)</td>
</tr>
<tr>
<td>1 kV-3 kV</td>
<td>5.0 m (16 ft 6 in.)</td>
<td>1.5 m (5 ft 0 in.)</td>
</tr>
<tr>
<td>5 kV-15 kV</td>
<td>5.0 m (16 ft 6 in.)</td>
<td>0.5 m (1 ft 8 in.)</td>
</tr>
<tr>
<td>15 kV-45 kV</td>
<td>5.0 m (16 ft 6 in.)</td>
<td>0.5 m (1 ft 8 in.)</td>
</tr>
<tr>
<td>45 kV-75 kV</td>
<td>3.0 m (9 ft 10 in.)</td>
<td>2.5 m (8 ft 2 in.)</td>
</tr>
<tr>
<td>75 kV-150 kV</td>
<td>3.5 m (11 ft 8 in.)</td>
<td>1.5 m (5 ft 0 in.)</td>
</tr>
<tr>
<td>150 kV-250 kV</td>
<td>8.6 m (28 ft 2 in.)</td>
<td>1.2 m (3 ft 10 in.)</td>
</tr>
<tr>
<td>250 kV-500 kV</td>
<td>6.0 m (19 ft 8 in.)</td>
<td>3.5 m (11 ft 8 in.)</td>
</tr>
<tr>
<td>500 kV-900 kV</td>
<td>8.0 m (26 ft 3 in.)</td>
<td>5.0 m (16 ft 6 in.)</td>
</tr>
</tbody>
</table>

Note: All dimensions are distances from exposed energized electrical conductors or circuit parts to worker.

Previously was:
Less than 100V
100V to 300V

Article 130 Work Involving Electrical Hazards

130.5 Arc Flash Risk Assessment.
(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 the potential severity of injury or damage to health

(3) To determine if additional protective measures are required, including the use of PPE
Article 130 Work Involving Electrical Hazards

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:

a. The design of the electrical equipment, including its overcurrent protective device and its operating time
b. 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
Article 130 Work Involving Electrical Hazards

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.

- Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems

Based on the following items:
- Task Being Performed
- Equipment Condition (Any, Normal, or Abnormal)
- Likelihood of Occurrence (Yes or No)

Was Table 130.7(C)(15)(A)(a) in NFPA 70E 2015

Table 130.5(C) Estimation of Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems

<table>
<thead>
<tr>
<th>Task</th>
<th>Equipment Condition</th>
<th>Likelihood of Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of a CB, switch, connect, or motor</td>
<td>Normal</td>
<td>No</td>
</tr>
<tr>
<td>Voltage testing on individual battery cells or individual multi-cell units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that do not expose live, energized electrical conduits and circuit parts</td>
<td>Abnormal</td>
<td>Yes</td>
</tr>
<tr>
<td>Opening a jointbox hinged door or cover to access dead front, overcurrent devices, Removal of battery nonconductive intercell connector covers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance and testing on individual battery cells or individual multi-cell units in an open rack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion or removal of individual cells or multicell units of a battery array in an open rack</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arcresistant loadgear Type 1 or 2 (for clearing times of less than 0.5 sec with a prospective fault current not to exceed the arcresistant rating of the equipment) and fault interrupter switchgear, fused or unfused of arc resistant type construction, 1 kV through 15 kV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion or removal (contact) of CBs from cubicles.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insertion or removal (contact) of ground and test devices or insertion or removal (contact) of antenna connectors on or off the bus.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Equipment condition considered to be “normal” if all of the following circumstances apply:
1. The equipment is properly installed in accordance with the manufacturer's recommendations and applicable industry codes and standards.
2. The equipment is properly maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards.
3. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
4. Equipment doors are closed and secured.
5. Equipment covers are in place and secured.
6. There is no evidence of impending failure such as wearing, coronaing, loose or bound equipment parts, visible damage, or deterioration.
TABLE 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for ac and dc Systems

- Where this table identifies “No” as an estimate of likelihood of occurrence, it means that an arc flash incident is not likely to occur.

- Where this table identifies “Yes” as an estimate of likelihood of occurrence, it means that additional protective measures are required to be selected and implemented according to the hierarchy of risk control identified in 110.1(H).

**Article 130 Work Involving Electrical Hazards**

130.5(E)(2) The arc flash boundary shall be permitted to be determined by Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) when the requirements of these tables apply.

There are two methods that can be used in an arc flash risk assessment to determine the arc flash boundary.

- The incident energy analysis method, which results in an arc flash boundary at a distance where the incident energy is 1.2 cal/cm².
- The other is the arc flash PPE category method, which results in an arc flash boundary selected directly from the tables in 130.7(C)(15).
Article 130 Work Involving Electrical Hazards

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.

