First Revision No. 137-NFPA 70E-2021 [Global Input]

Relocate all definitions into Article 100.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 15:06:14 EDT 2021

Committee Statement

Committee Statement: Existing definitions and those modified by other FR's are relocated into Article 100 to comply with Section 2.2.2 of the new 2020 NEC Style Manual. As specified in Section 2.2.2.3.2 parenthetical text is used to clarify specific application where a specific defined term is a duplicate of a general defined term.

Response Message: FR-137-NFPA 70E-2021

Public Input No. 121-NFPA 70E-2021 [Section No. 320.2]

Public Input No. 125-NFPA 70E-2021 [Section No. 360.2]

Public Input No. 108-NFPA 70E-2021 [Global Input]

Public Input No. 126-NFPA 70E-2021 [Global Input]

Public Input No. 124-NFPA 70E-2021 [Section No. 350.2]

Public Input No. 122-NFPA 70E-2021 [Section No. 330.2]

Public Input No. 290-NFPA 70E-2021 [Global Input]

Public Input No. 291-NFPA 70E-2021 [Global Input]

Public Input No. 293-NFPA 70E-2021 [Global Input]

Public Input No. 294-NFPA 70E-2021 [Global Input]

First Revision No. 147-NFPA 70E-2021 [Global Input]

see attached for new Annex S

Supplemental Information

File Name	Description	Approved
annex_s.docx	new annex S. for staff use.	
70E-2021_Annex_S-new_Global_FR-147.pdf	For ballot	

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 08:58:33 EDT 2021

Committee Statement

Committee Statement: This new informative annex provides non-mandatory guidance to assist qualified workers identify sources of information that are useful when assessing the condition of maintenance of electrical equipment.

Response Message: FR-147-NFPA 70E-2021

Public Input No. 246-NFPA 70E-2021 [Global Input]

Informative Annex S Assessing the Condition of Maintenance

This informative annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

S.1 Introduction.

Electrical safety programs contain requirements to consider the condition of maintenance of electrical equipment and systems. The objective of these requirements is to emphasize the inherent risk to workers associated with performing tasks on electrical equipment that is not properly rated, not properly installed, has not been properly maintained, or otherwise exhibits evidence of an increased risk level for electrical workers or operators. Sections S.2 through S.8 describe methods of obtaining information that are useful when assessing the condition of maintenance of electrical equipment and systems.

S.2 Assess the Risk.

Safe work practices should always be used when gathering information to be used to assess the condition of maintenance of electrical equipment. Tasks such as opening hinged doors or removal of bolted covers might expose workers to energized conductors or circuit parts inside the equipment. Works should always follow the requirements of their electrical safety program when assessing the condition of electrical equipment.

S.3 Visual Inspection.

Visual inspection of equipment might be used to verify that it is installed in a workmanlike manner in accordance with applicable industry codes and standards and the manufacturer's instructions. Visual inspections might also be used to identify evidence of issues or impending failure such as arcing, overheating, loose or bound mechanisms, missing hardware, visible damage, water or dust contamination, or corrosion damage.

S.4 Periodic Testing and Inspection.

Periodic testing and detailed inspection methods are used to help workers determine the condition of the equipment at the time of the test. Portable equipment is used to conduct manual tests and inspection such as infrared thermography, measure voltage and current, confirm overcurrent protective device operation, and conduct insulation resistance testing. Depending on the test or inspection, these tasks are performed with the equipment in an electrically safe work condition or with the equipment online.

S.5 Permanently Installed Monitoring.

Continuous monitoring of specific equipment conditions can be performed using an uninterrupted method of data collection. Examples include the use of permanently mounted counters, sensors, or controllers to measure a condition or state inside the equipment. Multiple types of data might be monitored, including voltage, current, temperature, humidity, cycle count, open/closed state, and others. The data could be used to actively alert personnel to the existence of a condition that is either above or below a predetermined control limit. Permanently installed monitoring systems often allow data collection without removing covers or opening doors and without exposing workers to electrical hazards. The use of real time data is useful when determining the condition of the equipment and is also used to modify

(shorten or lengthen) the predetermined maintenance intervals for other inspections and tests.

S.6 Predictive Techniques.

Predictive techniques monitor conditions in equipment using sensors and analyze and interpret the data using analytical methods and algorithms. These proactive techniques identify trends or issues and notify personnel of recommended actions before the condition reaches an alarm point or alert them to urgent issues that are at or over a predetermined level. These technologies and methods often detect minor items before they propagate into major issues or equipment failure, enabling workers to interact with or operate the equipment while it is still in a normal operating condition as opposed to an abnormal condition.

S.7 Maintenance History.

The maintenance history of electrical equipment is an important factor to consider when assessing if the equipment has been properly maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. Ready access to maintenance history gives workers important information that is useful in making their assessment. There are various methods used to communicate the maintenance history, but the two most common are labels and digital methods.

S.7.1 Labels.

Labels, decals, or other markings might be color coded and placed on the exterior enclosure or surface of the electrical equipment or device to communicate the condition of maintenance as of the last assessment. Generally, these markings provide a simple method to categorize the condition of the equipment at the time of the inspection. One example is a three-level system, such as serviceable, limited service, or nonserviceable.

S.7.2 Digital and other Electronic Methods.

Digital technology is used as a method of storing and sharing maintenance-related information. This method stores information locally within the equipment itself, on its associated network, or remotely in a digital asset management system. In addition to recording the last inspection date, these methods are real time and can contain additional details. For example, digital logs record the date and time of the trip events of a circuit breaker and the reason for the trip.

S.8 Standard for Electrical Equipment Maintenance.

NFPA 70B is an example of a document that contains further information on the practical safeguarding of persons, property, and processes from the risks associated with failure, breakdown, or malfunction. NFPA 70B provides a means to establish and maintain an acceptable condition of maintenance of electrical equipment and systems to address safety and reliability.

First Revision No. 63-NFPA 70E-2021 [Global Input]

In all locations in this Standard, change"leather protectors" to "protectors". This does not impact the titles of referenced standards

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 12:51:02 EDT 2021

Committee Statement

Committee Statement: This first revision modifies the terms to permit protectors other than leather. See a new definition in Article 100 for “Protector”.

Response Message: FR-63-NFPA 70E-2021

Public Input No. 383-NFPA 70E-2021 [Global Input]

First Revision No. 109-NFPA 70E-2021 [Detail]

Moving Informational Note No. 2 following 130.7(C)(15)(b) to follow Section 130.5(B).

Informational Note: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack-out).

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 07:07:27 EDT 2021

Committee Statement

Committee Statement: Informational Note No. 2 following 130.7(C)(15)(b) is relocated to follow Section 130.5(B). This relocation is accurate as this informational note (IN) applies to all arc flash risk assessments.

Response Message: FR-109-NFPA 70E-2021

Public Input No. 352-NFPA 70E-2021 [Section No. 130.5(A)]

First Revision No. 113-NFPA 70E-2021 [Detail]

Add new 215.1 Scope to Article 215. Renumber remaining sections.

215.1 Scope.

This article covers specific safety-related maintenance practices for premises wiring.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 08:37:07 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-113-NFPA 70E-2021

Public Input No. 232-NFPA 70E-2021 [Article 215]

Public Input No. 134-NFPA 70E-2021 [New Section after 215.1]

First Revision No. 114-NFPA 70E-2021 [Detail]

Add new 230.1 Scope to Article 230. Renumber remaining sections.

230.1 Scope.

This article covers specific safety-related maintenance practices for rotating equipment.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 08:47:26 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-114-NFPA 70E-2021

Public Input No. 233-NFPA 70E-2021 [Article 230]

Public Input No. 137-NFPA 70E-2021 [New Section after 230.1]

First Revision No. 116-NFPA 70E-2021 [Detail]

Add new 240.1 Scope to Article 240. Renumber remaining sections.

240.1 Scope.

This article covers specific safety-related maintenance practices for batteries and battery rooms.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 08:53:00 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-116-NFPA 70E-2021

Public Input No. 139-NFPA 70E-2021 [New Section after 240.1]

Public Input No. 234-NFPA 70E-2021 [Article 240]

First Revision No. 117-NFPA 70E-2021 [Detail]

Add new 245.1 Scope to Article 245. Renumber remaining sections.

245.1 Scope.

This article covers specific safety-related maintenance practices for portable electrical tools and equipment.

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Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 08:57:31 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-117-NFPA 70E-2021

Public Input No. 235-NFPA 70E-2021 [Article 245]

Public Input No. 140-NFPA 70E-2021 [New Section after 245.1]

First Revision No. 118-NFPA 70E-2021 [Detail]

Add new section 250.1 Scope. Renumber remaining sections.

250.1 Scope.

This article covers specific safety-related maintenance practices for personal safety and protective equipment.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 09:11:46 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-118-NFPA 70E-2021

Public Input No. 236-NFPA 70E-2021 [Article 250]

Public Input No. 141-NFPA 70E-2021 [New Section after 250.1]

First Revision No. 142-NFPA 70E-2021 [Detail]

See attached for changes to Table 130.7(C)(15)(b) and new Informational Note No. 3.

Supplemental Information

File Name	Description	Approved
Detail_FR-142_Table_130.7_C_15_b_for_FR-108.docx	For ballot	

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 09 15:47:49 EDT 2021

Committee Statement

Committee Statement: Recent test data indicates that the probability of sustaining an arc for 125-volt dc nominal systems is minimal for available fault currents less than 17,000 amps. Technical references support this change include, Kinectrics report referenced in Informative Annex D.5.2 and those listed in new informational Note No.3.

