Electrical Safety Standards in the Workplace – Quick Tips

The National Fire Protection Association (NFPA) is a nonprofit organization devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. The Occupational Safety and Health Administration (OSHA) and the NFPA have written many standards and regulations that build on one another. In the case of NFPA 70E: Standard for Electrical Safety in the Workplace, the OSHA regulations and NFPA standards work so well together it's been said that OSHA provides the "shall" while NFPA provides the "how."

OSHA bases its electrical safety standards (found in 29 Code of Federal Regulations (CFR) Part 1910 Subpart S and 29 CFR Part 1926 Subpart K) on the comprehensive information found in NFPA 70E. 29 CFR 1910.333(a) states that employers must employ safety-related work practices to prevent electrical shock or other injuries resulting from either direct or indirect electrical contact. NFPA 70E is the tool employers use to meet this OSHA requirement. For example, OSHA mandates that all services to electrical equipment be done in a de-energized state. "Working live" can only be done under special circumstances. NFPA 70E defines those special circumstances and sets rigid electrical safety limits on voltage exposures, work zone boundary requirements and necessary personal protective equipment (PPE). (See NFPA 70E-2021 Article 130 and OSHA subpart S part 1910.333(a)(1)-(2) and (c) for complete details.)

It is important to note that NFPA 70E is a voluntary national consensus safety standard published by NFPA primarily to assist OSHA in preparing its electrical safety standards. Federal OSHA has not incorporated NFPA 70E into the Code of Federal Regulations.

History of NFPA 70E

The first edition of NFPA 70E was published in 1979 and contained installation safety requirements borrowed from the National Electric Code. In 1981 safety-related work practice requirements were added. In 1995 "limits of approach" and "arc flash" concepts were introduced. In the 1990s and through 2012 the emphasis was on arc flash PPE requirements. Beginning with the 2015 edition, the focus began to shift from PPE requirements to the employer's duty to create a comprehensive electrical safety program and integrate it into their occupational health and safety management system (OHSMS). Risk management terminology was defined and all requirements in the standard were harmonized with risk management principles. The hierarchy of risk control methods was introduced in an explanatory/informational note. The 2018 edition continued to evolve to address risk assessment and introduced human factors, such as human error, as part of the shock and arc flash risk assessments. This edition emphasized the need to use the hierarchy of risk controls (moved from an informational note into mandatory text) and explicitly stated that the priority must

be the elimination of the hazard. The most notable change for the 2018 edition was that tables and text that specified PPE standards were moved to informational tables or notes and 130.7(C)(14)(b) was added to provide guidance on conformity assessment of PPE.

NFPA 70E-2021

The 2021 edition continues to focus on risk assessment and emphasize the need to follow the hierarchy of risk controls to eliminate and reduce the potential hazards.

Most notable changes to the 2021 edition include:

- Article 110 General Requirements for Electrical Safety-Related Work Practices has been revised to incorporate the general requirements for electrical safety-related work programs, practices and procedures from other articles to emphasize their importance.
- Reference to arc-resistant switchgear has been changed to arc-resistant equipment in Tables 130.5(C) and 130.7(C)(15)(a) to address the use of other types of arc-resistant equipment.
- Modifications to Table 130.5(C) – it now lists tasks as either normal or abnormal as a risk assessment condition, and batteries have been added. Also, a new task has been added as YES for likelihood of an arc flash incident for any condition: “Operation of a CB or switch the first time after installation or completion of maintenance in the equipment.”
- Changes to PPE include the incorporation of ASTM D120 for voltage gloves and the requirement for outer layers of clothing. If an outer layer of clothing is worn it must be arc-rated and the inner layer must meet the calorie requirement of the job task.
- Article 360 Safety-Related Requirements for Capacitors and Annex R Working with Capacitors have been added to addresses specific safety related requirements unique to capacitors.
- Annex D Incident Energy and Arc Flash Boundary Calculation Methods has been revised to refer to IEEE-1584-2018 as a method of calculation.
- Annex F Risk Assessment and Risk Control contains new material that provides guidance on how to select PPE using a battery risk assessment process when multiple hazards are present.
- Annex I Job Briefing and Job Safety Planning Checklist contains comprehensive job-planning checklist to aid in pre-job assessments.

Need for NFPA 70E

NFPA 70E Article 110 identifies the General Requirements for Electrical Safety-Work Practices. One major requirement is performing a risk assessment before any work is started. The risk assessment must address employee exposure to electrical hazards and identify the process to be used by the employee to identify hazards, assess risks and implement risk control according to the hierarchy of risk control methods. The procedure must address the potential for human error and its negative consequences on people, processes, the work environment and equipment.