Article 130 Work Involving Electrical Hazards

130.5(G) Incident Energy Analysis Method
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.
*Use Table 130.5(G) For PPE when using this method
Article 130 Work Involving Electrical Hazards

Table 130.5(G) identifies the arc-rated clothing and other PPE requirements...and used with the incident energy analysis method of selecting arc flash PPE.

No PPE specified for less than 1.2 cal/cm²
PPE for 1.2 cal/cm² to 12 cal/cm²
PPE for greater than 12 cal/cm²
Article 130 Work Involving Electrical Hazards

130.5(H) Equipment Labeling: Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are in other than dwelling units and that are likely to require examination, adjustment, servicing, or maintenance while energized shall be marked with a label containing all the following information:

1. Nominal system voltage
2. Arc flash boundary
3. At least one of the following:
   a. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 30.7(C)(15)(a) or Table 130.7(C)(15)(b) for the equipment, but not both
   b. Minimum arc rating of clothing
   c. Site-specific level of PPE

Sample Labels
**Article 130 Work Involving Electrical Hazards**

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.

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**Personal and Other Protective Equipment**

130.7 (A) General. Employees exposed to electrical hazards when the risk associated with that hazard is not adequately reduced by the applicable electrical installation requirements shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed.
Personal and Other Protective Equipment

130.7 (B) Care of Equipment. Protective equipment shall be maintained in a safe, clean, and reliable condition and in accordance with manufacturers’ instructions. The protective equipment shall be visually inspected before each use. Protective equipment shall be stored in a manner to prevent damage from physically damaging conditions and from moisture, dust, or other deteriorating agents.

Personal and Other Protective Equipment

• 130.7(C)(7) Hand and Arm Protection. Hand and arm protection shall be provided in accordance with 130.7(C)(7)(a), (b), and (c).

• Rubber insulating gloves shall be permitted to be used without leather protectors, under the following conditions:
  (1) There shall be no activity performed that risks cutting or damaging the glove.
  (2) The rubber insulating gloves shall be electrically retested before reuse.
  (3) The voltage rating of the rubber insulating gloves shall be reduced by 50 percent for class 00 and by one whole class for classes 0 through 4.
Personal and Other Protective Equipment

- 130.7(C)(9)(c) Deleted “underwear next to the skin” to have requirement apply to all under layers.

- 130.7(C)(10)(b)(1) Revised to clarify that either a hood or balaclava may be used to protect the head.

- 130.7(C)(10)(e) Revised to include dielectric footwear to correlate with 130.7(C)(8) where dielectric footwear is permitted as an alternative to leather.

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Personal and Other Protective Equipment

130.7(C)(11) Clothing Material Characteristics.

Personal and Other Protective Equipment

Arc Flash PPE Category Method. The requirements of 130.7(C)(15) shall apply when the arc flash PPE category method is used for the selection of arc flash PPE.

TABLE 130.7(C)(15)(a) Arc-Flash PPE Categories for AC Systems

<table>
<thead>
<tr>
<th>Partial of Table 130.7 (C) (15)(a) Arc-Flash PPE Categories for Alternating Current (ac) Systems</th>
<th>Arc-Flash PPE Category</th>
<th>Arc-Flash Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 volts and below</td>
<td>1</td>
<td>485 mm (19 in.)</td>
</tr>
<tr>
<td>Panelboards or other equipment rated greater than 240 volts and up to 600 volts</td>
<td>2</td>
<td>909 mm (36 in.)</td>
</tr>
<tr>
<td>600-volt class motor control centers (MCCs)</td>
<td>2</td>
<td>1.5 m (5 ft)</td>
</tr>
<tr>
<td>600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards</td>
<td>4</td>
<td>4.3 m (14 ft)</td>
</tr>
<tr>
<td>Other 600-volt class (277 volts through 600 volts, nominal) equipment</td>
<td>4</td>
<td>6 m (20 ft)</td>
</tr>
<tr>
<td>NEMA E2 (fused contactor) motor starters, 2.2 kV through 7.2 kV</td>
<td>2</td>
<td>1.5 m (5 ft)</td>
</tr>
<tr>
<td>Metal clad switchgear, 1 kV through 15 kV</td>
<td>4</td>
<td>12 m (40 ft)</td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA available fault current; maximum of 0.63 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA available fault current; maximum of 0.63 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA available fault current; maximum of 0.63 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA available fault current; maximum of 0.63 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kA available fault current; maximum of 0.63 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Partial Table 130.7 (C) (15)(b) Arc-Flash PPE Categories for Direct Current (dc) Systems