Response Message: FR-142-NFPA 70E-2021

Public Input No. 307-NFPA 70E-2021 [Section No. 130.7(C)(15)]

Table 130.7(C)(15)(b) Arc Flash PPE Categories for dc Systems

Equipment	Arc Flash PPE Category	Arc Flash Boundary
~~Storage batteries, dc switchboards, and other dc supply sources~~		
~~Parameters: Greater than or equal to 100 volts and less than or equal to 250 volts~~		
~~Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)~~		
~~Available fault current less than 4 kA~~	~~2~~	~~900 mm (3 ft)~~
~~Available fault current greater than or equal to 4 kA and less than 7 kA~~	~~2~~	~~1.2 m (4 ft)~~
~~Available fault current greater than or equal to 7 kA and less than 15 kA~~	~~3~~	~~1.8 m (6 ft)~~
Storage batteries, dc switchboards, and other dc supply sources		
Parameters: Greater than ~~250~~ 150 volts and less than or equal to 600 volts		
Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 1.5 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 1.5 kA and less than 3 kA	2	1.2 m (4 ft)
Available fault current greater than or equal to 3 kA and less than 7 kA	3	1.8 m (6 ft.)
Available fault current greater than or equal to 7 kA and less than 10 kA	4	2.5 m (8 ft)

Notes:

(1) Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:

(a) Be evaluated for electrolyte protection

Formatted Table

Informational Note: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

Informational Note: ASTM F1891, *Standard Specification for Arc and Flame Resistant Rainwear*, contains information on evaluating arc-rated apparel.

(2) A two-second arc duration is assumed if there is no overcurrent protective device (OCPD) or if the fault clearing time is not known. If the fault clearing time is known and is less than 2 seconds, an incident energy analysis could provide a more representative result.

Informational Note No. 1: When determining available fault current, the effects of cables and any other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. See D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment.

Informational Note No. 2: The methods for estimating the dc arc flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table.

Informational Note No. 3: See the following references for dc voltages below 150 volts nominal:

1) J. G Hildreth and K. Feeney, "*Arc Flash Hazards Station Battery Systems*," 2018 IEEE Power & Energy Society General Meeting (PESGM), 2018, pp. 1-5,
2) Doi 10.1109/PESGM.2018.8586181.', 'US Department of Energy - *Bonneville Power Administration Engineering and Technical Services Report* BPA F 5450.05 DC Arc Flash: 125V, 1300 amp-hour battery dated May 11, 2017'
3) K. Gray, S. Robert and T. L. Gauthier, "*Low Voltage 100–500 Vdc Arc Flash Testing*," 2020 IEEE IAS Electrical Safety Workshop (ESW), 2020, pp. 1-7, doi: 10.1109/ESW42757.2020.9188336.'

First Revision No. 182-NFPA 70E-2021 [Detail]

360 [moving to 100]

Research and Development (R&D).

An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment. (350)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 31 17:40:44 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-182-NFPA 70E-2021

First Revision No. 35-NFPA 70E-2021 [Detail]

Add scope section 90.1 and renumber remaining Article 90

90.1 Scope.

This article covers the use, application, and arrangement of this standard.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 09:44:05 EDT 2021

Committee Statement

Committee Statement: The article has been reorganized to comply with the 2020 NEC Style Manual, which requires the first section to provide the scope of the article. The technical committee understands that scope statements are the responsibility of the correlating committee.

Response Message: FR-35-NFPA 70E-2021 Dual units of measurement are provided throughout NFPA 70E in order to improve clarity and useability of the standard. In some cases metric units, known as International System of Units (SI), are the primary with inch-pound listed secondary. This occurs primarily in distance measurements. In other cases, dual SI units are utilized to reflect industry practices, such as for quantifying incident energy levels.

Public Input No. 106-NFPA 70E-2021 [Global Input]

First Revision No. 43-NFPA 70E-2021 [Detail]

Add new scope and renumber rest of article.

110.1 Scope

This article covers the general requirements for electrical safety-related work practices.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 12:38:14 EDT 2021

Committee Statement

Committee Statement: Scope added to comply with 2020 NEC Style Manual 2.2.1 which requires each article to have a scope, which shall be the first section of the article.

Response Message: FR-43-NFPA 70E-2021

Public Input No. 129-NFPA 70E-2021 [New Section after 110.1]

First Revision No. 44-NFPA 70E-2021 [Detail]

Added new 120.1 scope and renumber rest of article.

120.1 Scope
This article covers requirements for establishing an electrically safe work condition.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 13:03:40 EDT 2021

Committee Statement

Committee Statement: This revision satisfies the requirements of Section 2.2.1 of the new 2020 NEC Style Manual.

Response Message: FR-44-NFPA 70E-2021

Public Input No. 130-NFPA 70E-2021 [New Section after 120.1]

First Revision No. 92-NFPA 70E-2021 [Detail]

Add new 205.1 Scope to Article 205. Renumber remaining sections.

205.1 Scope.

This article covers general safety-related maintenance practices requirements for electrical equipment.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:35:48 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual

Response Message: FR-92-NFPA 70E-2021

Public Input No. 230-NFPA 70E-2021 [Article 205]

Public Input No. 132-NFPA 70E-2021 [New Section after 205.1]

First Revision No. 94-NFPA 70E-2021 [Detail]

add scope section to 210.1 renumber remaining sections

210.1 Scope.

This article covers specific safety-related maintenance practices for substations, switchgear assemblies, switchboards, panelboards, motor control centers and disconnect switches.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:44:58 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-94-NFPA 70E-2021

Public Input No. 231-NFPA 70E-2021 [Article 210]

Public Input No. 133-NFPA 70E-2021 [New Section after 210.1]

First Revision No. 96-NFPA 70E-2021 [Detail]

add new scope section 225.1 and renumber remainder of article.

225.1 Scope.

This article covers specific safety-related maintenance practices for fuses and circuit breakers.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:56:06 EDT 2021

Committee Statement

Committee Statement: A scope statement is required in accordance with 2.2.1 of the 2020 NEC Style Manual.

Response Message: FR-96-NFPA 70E-2021

Public Input No. 136-NFPA 70E-2021 [New Section after 225.1]

First Revision No. 36-NFPA 70E-2021 [Section No. 90.2]

90.3 ~~Scope~~ Use and Application .

(A) Workplaces Covered.

This standard addresses electrical safety-related work practices, safety-related maintenance requirements, and other administrative controls for employee workplaces that are necessary for the practical safeguarding of employees relative to the hazards associated with electrical energy during activities such as the installation, removal, inspection, operation, maintenance, and demolition of electric conductors, electric equipment, signaling and communications conductors and equipment, and raceways. This standard also includes safe work practices for employees performing other work activities that can expose them to electrical hazards as well as safe work practices for the following:

(1) Installation of conductors and equipment that connect to the supply of electricity

(2) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings that are not an integral part of a generating plant, substation, or control center

Informational Note: This standard addresses safety of workers whose job responsibilities involve interaction with energized electrical equipment and systems with potential exposure to electrical hazards. Concepts in this standard are often adapted to other workers whose exposure to electrical hazards is unintentional or not recognized as part of their job responsibilities. The highest risk for injury from electrical hazards for other workers involve unintentional contact with overhead power lines and electric shock from machines, tools, and appliances.

(B) Workplaces Not Covered.

This standard does not cover safety-related work practices for the following:

(1) Installations in ships, watercraft other than floating buildings, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles

(2) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes

(3) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations

(4) Installations under the exclusive control of an electric utility where such installations:

a. Consist of service drops or service laterals, and associated metering, or

b. Are located in legally established easements or rights-of-way designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations, or

c. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, or distribution of electric energy, or

d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to installations for the purpose of communications, metering, generation, control, transformation, transmission, or distribution of electric energy where legally established easements or rights-of-way cannot be obtained. These installations shall be limited to federal lands, Native American reservations through the U.S. Department of the Interior Bureau of Indian Affairs, military bases, lands controlled by port authorities and state agencies and departments, and lands owned by railroads.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 09:49:04 EDT 2021

Committee Statement

Committee Statement: Section 90.3 has been retitled to reflect that it provides information relative to the use and application of the Standard. Subdivisions 90.3(A) and 90.3(B) have been retitled to clarify which workplaces are covered and not covered.

Response Message: FR-36-NFPA 70E-2021 RESPONSE TO PI 106: Dual units of measurement are provided throughout NFPA 70E in order to improve clarity and useability of the standard. In some cases metric units, known as International System of Units (SI), are the primary with inch-pound listed secondary. This occurs primarily in distance measurements. In other cases, dual SI units are utilized to reflect industry practices, such as for quantifying incident energy levels.

Public Input No. 106-NFPA 70E-2021 [Global Input]

First Revision No. 37-NFPA 70E-2021 [Section No. 90.4(C)]

(C) Explanatory Material.

Explanatory material, such as references to other standards, references to related sections of this standard, or information related to a rule in this standard, is included in this standard in the form of informational notes or informative annexes . Such notes and annexes are informational only and are not enforceable as requirements of this standard.

Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.

Informational Note: The format and language used in this standard follow guidelines established by NFPA and published in the *National Electrical Code Style Manual*. Copies of this manual can be obtained from NFPA.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 09:54:54 EDT 2021

Committee Statement

Committee Statement: Section 90.4(C) is revised to include informative annexes for clarity.

Response Message: FR-37-NFPA 70E-2021 Informative Annex A includes the revision date associated with the standard that the committee wishes to be referenced. Automatically referencing the most recent edition of the standard could result in unintended consequences such as the inclusion of material that has not been reviewed by the NFPA 70E technical committee.

Public Input No. 260-NFPA 70E-2021 [Section No. 90.4(C)]

First Revision No. 4-NFPA 70E-2021 [Definition: Boundary, Arc Flash.]

Boundary, Arc Flash. **(Arc Flash Boundary)**

When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

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/cm^2 (5 J/cm^2) for one second.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:29:55 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-4-NFPA 70E-2021

Public Input No. 142-NFPA 70E-2021 [Definition: Boundary, Arc Flash.]

First Revision No. 7-NFPA 70E-2021 [Definition: Conductor, Bare.]

Conductor, Bare. (Bare Conductor)

A conductor having no covering or electrical insulation whatsoever. [**70:**100]

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:44:05 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-7-NFPA 70E-2021

Public Input No. 145-NFPA 70E-2021 [Definition: Conductor, Bare.]