Article 120 Establishing an Electrically Safe Work Condition requires employers to establish, document, and implement a lockout/tagout program and specify lockout/tagout procedures to safeguard workers from exposure to electrical hazards.

Article 130 Work Involving Electrical Hazards covers requirements for work involving electrical hazards when an electrically safe work condition cannot be established.

To quantify the risk present in the covered work two assessments that must be done for each affected electrical equipment piece:

- Shock Risk Assessment – 130.4(A)(1) – (3)
- Arc Flash Risk Assessment – 130.5(A)(1) – (3)

These assessments must identify the hazards, estimate the likelihood of the occurrence and potential severity of injury or damage to health and determine if additional protective measures are required, including the use of personal protective equipment (PPE).

Table 130.5(C) Estimate of the Likelihood of Occurrence of an Arc Flash Incident for Alternating Current (AC) and Direct Current (DC) Systems may be used to estimate the likelihood of occurrence of an arc flash event to determine if additional protective measures are required. Tasks are now listed as “normal” or “abnormal” as a risk assessment condition. If likelihood of occurrence does exist (designated as a yes response in the table) appropriate arc flash PPE must be determined by one of two methods:

- Incident energy analysis method – Annex D and 130.5(G), or
- Arc flash PPE category method – 130.7(C)(15)(a) or (b)*

One or the other method must be used, but not both on the same piece of electrical equipment.

Article 130.7 addresses requirements for personal and other protective equipment for employees exposed to electrical shock and arc flash hazards when the risk associated with these hazards is not adequately reduced by the first five hierarchy of risk control methods: (1) elimination, (2) substitution, (3) engineering controls, (4) awareness, or (5) administrative controls.

*The maximum available fault current, maximum fault clearing times (cycle fault) of overcurrent protective devices and minimum working distance must be known to use this method. If not known an incident energy analysis must be completed.

Incident Energy Analysis Method

Annex D provides guidance on completing an incident energy analysis to calculate the incident energy and flash boundary. Once the calculations are completed Table 130.5(G) can be referenced to select appropriate arc-rated clothing and other PPE. It should be noted table 130.5(G) only references two PPE energy levels and corresponding PPE:

- Incident energy exposure equal to 1.2 calories/square centimeter (cal/cm^2) up to 12 cal/cm^2
- Incident energy exposures greater than 12 cal/cm^2

Incident Energy Analysis Method	
1.2–12 cal/cm^2	> 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[1]	Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[1]
Long sleeve shirt and pants or coverall or arc flash suit – select one	Long sleeve shirt and pants or coverall or arc flash suit – select one
Arc-rated face shield and arc-rated balaclava or arc flash suit hood – select one[2]	Arc flash suit hood
Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) – as needed[3]	Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) – as needed[3]
Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors – select one[4]	Arc-rated gloves, or rubber insulating gloves with leather protectors – select one[4]
Hard hat	Hard hat
Safety glasses or safety goggles – select one	Safety glasses or safety goggles – select one
Hearing protection	Hearing protection
Leather footwear[5]	Leather footwear[5]

1.Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for a flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.
2. Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required. Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.
3. The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, that are not used as part of a layered system, are not required to be equal to or greater than the estimated incident energy exposure.
4. Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.
5. Footwear other than leather or dielectric is permitted to be used provided it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure.

Arc Flash PPE Category Method

The PPE category method first references Table 130.7(C)(15)(a) for AC current applications or 130.7(C)(15)(b) for DC current applications to determine the arc flash PPE category and arc flash boundary based on the equipment being evaluated. The maximum available fault current, maximum fault-clearing time, and minimum working distances for each equipment type must be known and followed to use this Table. If any condition fall outsides the listed parameters or are unknown the incident energy analysis method must be used. Once the arc-flash category is determined, Table 130.7(C)(15)(c) is referenced to identify all PPE needed for each applicable arc-flash PPE category.