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Arc-Flash PPE Category</th>
<th>Arc-Flash Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage batteries, dc switchboards, and other dc supply sources</td>
<td>2</td>
<td>900 mm (3 ft)</td>
</tr>
<tr>
<td>Parameters: Greater than or equal to 100 V and less than or equal to 250 V Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available fault current less than 4 kA</td>
<td>2</td>
<td>900 mm (3 ft)</td>
</tr>
<tr>
<td>Available fault current greater than or equal to 4 kA and less than 7 kA</td>
<td>2</td>
<td>1.2 m (4 ft)</td>
</tr>
<tr>
<td>Available fault current greater than or equal to 7 kA and less than 15 kA</td>
<td>3</td>
<td>1.8 m (6 ft)</td>
</tr>
<tr>
<td>Storage batteries, dc switchboards, and other dc supply sources</td>
<td>2</td>
<td>900 mm (3 ft)</td>
</tr>
<tr>
<td>Parameters: Greater than 250 V and less than or equal to 600 V Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available fault current less than 1.5 kA</td>
<td>2</td>
<td>900 mm (3 ft)</td>
</tr>
</tbody>
</table>

Personal and Other Protective Equipment

TABLE 130.7(C)(15)(c) Personal Protective Equipment (PPE) is not applicable to evaluations conducted using the incident energy analysis method. For arc flash PPE clothing requirements for the incident energy analysis method, see 130.5(G) and 130.7(C)(1) through (C)(14).
### Part of Table 130.7 (C)(15)(c) Personal Protective Equipment (PPE)

<table>
<thead>
<tr>
<th>Arc Flash PPE Category</th>
<th>PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)</td>
<td>Arc-rated long-sleeve shirt and pants or arc-rated coverall, Arc-rated face shield, or arc flash suit level Arc-rated jacket, pant, rainwear, or hard hat liner (ANS) Protective Equipment: Hard hat, Safety glasses or safety-goggles (SR), Hearing protection (ear canal inserts), Heavy-duty leather gloves, Leather footprint</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (35.5 J/cm²)</td>
<td>Arc-rated long-sleeve shirt and pants or arc-rated coverall, Arc-rated flash suit level or arc-rated flash suit, or arc-rated flash suit Arc-rated jacket, pant, rainwear, or hard hat liner (ANS) Protective Equipment: Hard hat, Safety glasses or safety-goggles (SR), Hearing protection (ear canal inserts), Heavy-duty leather gloves, Leather footprint</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 15 cal/cm² (59.4 J/cm²)</td>
<td>Arc-rated long-sleeve shirt (AR), Arc-rated pants (AR), Arc-rated coverall (AR), Arc-rated arc-flash suit jacket (AR), Arc-rated arc-flash suit pants (AR), Arc-rated arc-flash suit hood, Arc-rated gloves (AR), Arc-rated jacket, pant, rainwear, or hard hat liner (ANS) Protective Equipment: Hard hat, Safety glasses or safety-goggles (SR), Hearing protection (ear canal inserts), Leather footprint</td>
</tr>
</tbody>
</table>

### Additional Changes

- Article 205 General Maintenance Requirements
  - 205.3 – Informational Note No.2 – “Noncontact diagnostic methods in addition to scheduled maintenance activities of electrical equipment can assist in the identification of electrical anomalies”
Additional Changes

- Article 350 Safety-Related Work Requirements: Research and Development Laboratories
- 350.4 – Electrical Safety Authority (ESA) – new section – permits each laboratory or R&D System application to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls.

NFPA 70E Annexes

- Annex A: Informative Publications: Revised some dates of these documents
- Annex B: is RESERVED
- Annex C: Limits of Approach: Updated Table
- Annex D: Incident Energy and Arc Flash Boundary Calculation Methods: Revised some of the figures and tables.
- Annex E: Electrical Safety Program
- Annex F: Risk Assessment and Risk Control
- Annex G: Sample Lockout/Tagout Program
NFPA 70E Annexes

- Annex H: Guidance on PPE
- Annex I: Job Briefing and Planning Checklist
- Annex J: Electrical Work Permit
- Annex K: General Categories of Electrical Hazards
- Annex L: Typical Application of Safeguards in the Cell Line Working Zone
- Annex M: Layering of Protective Clothing and Total System Arc Rating
- Annex O: Safety-Related Design Requirements
Wrong Tool for Energized Work

Reenactment: Serious Burn Resulted
Uninsulated screw driver contacted electrically energized wire.
Any Questions?