First Revision No. 8-NFPA 70E-2021 [Definition: Conductor, Covered.]

Conductor, Covered. (Covered Conductor)

A conductor encased within material of composition or thickness that is not recognized by *NFPA 70*, *National Electrical Code*, as electrical insulation. [**70:**100]

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:46:53 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-8-NFPA 70E-2021

Public Input No. 146-NFPA 70E-2021 [Definition: Conductor, Covered.]

First Revision No. 9-NFPA 70E-2021 [Definition: Conductor, Insulated.]

Conductor, Insulated. (Insulated Conductor)

A conductor encased within material of composition and thickness that is recognized by *NFPA 70*, *National Electrical Code*, as electrical insulation. [**70:**100]

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:50:47 EDT 2021

Committee Statement

Committee Statement: The definition title structure to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the new 2020 NEC Style Manual.

Response Message: FR-9-NFPA 70E-2021

Public Input No. 147-NFPA 70E-2021 [Definition: Conductor, Insulated.]

First Revision No. 2-NFPA 70E-2021 [Definition: Arc Flash Hazard.]

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: See 110.4(D) for further information regarding normal operation. 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. ~~See 110.4(D) for further information.~~

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

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:05:47 EDT 2021

Committee Statement

Committee Statement: The informational note structure is modified to comply with 3.1.3.1 of the 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text. Information further explaining the definition has been moved to an informational note.

Response Message: FR-2-NFPA 70E-2021

Public Input No. 158-NFPA 70E-2021 [Definition: Arc Flash Hazard.]

First Revision No. 3-NFPA 70E-2021 [Definition: Arc Rating.]

Arc Rating.

The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm^2 and is derived from the determined value of the arc thermal performance value (ATPV) or energy of breakopen threshold (E_{BT}) (should a material system exhibit a breakopen response below the ATPV value). Arc rating is reported as either ATPV or E_{BT}, whichever is the lower value.

Informational Note No. 1: Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame-resistant clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame resistant.

Informational Note No. 2: ~~ATPV is defined in~~ See ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, which defines ATPV as the incident energy (cal/cm^2) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Informational Note No. 3: ~~E BT is defined in~~ See ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, which defines E BT as the incident energy (cal/cm^2) on a material or a material system that results in a 50 percent probability of breakopen. Breakopen is a material response evidenced by the formation of one or more holes of a defined size [an area of 1.6 cm^2 (0.5 in.^{2}) or an opening of 2.5 cm (1.0 in.) in any dimension] in the innermost layer of arc-rated material that would allow thermal energy to pass through the material.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:08:34 EDT 2021

Committee Statement

Committee Statement: The informational note structure is modified to comply with 3.1.3.1 of the 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text.

Response Message: FR-3-NFPA 70E-2021

Public Input No. 159-NFPA 70E-2021 [Definition: Arc Rating.]

First Revision No. 5-NFPA 70E-2021 [Definition: Boundary, Limited Approach.]

Boundary, Limited Approach. (Limited Approach Boundary)

An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:38:10 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-5-NFPA 70E-2021

Public Input No. 143-NFPA 70E-2021 [Definition: Boundary, Limited Approach.]

First Revision No. 6-NFPA 70E-2021 [Definition: Boundary, Restricted Approach.]

Boundary, Restricted Approach. (Restricted Approach Boundary)

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.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 13:40:31 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-6-NFPA 70E-2021

Public Input No. 144-NFPA 70E-2021 [Definition: Boundary, Restricted Approach.]

First Revision No. 10-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]

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.

Informational Note: An electrically safe work condition is not a procedure, it is a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are maintained in a de-energized state for the purpose of ~~temporarily~~ eliminating electrical hazards for the period of time for which the state is maintained.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:00:57 EDT 2021

Committee Statement

Committee Statement: The word “temporarily” is removed as it is redundant with existing language in the remainder of the informational note.

Response Message: FR-10-NFPA 70E-2021

Public Input No. 326-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]

First Revision No. 11-NFPA 70E-2021 [Definition: Equipment, Arc-Resistant.]

Equipment, Arc-Resistant. (Arc-Resistant Equipment)

Equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee.

Informational Note No. 1: ~~An example of a standard that provides information for arc-resistant equipment is~~ See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*, as an example of a standard that provides information for arc-resistant equipment .

Informational Note No. 2: See O.2.4(9) for information on arc-resistant equipment.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:20:54 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the new 2020 NEC Style Manual.

The informational note structure is modified to comply with 3.1.3.1 of the 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text.

Response Message: FR-11-NFPA 70E-2021

Public Input No. 148-NFPA 70E-2021 [Definition: Equipment, Arc-Resistant.]

Public Input No. 160-NFPA 70E-2021 [Definition: Equipment, Arc-Resistant.]

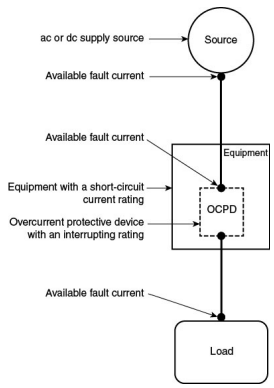
First Revision No. 13-NFPA 70E-2021 [Definition: Fault Current, Available.]

Fault Current, Available. (Available Fault Current)

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

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

Figure Informational Note Figure 100.0 Available Fault Current.



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

Informational Note No. 3: The available fault current varies at different locations within the system due to the location of sources and system impedances.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:26:07 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

The informational note structure is modified to comply with 3.1.3.1 of the 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text.

Response Message: FR-13-NFPA 70E-2021

Public Input No. 149-NFPA 70E-2021 [Definition: Fault Current, Available.]

Public Input No. 161-NFPA 70E-2021 [Definition: Fault Current, Available.]

First Revision No. 14-NFPA 70E-2021 [Definition: Ground-Fault Circuit Interrupter (GFCI).]

Ground-Fault Circuit Interrupter (GFCI).

A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. [**70:**100]

Informational Note: ~~Class A~~ See ANSI/UL 943, *Standard for Ground-Fault Circuit Interrupters* , for further information. A ground-fault circuit ~~interrupters trip~~ interrupter trips when the current to ground is 6 mA or higher and ~~do~~ does not trip when the current to ground is less than 4 mA. ~~For further information, see ANSI/UL 943, *Standard for Ground-Fault Circuit Interrupters* .~~

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:44:08 EDT 2021

Committee Statement

Committee Statement: The informational note structure is modified to comply with 3.1.3.1 of the new 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text.

The reference to UL 943 is updated for clarity.

Response Message: FR-14-NFPA 70E-2021

Public Input No. 262-NFPA 70E-2021 [Definition: Ground-Fault Circuit Interrupter (GFCI).]

Public Input No. 162-NFPA 70E-2021 [Definition: Ground-Fault Circuit Interrupter (GFCI).]

First Revision No. 12-NFPA 70E-2021 [Definition: Grounded, Solidly.]

Grounded, Solidly. (Solidly Grounded)

Connected to ground without inserting any resistor or impedance device. [**70:**100]

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:22:16 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-12-NFPA 70E-2021

Public Input No. 150-NFPA 70E-2021 [Definition: Grounded, Solidly.]

First Revision No. 15-NFPA 70E-2021 [Definition: Grounding Conductor, Equipment (EGC).]

Grounding Conductor, Equipment (EGC). (Equipment Grounding Conductor)

The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both. [**70:**100]

Informational Note No. 1: It is recognized that the equipment grounding conductor also performs bonding.

Informational Note No. 2: See 250.118 of *NFPA 70*, *National Electrical Code*, for a list of acceptable equipment grounding conductors.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:49:12 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-15-NFPA 70E-2021

Public Input No. 151-NFPA 70E-2021 [Definition: Grounding Conductor, Equipment (EGC).]

First Revision No. 16-NFPA 70E-2021 [Definition: Maintenance, Condition of.]

Maintenance, Condition of. (Condition of Maintenance)

The state of the electrical equipment considering the manufacturers' instructions, manufacturers' recommendations, and applicable industry codes, standards, and recommended practices.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 14:52:40 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-16-NFPA 70E-2021

Public Input No. 152-NFPA 70E-2021 [Definition: Maintenance, Condition of.]

First Revision No. 19-NFPA 70E-2021 [Definition: Switch, Isolating.]

Switch, Isolating. (Isolating Switch)

A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means. [**70:**100]

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 15:49:01 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-19-NFPA 70E-2021

Public Input No. 153-NFPA 70E-2021 [Definition: Switch, Isolating.]

First Revision No. 17-NFPA 70E-2021 [Definition: Switchgear, Metal-Clad.]

Switchgear, Metal-Clad. (Metal-Clad Switchgear)

A switchgear assembly completely enclosed on all sides and top with sheet metal, having drawout switching and interrupting devices, and all live parts enclosed within grounded metal compartments.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 15:46:53 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-17-NFPA 70E-2021

Public Input No. 154-NFPA 70E-2021 [Definition: Switchgear, Metal-Clad.]

First Revision No. 18-NFPA 70E-2021 [Definition: Switchgear, Metal-Enclosed.]

Switchgear, Metal-Enclosed. **(Metal-Enclosed Switchgear)**

A switchgear assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows), containing primary power circuit switching, interrupting devices, or both, with buses and connections. This assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors, removable covers, or both. Metal-enclosed switchgear is available in non-arc-resistant or arc-resistant constructions.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 15:47:46 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-18-NFPA 70E-2021

Public Input No. 155-NFPA 70E-2021 [Definition: Switchgear, Metal-Enclosed.]

First Revision No. 20-NFPA 70E-2021 [Definition: Voltage, Nominal.]

Voltage, Nominal. (Nominal Voltage)

A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 volts, 480Y/277 volts, 600 volts). [**70:**100]

Informational Note No. 1: The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

Informational Note No. 2: See ANSI C84.1, *Electric Power Systems and Equipment — Voltage Ratings (60 Hz)*.