Personal Protective Equipment Category Method			
Category 1–4 cal/cm^2	Category 2–8 cal/cm^2	Category 3–25 cal/cm^2	Category 4–40 cal/cm^2
Arc-rated long-sleeve shirt and pants or arc-rated coverall	Arc-rated long-sleeve shirt and pants or arc-rated coverall	Arc-rated long-sleeve shirt, pants, coverall, flash suit jacket, and flash suit pants – as required	Arc-rated long-sleeve shirt, pants, coverall, flash suit jacket, and flash suit pants – as required
Arc-rated face shield[1] or arc flash suit hood	Arc-rated face shield[1] and arc-rated balaclava or arc-rated flash suit hood	Arc-rated arc flash suit hood	Arc-rated arc flash suit hood
Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner – as needed[5]	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner – as needed[5]	Arc-rated gloves, or rubber insulating gloves with leather protectors – select one[3]	Arc-rated gloves, or rubber insulating gloves with leather protectors – select one[3]
Hard hat	Hard hat	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner – as needed[5]	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner – as needed[5]

Safety glasses or safety goggles – select one	Safety glasses or safety goggles – select one	Hard hat	Hard hat
Hearing protection (ear canal inserts)[2]	Hearing protection (ear canal inserts)[2]	Safety glasses or safety goggles – select one	Safety glasses or safety goggles - select one
Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors as required[3]	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors as required[3]	Hearing protection (ear canal inserts)[2]	Hearing protection (ear canal inserts)[2]
Leather footwear[4]	Leather footwear[4]	Leather footwear[4]	Leather footwear[4]

1. Face shields must have wrap-around guarding not only to protect the face, but also the forehead, ears, and neck, or alternatively, an arc-rated arc flash suit hood is required to be worn.

2. Other types of hearing protection are permitted in lieu of or in addition to ear canal inserts provided they are worn under an arc-rated arc flash suit hood.

3. Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.

4. Footwear other than leather or dielectric is permitted to be used provided it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure.

5. The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, that are not used as part of a layered system, are not required to be equal to or greater than the estimated incident energy exposure.

Labeling Electrical Hazards

Article 130.5(H) states electrical equipment that is 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:
    1. Available incident energy and the corresponding working distance, or the arc flash PPE category in Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) for the equipment; but not both
    2. Minimum arc rating of clothing; or
    3. Site-specific level of PPE

*Exception 1: Unless changes in the electrical distribution system(s) render the label inaccurate, labels applied prior to the effective date of this edition of the standard are acceptable if they complied with the requirements for equipment labeling in that standard in effect at the time the labels were applied.

*Exception 2: In supervised industrial installations where conditions of maintenance and engineering supervisions ensure that only qualified persons monitor and service the system, the information required in 130.5(H)(1) – (3) is 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.

It is important to note the information displayed on the label should only be present based on the method used to determine the arc-flash risk assessment. If the arc-flash PPE category method is used, only the PPE category should appear (1–4). If an incident energy analysis method is used the incident energy (cal/cm^2) should appear. Must be one or the other displayed.

All calculations and data on the label must be documented to support the information on the label. The data shall be reviewed for accuracy at intervals not to exceed five years. The owner of the electrical equipment is responsible for the documentation, installation and maintenance of the labels.

Commonly Asked Questions

Q: What if my job task is not listed in Table 130.7(C)(15)(a) or 130.7(C)(15)(b) of NFPA 70E-2021?

A: If your job task is not listed in either Table 130.7(C)(15)(a) or 130.7(C)(15)(b) then the incident energy must be calculated for the job task. Annex D of the NFPA 70E-2021 standard can be referenced, or an approved online arc calculator like the Duke Flux calculator can be used.

Q: Is compliance with NFPA 70E electrical safety standard mandatory?

A: No. NFPA 70E is a national consensus safety standard published by NFPA primarily to assist OSHA in preparing electrical safety standards. Federal OSHA has not incorporated it into the CFRs.

Q: Can I be cited for not complying with NFPA 70E?

A: Yes. The employer must assess the workplace for electrical hazards and the need for PPE under 29 CFR 1910.335(a)(1)(i). Details on how to comply with this standard are left up to the employer. The employer is expected to use the best means available to comply with this requirement, and that is done through consensus standards like NFPA 70E. Compliance with 70E will help ensure compliance with this OSHA requirement. In the event of an injury or death due to an electrical accident, if OSHA determines that compliance with 70E electrical safety standard would have prevented or lessened

the injury, OSHA may cite the employer under the general duty clause. In a 2003 standards interpretation letter, OSHA stated 70E electrical safety standard can be used as evidence of whether the employer acted reasonably.

Sources

NFPA 70E-2021 Standard for Electrical Safety in the Workplace.

Occupational Safety and Health Administration (OSHA), – 29 CFR Part 1910 Subpart S and 29 CFR Part 1926 Subpart K)

Source: Grainger Know How – https://www.grainger.com/know-how