Informational Note No. 3: Certain battery units are rated at nominal 48 volts dc but have a charging float voltage up to 58 volts. In dc applications, 60 volts is used to cover the entire range of float voltages.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 02 16:05:31 EDT 2021

Committee Statement

Committee Statement: The definition title structure is updated to assist with electronic searching and to comply with 2.2.2.3 and 2.2.2.3.1 of the 2020 NEC Style Manual.

Response Message: FR-20-NFPA 70E-2021

Public Input No. 156-NFPA 70E-2021 [Definition: Voltage, Nominal.]

First Revision No. 21-NFPA 70E-2021 [Definition: Working Distance.]

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 130.5(C)(1) for further information. Incident energy increases as the distance from the arc source decreases.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 10:17:39 EDT 2021

Committee Statement

Committee Statement: The informational note is modified to comply with 3.1.3.1 of the 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text.

Response Message: FR-21-NFPA 70E-2021

Public Input No. 163-NFPA 70E-2021 [Definition: Working Distance.]

First Revision No. 22-NFPA 70E-2021 [Definition: Working On (energized electrical conductors or ...]

Working On (energized electrical conductors or circuit parts).

Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing.

Informational Note: ~~There are two categories~~ Examples of "working on": ~~*Diagnostic (testing)* is~~ can include but are not limited to *diagnostic testing* (such as taking readings or measurements of electrical equipment, conductors, or circuit parts with approved test equipment that does not require making any physical change to the electrical equipment, conductors, or circuit parts~~.~~) and *repair* or ~~*Repair* is any~~ physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 10:22:41 EDT 2021

Committee Statement

Committee Statement: The informational note is modified to comply with 3.1.3.1 of the 2020 NEC Style Manual. The structure now references a requirement or other standard first, followed by further explanatory text.

Response Message: FR-22-NFPA 70E-2021

Public Input No. 47-NFPA 70E-2021 [Definition: Working On (energized electrical conductors or ...]

First Revision No. 62-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]

Protector.

Leather or non-leather glove or mitten designed to be worn over rubber insulating gloves.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 12:44:35 EDT 2021

Committee Statement

Committee Statement: Other standards recognize "protector" gloves that are not made of leather. This definition provides clarity by describing what is meant by a “protector” and allows for a global revision to simply reference “protectors” without qualifying the type of material.

Response Message: FR-62-NFPA 70E-2021

First Revision No. 130-NFPA 70E-2021 [New Definition after Definition: Qualified Person.]

Radiation, Ionizing. (Ionizing Radiation)

Radiation consisting of particles, X-rays, or gamma rays with sufficient energy to cause ionization of atoms or molecules through which it passes. (340)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 11:10:56 EDT 2021

Committee Statement

Committee Statement: Article 340 discusses both ionizing and nonionizing radiation. Defining each of the terms will improve understanding and use of the article.

Response Message: FR-130-NFPA 70E-2021

Public Input No. 297-NFPA 70E-2021 [New Definition after Definition: Radiation Worker.]

First Revision No. 148-NFPA 70E-2021 [New Definition after Definition: Qualified Person.]

Radiation, Nonionizing. (Nonionizing Radiation)

Static electric and magnetic (0 to 1 Hz), sub radiofrequency (1Hz to 3 kHz) and radiofrequency (3 kHz to 300 GHz) fields. This includes infrared, visible light, and near UV that cannot ionize an atom or molecule. (340)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 09:05:20 EDT 2021

Committee Statement

Committee Statement: Article 340 discusses both ionizing and nonionizing radiation. Defining each of the terms will improve understanding and use of the article.

Response Message: FR-148-NFPA 70E-2021

Public Input No. 299-NFPA 70E-2021 [New Definition after Definition: Radiation Worker.]

First Revision No. 106-NFPA 70E-2021 [New Definition after Definition: Switching Device.]

Thermal Contact Hazard.

A source of possible injury or damage to health associated with current through conductive tools or jewelry in contact with the body from heating of the metal resulting in burns to the skin.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 18:49:50 EDT 2021

Committee Statement

Committee Statement: A new definition is added to describe the thermal hazard identified in the definition of “electrical hazard” within the scope of NFPA 70E.

Response Message: FR-106-NFPA 70E-2021

Public Input No. 282-NFPA 70E-2021 [New Definition after Definition: Prospective Short-Circuit ...]

First Revision No. 23-NFPA 70E-2021 [Section No. 105.1]

105.1 Scope.

~~Chapter~~ 1 This article covers electrical safety-related work practices and procedures for employees who are exposed to an electrical hazard in workplaces covered in the scope of this standard.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 10:26:19 EDT 2021

Committee Statement

Committee Statement: Article scope is added to comply with 2020 NEC Style Manual 2.2.1 which requires each article to have a scope, which shall be the first section of the article.

Response Message: FR-23-NFPA 70E-2021

Public Input No. 128-NFPA 70E-2021 [Section No. 105.1]

First Revision No. 24-NFPA 70E-2021 [Section No. 105.2]

105.2 Purpose.

These practices and procedures are intended to provide for employee safety relative to electrical hazards in the workplace.

Informational Note: See Informative Annex K ~~For~~ for general categories of electrical hazards~~, see Informative Annex K~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 10:30:24 EDT 2021

Committee Statement

Committee Statement: The informational note is revised to place the reference to the annex first to comply with 2020 NEC Style Manual 3.1.3.1 which requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-24-NFPA 70E-2021

Public Input No. 164-NFPA 70E-2021 [Section No. 105.2]

First Revision No. 52-NFPA 70E-2021 [Sections 110.1, 110.2, 110.3, 110.4]

110.2 Electrically Safe Work Condition.

(A) ~~Priority~~ Policy .

~~Hazard elimination shall be the first priority in the implementation of safety-related work practices.~~ An employer shall establish, document, and implement an electrically safe work condition policy that does both of the following:

(1) Requires ~~Hazard~~ hazard elimination ~~shall~~ to be the first priority in the implementation of safety-related work practices~~.~~

(2) Complies with 110.2(C)

Informational Note No. 1: See Annex F for examples of hazard elimination. Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.3(H)(3). ~~See Annex F for examples of hazard elimination.~~

Informational Note No. 2: An electrically safe work condition is a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are placed and maintained in a de-energized state, for the purpose of temporarily eliminating electrical hazards. ~~See Article 120 for requirements to establish an electrically safe work condition for the period of time for which the state is maintained. See Informative Annex F for information regarding the hierarchy of risk control and hazard elimination.~~

Informational Note No. 3: See ~~Article 120~~ 120.6 for requirements to establish an electrically safe work condition for the period of time for which the state is maintained.

Informational Note No. 4: The electrically safe work condition policy could be documented in the employer's electrical safety program or in the employer's management system or similar documentation.

(B) ~~General~~ Requirements Until Established .

Electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the applicable requirements of ~~Article 120~~ 120.6 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used ~~in accordance with Article 110 and 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.~~

(C) When Required.

Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work if any of the following conditions exist:

(1) The employee is within the limited approach boundary.

(2) The employee interacts with equipment where conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

Exception No. 1: ~~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 rated for the available fault current.

(4) The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.

(5) The equipment doors are closed and secured.

(6) All equipment covers are in place and secured.

(7) There is no evidence of impending failure.

Informational Note No. 1: 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, or water damage .

Informational Note No. 2: See NEMA GD 1-2019, *Evaluating Water-Damaged Electrical Equipment* , as an example of a document that provides further information on evaluating electrical equipment that may have been exposed to water.

Exception No. 2: An energized disconnecting means or isolating element shall be permitted to be operated to achieve an electrically safe work condition or to return equipment to service that has been placed in an electrically safe work condition. The equipment supplying the disconnecting means or isolating element shall not be required to be placed in an electrically safe work condition provided a risk assessment is performed and there is no unacceptable risk identified.

Exception No. 3: ~~Infeasibility.~~ Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

Informational Note:: Examples of work that might be performed within the limited approach boundary of exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include performing diagnostics and testing (for example, start-up or troubleshooting) of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

Exception No. 4: ~~Additional Hazards or Increased Risk~~ Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

Informational Note: Examples of additional hazards or increased risk include, but are not limited to, interruption of life-support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment.

Exception No. 5: ~~Equipment Operating at Less Than 50 Volts.~~ Energized electrical

conductors and circuit parts that operate at less than 50 volts shall not be required to be de-energized where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electric arcs.

Supplemental Information

File Name	Description	Approved
FR-52_reorg_of_110.2_to_110.4.docx	reorg of start of Article 110. For staff use	
70E_FR-52_110.1_reorg_current.docx	FINAL FOR PRODUCTION	
70E_FR-52_110.1_reorg_map.docx	FINAL FOR PRODUCTION	

Submitter Information Verification

Committee: EEW-AAA
Submittal Date: Thu Aug 05 08:51:40 EDT 2021

Committee Statement

Committee Statement: New Section 110.2(A):

Existing 110.1 Priority and existing 110.5(K) are merged and relocated to new 110.2(A) under the title “Policy” to eliminate redundancy.

Existing 110.1 Informational Note No. 1 is revised to place the reference to the annex first to comply with 2020 NEC Style Manual which requires the reference to be located at the start of the note. The word “informational” is added to “Annex F” to correlate with similar uses throughout the document.

In existing 110.1 Informational Note No. 2, the second sentence is moved to new Informational Note No. 3. The reference to "Article 120" is revised to "120.5" to comply with the 2020 NEC Style Manual which prohibits normative references to entire articles and redundant reference to Annex F was deleted.

Informational Note No. 4 is added to new 110.2(A) to clarify that the electrically safe work condition policy can be documented in the employer’s electrical safety program or in other documents.

New Section 110.2(B):

Existing 110.2 is relocated to new 110.2(B) Requirement Until Established. The the word "applicable" is added to “requirements” to qualify that not all the steps of 120.5 may apply. The 110.2 informational note is deleted as the revision to the first sentence in 110.2 makes the note redundant.

New Section 110.2(C):

Existing 110.3 and 110.4 are merged into new 110.2(C) When Required. Existing 110.3 serves as the overarching requirement to reinforce that establishing an electrically safe work condition is the primary safety-related work practice, followed by the situations that were previously listed in 110.4. Existing 110.4 has been rephrased as exceptions to clarify the intent of the list items and the list of exceptions are reordered in a more logical order.

New 110.2(C) Exception No. 1 Item (3): It is essential for safety that equipment is rated for available fault current. This condition, even though included in manufacturer’s instructions is often overlooked as power distribution systems change and fault currents

increase, should be specifically stated as part of normal operating condition.

In existing 110.4(D) item (6) (new 110.2(C) Exception No. 1 Item (7)) “Water damage” is added to the list of indications of potential failure in the informational note to provide additional guidance, and a second informational note is added to a readily available, free NEMA “Evaluating Water-Damaged Electrical Equipment” publication that includes guidelines and safety related information for electrical equipment that has been exposed to water.

Exception No. 2 is added to new 110.2(C) to address operation of a disconnecting means to establish an electrically safe work condition in situations where not all of the "normal operating condition" requirements exist.

Response Message: FR-52-NFPA 70E-2021

Public Input No. 310-NFPA 70E-2021 [Section No. 110.5(K)]

Public Input No. 306-NFPA 70E-2021 [Section No. 110.1]

Public Input No. 357-NFPA 70E-2021 [Section No. 110.4(D)]

Public Input No. 275-NFPA 70E-2021 [Section No. 110.2]

Public Input No. 256-NFPA 70E-2021 [Section No. 110.3]

Public Input No. 248-NFPA 70E-2021 [Section No. 110.4(D)]

Public Input No. 165-NFPA 70E-2021 [Section No. 110.1]

Public Input No. 354-NFPA 70E-2021 [Section No. 110.3]

Public Input No. 255-NFPA 70E-2021 [Section No. 110.2]

Public Input No. 110-NFPA 70E-2021 [Section No. 110.4]

Public Input No. 111-NFPA 70E-2021 [Section No. 110.3]

Public Input No. 218-NFPA 70E-2021 [Section No. 110.2]

Public Input No. 48-NFPA 70E-2021 [Section No. 110.1]

First Revision No. 25-NFPA 70E-2021 [Section No. 110.5(A)]

(A) General.

The employer shall implement and document an overall electrical safety program that directs activity appropriate to the risk associated with electrical hazards.

Informational Note No. 1: Safety-related work practices such as verification of proper maintenance and installation, alerting techniques, auditing requirements, and training requirements provided in this standard are administrative controls and part of an overall electrical safety program.

Informational Note No. 2: See Informative Annex P for information on implementing an electrical safety program within an employer's occupational health and safety management system.

Informational Note No. 3: See IEEE 3007.1, *Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems*, which provides additional guidance for the implementation of the electrical safety program.

Informational Note No. 4: See IEEE 3007.3, *Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems*, which provides additional guidance for electrical safety in the workplace.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 15:24:51 EDT 2021

Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-25-NFPA 70E-2021

Public Input No. 166-NFPA 70E-2021 [Section No. 110.5(A)]

First Revision No. 26-NFPA 70E-2021 [Section No. 110.5(E)]

(E) Electrical Safety Program Principles.

The electrical safety program shall identify the principles upon which it is based.

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

Submitter Information Verification

Committee: EEW-AAA

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Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-26-NFPA 70E-2021

Public Input No. 167-NFPA 70E-2021 [Section No. 110.5(E)]

First Revision No. 34-NFPA 70E-2021 [Section No. 110.5(F)]

(F) Electrical Safety Program Controls.

An electrical safety program shall identify the controls by which it is measured and monitored.

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

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 09:04:32 EDT 2021

Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-34-NFPA 70E-2021

Public Input No. 168-NFPA 70E-2021 [Section No. 110.5(F)]

First Revision No. 27-NFPA 70E-2021 [Section No. 110.5(G)]

(G) 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: See Informative Annex E ~~For~~ for an example of a typical electrical safety program procedure~~, see Informative Annex E~~ .

Submitter Information Verification

Committee: EEW-AAA

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Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-27-NFPA 70E-2021

Public Input No. 169-NFPA 70E-2021 [Section No. 110.5(G)]

First Revision No. 28-NFPA 70E-2021 [Section No. 110.5(H)(1)]

(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 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

Informational Note No. 1: The risk assessment procedure could include identifying when a second person could be required and the training and equipment that person should have.

Informational Note No. 2: See Informative Annex F ~~For~~ for more information regarding risk assessment and the hierarchy of risk control~~, see Informative Annex F~~ .

Submitter Information Verification

Committee: EEW-AAA

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Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-28-NFPA 70E-2021

Public Input No. 170-NFPA 70E-2021 [Section No. 110.5(H)(1)]

First Revision No. 29-NFPA 70E-2021 [Section No. 110.5(H)(2)]

(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 relative to the electrical hazards in the workplace.

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

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 15:31:48 EDT 2021

Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-29-NFPA 70E-2021

Public Input No. 171-NFPA 70E-2021 [Section No. 110.5(H)(2)]

First Revision No. 30-NFPA 70E-2021 [Section No. 110.5(I)(1)]

(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. A description of the job and the individual tasks

b. Identification of the electrical hazards associated with each task

c. A shock risk assessment in accordance with 130.4 for tasks involving a shock hazard

d. An arc flash risk assessment in accordance with 130.5 for tasks involving an arc flash hazard

e. Work procedures involved, special precautions, and energy source controls

f. An emergency response plan

Informational Note: See Figure I.2 ~~For~~ for an example of a job safety planning checklist ~~see Figure I.2~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 15:32:51 EDT 2021

Committee Statement

Committee Statement: Section 3.1.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text. Identifying an emergency response plan as part of the job safety planning will facilitate a quick response to electrical incidents.

Response Message: FR-30-NFPA 70E-2021

Public Input No. 259-NFPA 70E-2021 [Section No. 110.5(I)(1)]

Public Input No. 172-NFPA 70E-2021 [Section No. 110.5(I)(1)]

First Revision No. 31-NFPA 70E-2021 [Section No. 110.5(I)(3)]

(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: See Figure I.1~~For~~ for an example of a job briefing checklist~~, see Figure I.1~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 16:00:00 EDT 2021

Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-31-NFPA 70E-2021

Public Input No. 173-NFPA 70E-2021 [Section No. 110.5(I)(3)]

First Revision No. 143-NFPA 70E-2021 [Section No. 110.5(K)]

~~**(K)** Electrically Safe Work Condition Policy.~~

~~An electrical safety program shall include an electrically safe work condition policy that complies with 110.2 .~~

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 10 11:09:15 EDT 2021

Committee Statement

Committee Statement: The requirement in 110.5(K) has been incorporated into the new 110.2(A) as part of the 110.2 revision.

Response Message: FR-143-NFPA 70E-2021

First Revision No. 32-NFPA 70E-2021 [Section No. 110.5(M)(3)]

(3) Lockout/Tagout Program and Procedure Audit.

The lockout/tagout program and procedures required by ~~Article 120~~ 120.2 through 120.5 shall be audited by a qualified person at intervals not to exceed 1 year. The audit shall cover at least one lockout/tagout in progress. The audit shall be designed to identify and correct deficiencies in the following:

(1) The lockout/tagout program and procedures

(2) The lockout/tagout training

(3) Worker execution of the lockout/tagout procedure

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 16:04:04 EDT 2021

Committee Statement

Committee Statement: General reference to Article 120 is changed to a specific reference to 120.1 through 120.4 because 4.1.4 of the 2020 NEC Style Manual prohibits references to entire articles.

Response Message: FR-32-NFPA 70E-2021

Public Input No. 219-NFPA 70E-2021 [Section No. 110.5(M)(3)]

First Revision No. 33-NFPA 70E-2021 [Section No. 110.6(A)(1)]

(1) Qualified Person.

A qualified person shall be trained and knowledgeable in the construction and operation of equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method.

(a) Such persons shall also be familiar with the proper use of ~~the special~~ applicable precautionary techniques, ~~applicable~~ electrical policies ~~and~~ , procedures, PPE, insulating ~~and~~ materials, shielding materials, and insulated tools and test equipment.

(b) A person ~~can~~ shall be ~~considered~~ qualified ~~with respect to~~ for certain equipment and tasks ~~but still be unqualified for others~~ to be performed .

(c) A person shall be permitted to be qualified for some equipment or tasks and not others.

(d) Such persons permitted to work within the limited approach boundary shall, at a minimum, be additionally trained in all of the following:

(1) Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment

(2) Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts

(3) Approach distances specified in Table 130.4(E)(a) and Table 130.4(E)(b) and the corresponding voltages to which the qualified person will be exposed

(4) Decision-making process necessary to be able to do the following:

a. Perform the job safety planning

b. Identify electrical hazards

c. Assess the associated risk

d. Select the appropriate risk control methods from the hierarchy of controls identified in 110.3(H)(3), including PPE

(e) An employee who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person, and who in the course of such training demonstrates an ability to perform specific duties safely at his or her level of training, and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those specific duties.

(f) Employees shall be trained to select an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the employee to understand all limitations of each test instrument that might be used.

(g) The employer shall determine through regular supervision or through inspections conducted on at least an annual basis that each employee is complying with the safety-related work practices required by this standard.

Supplemental Information

File Name	Description	Approved

70E_FR-33_110.6_A_1_.docx FINAL FOR PRODUCTION

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 03 16:09:29 EDT 2021

Committee Statement

Committee Statement: This revision in 110.6(A)(1)(b) changes “can” to “shall” to address use of mandatory language to conform to the 2020 NEC Style Manual Sections 3.1.1 and 3.1.2. additionally, 110.6(A)(1)(b) was separated into two statements ((b) and (c)) to clarify that qualified persons need not be qualified for all equipment and all tasks.

Relocating the word "applicable" improves the wording and makes it clear that qualified persons need only be familiar with techniques they need to use.

Response Message: FR-33-NFPA 70E-2021

Public Input No. 96-NFPA 70E-2021 [Section No. 110.6(A)(1)]

Public Input No. 349-NFPA 70E-2021 [Section No. 110.6(A)(1)]

First Revision No. 53-NFPA 70E-2021 [Section No. 110.6(A) [Excluding any Sub-Sections]]

The training requirements contained in 110.4(A) shall apply to employees exposed to an electrical hazard when the risk associated with that hazard is not reduced to a safe level by the applicable electrical installation requirements. Such employees shall be trained to understand the specific hazards associated with electrical energy. They shall be trained in safety-related work practices and procedural requirements, as necessary, to provide protection from the electrical hazards associated with their respective job or task assignments. Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.

Informational Note: See *NFPA 70* , *National Electrical Code* , ~~For~~ for further information concerning installation requirements~~, see *NFPA 70* , *National Electrical Code*~~ .

Submitter Information Verification

Committee: EEW-AAA

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Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-53-NFPA 70E-2021

Public Input No. 174-NFPA 70E-2021 [Section No. 110.6(A) [Excluding any Sub-Sections]]

First Revision No. 38-NFPA 70E-2021 [Section No. 110.8(B)]

(B) Rating.

Test instruments, equipment, and their accessories shall be as follows:

(1) Rated for circuits and equipment where they are utilized

(2) Approved for the purpose

(3) Used in accordance with any instructions provided by the manufacturer

Informational Note: See UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 1: General Requirements*, ~~for rating~~ and ~~design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below and~~ UL 61010-2-033, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 2-033: Particular Requirements for Hand-Held Multimeters and Other Meters, for Domestic and Professional use, Capable of Measuring Mains Voltage*, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 10:41:16 EDT 2021

Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-38-NFPA 70E-2021

Public Input No. 175-NFPA 70E-2021 [Section No. 110.8(B)]

First Revision No. 39-NFPA 70E-2021 [Section No. 110.10(A)]

(A) General.

Employees shall be provided with listed ground-fault circuit-interrupter (GFCI) ~~protection~~ protective devices where required by applicable state, federal, or local codes and standards. Listed cord sets or devices incorporating listed GFCI protection for personnel identified for portable use shall be permitted.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 11:00:18 EDT 2021

Committee Statement

Committee Statement: This revision clarifies that where GFCI protective devices are required, they must be listed.

Response Message: FR-39-NFPA 70E-2021

Public Input No. 266-NFPA 70E-2021 [Section No. 110.10(A)]

First Revision No. 40-NFPA 70E-2021 [Sections 110.10(B), 110.10(C)]

(B) Maintenance and Construction.

GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction activity supplied by ~~125~~ 120 -volt, 15-, 20-, or 30-ampere circuits. Where employees operate or use equipment supplied by greater than ~~125~~ 120 -volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

Informational Note No. 1: See Informative Annex O . Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. ~~See Informative Annex O .~~

Informational Note No. 2: See applicable state, federal, or local codes and standards such as *NFPA 70* , *National Electrical Code* , Section 590.6(B)(2) for more information regarding implementation of an assured equipment grounding conductor program.

(C) Outdoors.

GFCI protection shall be provided when an employee is outdoors and operating or using cord sets (extension cords) or cord- and plug-connected equipment supplied by ~~125~~ 120 -volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors operate or use equipment supplied by greater than ~~125~~ 120 -volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

Informational Note No. 1: See Informative Annex O Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. ~~See Informative Annex O .~~

Informational Note No. 2: See applicable state, federal, or local codes and standards such as *NFPA 70* , *National Electrical Code* , Section 590.6(B)(2) for more information regarding implementation of an assured equipment grounding conductor program.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 11:03:32 EDT 2021

Committee Statement

Committee Statement: 125-volt is changed to 120-volt to align with nominal circuit voltage.

Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Informational Note 2 is added to provide guidance on implementing an assured equipment grounding conductor program for maintenance and outdoors.

Response Message: FR-40-NFPA 70E-2021

Public Input No. 176-NFPA 70E-2021 [Section No. 110.10(B)]

Public Input No. 177-NFPA 70E-2021 [Section No. 110.10(C)]

Public Input No. 244-NFPA 70E-2021 [Section No. 110.10(C)]

Public Input No. 243-NFPA 70E-2021 [Section No. 110.10(B)]

Public Input No. 70-NFPA 70E-2021 [Sections 110.10(B), 110.10(C)]

First Revision No. 54-NFPA 70E-2021 [Section No. 110.11]

110.9 Overcurrent Protection Modification.

Overcurrent protection of circuits and conductors shall not be modified, even on a temporary basis, beyond what is permitted by applicable portions of electrical codes and standards dealing with overcurrent protection.

Informational Note: See Article 240 of *NFPA 70* , *National Electrical Code* , ~~For~~ for further information concerning electrical codes and standards dealing with overcurrent protection~~, refer to Article 240 of *NFPA 70* , *National Electrical Code*~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 09:48:19 EDT 2021

Committee Statement

Committee Statement: Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-54-NFPA 70E-2021

Public Input No. 178-NFPA 70E-2021 [Section No. 110.11]

First Revision No. 45-NFPA 70E-2021 [Section No. 120.1(A)]

(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~~ 120.2 through 120.6

(3) Apply to fixed, permanently installed equipment, temporarily installed equipment, and portable equipment

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 13:10:57 EDT 2021

Committee Statement

Committee Statement: General reference to Article 120 is changed to a specific references to 120.1 through 120.5. Section 4.1.4 of the 2020 NEC Style Manual prohibits references to entire articles.

Response Message: FR-45-NFPA 70E-2021

Public Input No. 220-NFPA 70E-2021 [Section No. 120.1(A)]

First Revision No. 46-NFPA 70E-2021 [Section No. 120.1(B)]

(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 110.4(B)

(3) Auditing the lockout/tagout program in accordance with 110.3(L)(3)

(4) Auditing execution of the lockout/tagout procedures in accordance with 110.3(L)(3)

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

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 13:25:58 EDT 2021

Committee Statement

Committee Statement: This change is required under the rules of the 2020 NEC Style Manual Section 3.1.3.1

Response Message: FR-46-NFPA 70E-2021

Public Input No. 179-NFPA 70E-2021 [Section No. 120.1(B)]

First Revision No. 47-NFPA 70E-2021 [Section No. 120.3(D)]

(D) Tagout Device.

The tagout device shall meet the following requirements:

(1) A tagout device shall include a tag together with an attachment means.

(2) The tagout device shall be readily identifiable as a tagout device and suitable for the environment and duration of the tagout.

(3) A tagout device attachment means shall be capable of withstanding at least ~~224~~ 222 .4 N (50 lb) of force exerted at a right angle to the disconnecting means surface. The tag attachment means shall be nonreusable, attachable by hand, self-locking, nonreleasable, and equal to an all-environmental tolerant nylon cable tie.

(4) Tags shall contain a statement prohibiting unauthorized operation of the disconnecting means or removal of the tag.

(5) A hold card tagging tool on an overhead conductor in conjunction with a hotline tool to install the tagout device safely on a disconnect that is isolated from the work(s) shall be permitted. Where a hold card is used, the tagout procedure shall include the method of accounting for personnel who are working under the protection of the hold card.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 13:40:13 EDT 2021

Committee Statement

Committee Statement: This corrected conversion improves the technical accuracy of this standard.

Response Message: FR-47-NFPA 70E-2021

Public Input No. 78-NFPA 70E-2021 [Section No. 120.3(D)]

First Revision No. 48-NFPA 70E-2021 [Section No. 120.4(A)(1)]

(1) Locating Sources.

Up-to-date single-line drawings shall be considered a primary reference source for such information. When up-to-date drawings are not available, the employer shall be responsible for ensuring that an equally effective means of locating all sources of energy is employed.

Informational Note: Locating sources of supply could include identifying situations where a neutral conductor continues to carry current after phase conductors have been de-energized.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 13:43:41 EDT 2021

Committee Statement

Committee Statement: This revision addresses a potentially hazardous condition that may be overlooked. This improves worker safety.

Response Message: FR-48-NFPA 70E-2021 The informational note was moved to 120.4(A)(1) where the intent of the informational note was more applicable.

Public Input No. 237-NFPA 70E-2021 [Section No. 120.5]

First Revision No. 49-NFPA 70E-2021 [Section No. 120.4(B)(2)]

(2) Stored Energy.

The procedure shall include requirements for releasing stored electric or mechanical energy that might endanger personnel. All capacitors shall be discharged, and high-capacitance elements shall also be short-circuited and grounded before the associated equipment is touched or worked on. Springs shall be released or physical restraint shall be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs. Other sources of stored energy shall be blocked or otherwise relieved to the extent that the circuit cannot be unintentionally energized .

Informational Note: ~~For more information on methods and procedures to place capacitors in an electrically safe work condition, see~~ See 360.3, 360.5, and Informative Annex R~~, Working with Capacitors~~ for more information on methods and procedures to place capacitors in an electrically safe work condition .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 14:09:36 EDT 2021

Committee Statement

Committee Statement: The revision to the requirements adds clarity to the standard. Mechanical energy involves more than springs.

The informational note is revised to comply with the NEC Style Manual Section 3.1.3.1

Response Message: FR-49-NFPA 70E-2021

Public Input No. 180-NFPA 70E-2021 [Section No. 120.4(B)(2)]

Public Input No. 358-NFPA 70E-2021 [Section No. 120.4(B)(2)]

First Revision No. 50-NFPA 70E-2021 [Section No. 120.5]

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

Establishing and verifying an electrically safe work condition shall include all of the following steps, which shall be performed in the order presented, if feasible:

(1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

(2) After properly interrupting the load current, open the disconnecting device(s) for each source.

(3) Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the test or fully disconnected position.

(4) Release stored electrical energy.

(5) Block or relieve stored nonelectrical energy in devices to the extent the circuit parts cannot be unintentionally energized by such devices.

(6) Apply lockout/tagout devices in accordance with a documented and established procedure.

(7) Use an adequately rated portable test instrument to test each phase conductor or circuit part at each point of work to test for the absence of voltage. 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.

Exception No. 1 to 7: An adequately rated permanently mounted absence of voltage tester shall be permitted to be used to test for the absence of voltage of the conductors or circuit parts at the work location, provided it meets all of the 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 testing for 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 testing for the absence of voltage.

Exception No. 2 to 7: On electrical systems over 1000 volts, noncontact capacitive test instruments shall be permitted to be used to test each phase conductor.

Informational Note No. 1: See UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements*, for rating, overvoltage category, and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below.

Informational No. 2: See UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices* , ~~For~~ for additional information on rating and design requirements for permanently mounted absence of voltage testers~~, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*~~ .

Informational Note No. 3: ~~For additional information on rating and design requirements for voltage detectors, refer to~~ See IEC 61243-1, *Live Working — Voltage Detectors — Part 1: Capacitive type to be used for voltages exceeding 1kV a.c.*, or IEC 61243-2, *Live Working — Voltage Detectors — Part 2: Resistive type to be used for voltages of 1kV to 36 kV a.c.*, or IEC 61243-3, *Live Working — Voltage Detectors — Part 3: Two-pole low voltage type*, for additional information on rating and design requirements for voltage detectors .

(8) Where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

a. *Placement.* Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being

exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.

b. *Capacity.* Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

Informational Note: See ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, which is an example of a standard that contains information on capacity of temporary protective grounding equipment.

c. *Impedance.* Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

Supplemental Information

File Name	Description	Approved
70E_FR-50_120.5.docx	FINAL FOR PRODUCTION	

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 16:11:59 EDT 2021

Committee Statement

Committee Statement: The revision in Item 7 clarifies that the point for testing for the absence of voltage is done at the actual work location.

Informational Notes No. 2 and No. 3 to 120.5(7) and Informational Note to 120.5(8) are revised to comply with the 2020 NEC Style Manual Section 3.1.3.1.

Response Message: FR-50-NFPA 70E-2021

Public Input No. 224-NFPA 70E-2021 [Section No. 120.5]

Public Input No. 181-NFPA 70E-2021 [Section No. 120.5]

First Revision No. 51-NFPA 70E-2021 [Section No. 130.1]

130.1 ~~General~~ Scope .

~~Article~~ ~~130~~ This article covers requirements for work involving electrical hazards such as the electrical safety-related work practices, assessments, precautions, and procedures when an electrically safe work condition cannot be established.

Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from electrical conductors or circuit parts that are or can become energized.

When energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts are not put into an electrically safe work condition, and work is performed as permitted in accordance with 110.4, all of the following requirements shall apply:

(1) Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.

(2) An energized electrical work permit shall be completed as required by 130.2.

(3) A shock risk assessment shall be performed as required by 130.4.

(4) An arc flash risk assessment shall be performed as required by 130.5.

All requirements of Article 130 shall apply whether an incident energy analysis is completed or if Table 130.7(C)(15)(a), Table 130.7(C)(15)(b), and Table 130.7(C)(15)(c) are used in lieu of an incident energy analysis.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 04 17:44:25 EDT 2021

Committee Statement

Committee Statement: The section was revised in accordance with 2.2.1 of the 2020 NEC Style Manual by including numbered and titled sections for the scope and general requirements.

Response Message: FR-51-NFPA 70E-2021

Public Input No. 131-NFPA 70E-2021 [Section No. 130.1]

First Revision No. 55-NFPA 70E-2021 [Section No. 130.2(B)]

(B) Elements of Work Permit.

The work permit shall include, but not be limited to, the following items:

(1) Description of the circuit and equipment to be worked on and their location

(2) Description of the work to be performed

(3) Justification for why the work must be performed in an energized condition *[see 110.2(C)]*

(4) Description of the safe work practices to be employed *(see 130.1)*

(5) Results of the shock risk assessment *[see 130.4(A)]*

a. Voltage to which personnel will be exposed

b. Limited approach boundary *[see 130.4(F), Table 130.4(E)(a), and Table 130.4(E)(b)]*

c. Restricted approach boundary *[see 130.4(G), Table 130.4(E)(a), and Table 130.4(E)(b)]*

d. Personal and other protective equipment required by this standard to safely perform the assigned task and to protect against the shock hazard *[see 130.4(F), 130.5(G) , 130.7(C)(1) through (C)(~~16~~ 15), and 130.7(D)]*

(6) Results of the arc flash risk assessment *[see 130.5(A)]*

a. Available incident energy at the working distance or arc flash PPE category *~~(~~ [see 130.5(F)~~)~~]*

b. Personal and other protective equipment required by this standard to protect against the arc flash hazard *[see 130.5(F), 130.7(C)(1) through (C)(~~16~~ 15), Table 130.7(C)(15)(c), and 130.7(D)]*

c. Arc flash boundary *[see 130.5(E)]*

(7) Means employed to restrict the access of unqualified persons from the work area *[see 130.8(O)]*

(8) Evidence of completion of a job briefing, including a discussion of any job-specific hazards *[see 110.3(I)]*

(9) Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s)

Informational Note: See Figure J.1 ~~For~~ for an example of an acceptable energized work permit~~, see Figure J.1~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 10:10:15 EDT 2021

Committee Statement

Committee Statement: The informational note was revised to comply with 3.1.3.1 of the 2020 NEC Style Manual.

Response Message: FR-55-NFPA 70E-2021

Public Input No. 182-NFPA 70E-2021 [Section No. 130.2(B)]

First Revision No. 56-NFPA 70E-2021 [Section No. 130.4(A)]

(A) General.

A shock risk assessment shall be performed:

(1) To identify shock 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~~

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 10:39:28 EDT 2021

Committee Statement

Committee Statement: The use of PPE as an additional protective measure is covered in 130.4(C).

Response Message: FR-56-NFPA 70E-2021

Public Input No. 378-NFPA 70E-2021 [Section No. 130.4(A)]

First Revision No. 183-NFPA 70E-2021 [Section No. 130.4(E)]

(E) Shock Protection Boundaries.

The shock protection boundaries identified as limited approach boundary and restricted approach boundary shall be applicable where personnel are approaching exposed energized electrical conductors or circuit parts. Table 130.4(E)(a) shall be used for the distances associated with various ac system voltages. Table 130.4(E)(b) shall be used for the distances associated with various dc system voltages.

Informational Note: In certain instances, the arc flash boundary might be a greater distance from the energized electrical conductors or circuit parts than the limited approach boundary. The shock protection boundaries and the arc flash boundary are independent of each other.

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

(1)	(2)	(3)	(4)
	Limited Approach Boundary[b]		
Nominal System Voltage Range, Phase to Phase[a]	Exposed Movable Conductor[c]	Exposed Fixed Circuit Part	Restricted Approach Boundary[b]; Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified
50 V–150 V[d]	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V–750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
751 V–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.8 m (2 ft 9 in.)
36.1 kV–46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
46.1 kV–72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
138 kV–145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
161 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.3 m (4 ft 3 in.)
230 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 8 in.)
345 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	2.8 m (9 ft 2 in.)
500 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	3.6 m (11 ft 8 in.)
765 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.)

Notes:

(1) For arc flash boundary, see 130.5(E).

(2) All dimensions are distance from exposed energized electrical conductors or circuit part to employee.

[a]For single-phase systems above 250 volts, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.

[b]See definition in Article 100 and text in ~~130.4(D)(2)~~ 130.4(F)(3) and Informative Annex C for

elaboration.

[c]*Exposed movable conductors* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

[d]This includes circuits where the exposure does not exceed 120 volts nominal.

Table 130.4(E)(b) Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct-Current Voltage Systems

(1)	(2)	(3)	(4)
Nominal Potential Difference	Limited Approach Boundary		Restricted Approach Boundary; Includes Inadvertent Movement Adder
	Exposed Movable Conductor*	Exposed Fixed Circuit Part	
Less than 50 V	Not specified	Not specified	Not specified
50 V–300 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
301 V–1 kV	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)
1.1 kV–5 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.5 m (1 ft 5 in.)
5.1 kV–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 2 in.)
15.1 kV–45 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.8 m (2 ft 9 in.)
45.1 kV– 75 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)
75.1 kV–150 kV	3.3 m (10 ft 8 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)
150.1 kV–250 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.6 m (5 ft 3 in.)
250.1 kV–500 kV	6.0 m (20 ft 0 in.)	6.0 m (20 ft 0 in.)	3.5 m (11 ft 6 in.)
500.1 kV–800 kV	8.0 m (26 ft 0 in.)	8.0 m (26 ft 0 in.)	5.0 m (16 ft 5 in.)

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

**Exposed movable conductor* describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Sep 21 14:15:10 EDT 2021

Committee Statement

Committee Statement: The revision corrects conflict in table.

Response Message: FR-183-NFPA 70E-2021

First Revision No. 57-NFPA 70E-2021 [Section No. 130.4(F)(2)]

(2) Working at or Close to the Limited Approach Boundary.

Where one or more unqualified persons are working at or close to the limited approach boundary, the alerting methods in 130.8(O) shall be applied to ~~advise~~ warn the unqualified person(s) of the electrical hazard and ~~warn him or her~~ to stay outside of the limited approach boundary.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 11:12:50 EDT 2021

Committee Statement

Committee Statement: The text was editorially revised for clarity and consistency.

Response Message: FR-57-NFPA 70E-2021

Public Input No. 117-NFPA 70E-2021 [Section No. 130.4(F)(2)]

First Revision No. 110-NFPA 70E-2021 [Section No. 130.5(C)]

(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 110.3(H)(3). 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.

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

Task	~~Equipment~~ Operating Condition[a]	Likelihood of Occurrence[b]
Reading a panel meter while operating a meter switch.	Any	No
Performing infrared thermography and other noncontact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.		
Working on control circuits with exposed energized electrical conductors and circuit parts, nominal 125 volts ac or dc, or below without any other exposed energized equipment over nominal 125 volts ac or dc, including opening of hinged covers to gain access.		
Examination of insulated cable with no manipulation of cable.		
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack.		
For ac systems, work on energized electrical conductors and circuit parts, including electrical testing.	Any	Yes
Operation of a CB or switch the first time after installation or completion of maintenance in the equipment.		
For dc systems, working on energized electrical conductors and circuit parts of series-connected battery cells, including electrical testing.		
Removal or installation of CBs or switches.		
Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers.		
Application of temporary protective grounding equipment, after voltage test.		
Working on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 volts.		
Insertion or removal of individual starter buckets from motor control center (MCC).		

Task	~~Equipment~~ Operating Condition[a]	Likelihood of Occurrence[b]
Insertion or removal (racking) of circuit breakers (CBs) or starters from cubicles, doors open or closed.		
Insertion or removal of plug-in devices into or from busways.		
Examination of insulated cable with manipulation of cable.		
Working on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center.		
Insertion or removal of revenue meters (kW-hour, at primary voltage and current).		
Insertion or removal of covers for battery intercell connector(s).		
For dc systems, working on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source.		
Opening voltage transformer or control power transformer compartments.		
Operation of outdoor disconnect switch (hookstick operated) at 1 kV through 15 kV.		
Operation of outdoor disconnect switch (gang-operated, from grade) at 1 kV through 15 kV.		
Operation of a CB, switch, contactor, or starter.	Normal	No
	Abnormal	Yes
Voltage testing on individual battery cells or individual multi-cell units.		
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts.		
Opening a panelboard hinged door or cover to access dead front overcurrent devices.		
Removal of battery nonconductive intercell connector covers.		
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	~~Abnormal~~	~~Yes~~
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.		
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:		
(1) Insertion or removal of individual starter buckets		
(2) Insertion or removal (racking) of CBs from cubicles		
(3) Insertion or removal (racking) of ground and test device		

Task	~~Equipment~~ Operating Condition[a]	Likelihood of Occurrence[b]
(4) Insertion or removal (racking) of voltage transformers on or off the bus		

[a]Equipment is considered to be in a “normal operating condition” if all of the conditions in ~~110.4(D)~~ 110.2(C), Exception No. 1 are satisfied.

[b]As defined in this standard, the two components of risk are 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 is an overall process that involves estimating both the likelihood of occurrence and severity to determine if additional protective measures are required. The estimate of the likelihood of occurrence contained in this table does not cover every possible condition or situation, nor does it address severity of injury or damage to health. 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 an arc flash incident should be considered likely to occur. The likelihood of occurrence must be combined with the potential severity of the arcing incident to determine if additional protective measures are required to be selected and implemented according to the hierarchy of risk control identified in 110.5(H)(3).

Informational Note No. 1: See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults* , ~~An~~ as an example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C) ~~is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*~~ .

Informational Note No. 2: Improper or inadequate maintenance can result in increased fault clearing time of the overcurrent protective device, thus increasing the incident energy. Where equipment is not properly installed or maintained, PPE selection based on incident energy analysis or the PPE category method might not provide adequate protection from arc flash hazards.

Informational Note No. 3: Both larger and smaller available fault currents could result in higher incident energy. If the available fault current increases without a decrease in the fault clearing time of the overcurrent protective device, the incident energy will increase. If the available fault current decreases, resulting in a longer fault clearing time for the overcurrent protective device, incident energy could also increase.

Informational Note No. 4: See Informative Annex O for safety-related design requirements. The occurrence of an arcing fault inside an enclosure produces a variety of physical phenomena very different from a bolted fault. For example, the arc energy resulting from an arc developed in the air will cause a sudden pressure increase and localized overheating. Equipment and design practices are available to minimize the energy levels and the number of procedures that could expose an employee to high levels of incident energy. Proven designs such as arc-resistant switchgear, remote racking (insertion or removal), remote opening and closing of switching devices, high-resistance grounding of low-voltage and 5000-volt (nominal) systems, current limitation, and specification of covered bus or covered conductors within equipment are available to reduce the risk associated with an arc flash incident. ~~See Informative Annex O for safety-related design requirements.~~

Informational Note No. 5: See Chapter 2 ~~For~~ for additional direction for performing maintenance on overcurrent protective devices~~, see Chapter 2 , Safety-Related Maintenance Requirements~~ .

Informational Note No. 6: See IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for more information regarding incident energy and the arc flash boundary for three-phase systems.

Supplemental Information

File Name	Description	Approved
FR_110_attachment_Table_130.5_C.docx	table 130.5(C) revised for FR-110. FINAL FOR PRODUCTION	

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 07:22:47 EDT 2021

Committee Statement

Committee Statement: The table header is modified for clarity. The header “Equipment Condition” is replaced with “Operating Condition” to correlate with requirements for normal operating conditions referenced in 110.4(D).

Editorial revisions are made in Informational Notes No. 1, 4 and 5 for compliance with NEC Style Manual.

The horizontal line separating normal and abnormal is editorially deleted. This line was inadvertently added in the 2021 edition..This action also deletes the misplaced horizontal line in Table 130.5(C).

Response Message: FR-110-NFPA 70E-2021

Public Input No. 14-NFPA 70E-2020 [Section No. 130.5(C)]

Public Input No. 250-NFPA 70E-2021 [Section No. 130.5(C)]

Public Input No. 184-NFPA 70E-2021 [Section No. 130.5(C)]

First Revision No. 58-NFPA 70E-2021 [Section No. 130.5(E)(1)]

(1)

The arc flash boundary shall be the distance at which the incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

Informational Note: See Informative Annex D ~~For~~ for information on estimating the arc flash boundary~~, see Informative Annex D~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 11:46:42 EDT 2021

Committee Statement

Committee Statement: The existing informational note is modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, Annex or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-58-NFPA 70E-2021

Public Input No. 183-NFPA 70E-2021 [Section No. 130.5(E)(1)]

First Revision No. 59-NFPA 70E-2021 [Section No. 130.5(G)]

Global FR-63

(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.

Informational Note: Changes that could affect the results of the incident energy analysis include changes made by utilities or other entities, such as transformer sizing, as well as modifications to protective devices or changes to protective settings.

Table 130.5(G) identifies the arc-rated clothing and other PPE requirements ~~of Article 130~~ and shall be permitted to be used with the incident energy analysis method of selecting arc flash PPE.

Informational Note No. 1: See Informative Annex D ~~For~~ for information on estimating the incident energy~~, see Informative Annex D~~ .

Informational Note No. 2: See Informative Annex H ~~For~~ for information on selection of arc-rated clothing and other PPE~~, see Informative Annex H~~ .

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/cm^2 up to and including 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
Arc-rated long-sleeve shirt and pants or arc-rated 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, high-visibility apparel) (AN)[e]
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[d]
Incident energy exposures greater than 12 cal/cm^2
Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
Arc-rated long-sleeve shirt and pants or arc-rated coverall or arc flash suit (SR)
Arc-rated arc flash suit hood
Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner, high-visibility apparel) (AN)[e]
Arc-rated gloves or rubber insulating gloves with ~~leather~~ protectors (SR)[c]
Hard hat
Safety glasses or safety goggles (SR)
Hearing protection
Leather footwear[d]

SR: Selection of one in group is required.

AN: As needed.

[a]Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc 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.

[b]Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). 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.

[c]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.

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

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

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 11:50:18 EDT 2021

Committee Statement

Committee Statement: The general reference to “Article 130” is deleted for compliance with 4.1.4 of the 2020 NEC Style Manual. The section prohibits references to entire articles. The reference to Article 130 is not required for complete understanding of the requirement.

A new IN is added to supplement the existing text that requires the incident energy analysis to be updated when changes occur in the electrical distribution system that could affect the results of the analysis. While some changes are obvious, such as reconfiguration of the system or replacement of equipment, this new IN addresses a few other changes that may not be as easy to identify.

The existing informational note (IN) is modified to comply with the NEC Style Manual. This IN is split into two in order to separately refer to each annex. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-59-NFPA 70E-2021

Public Input No. 185-NFPA 70E-2021 [Section No. 130.5(G)]

Public Input No. 222-NFPA 70E-2021 [Section No. 130.5(G)]

Public Input No. 247-NFPA 70E-2021 [Section No. 130.5(G)]

First Revision No. 60-NFPA 70E-2021 [Section No. 130.5(H)]

(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 130.7(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

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.

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 label shall be of sufficient durability to withstand the environment involved.

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

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 12:08:11 EDT 2021

Committee Statement

Committee Statement: The new sentence requires that where a label is installed, it must be of sufficient durability to withstand the environment involved.

Response Message: FR-60-NFPA 70E-2021

Public Input No. 118-NFPA 70E-2021 [Section No. 130.5(H)]

First Revision No. 111-NFPA 70E-2021 [Section No. 130.7(B)]

(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.

Informational Note: ~~Specific requirements for periodic testing of electrical protective equipment are given in~~ See 130.7(C)(14) and 130.7(E) for specific requirements for periodic testing of electrical protective equipment .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 07:41:12 EDT 2021

Committee Statement

Committee Statement: The existing informational note is modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-111-NFPA 70E-2021

Public Input No. 186-NFPA 70E-2021 [Section No. 130.7(B)]

First Revision No. 61-NFPA 70E-2021 [Section No. 130.7(C)(1)]

(1) General.

When an employee is working within the restricted approach boundary, the worker shall wear PPE in accordance with 130.4. When an employee is working within the arc flash boundary, he or she shall wear protective clothing and other PPE in accordance with 130.5. All parts of the body inside the arc flash boundary shall be protected.

Informational Note: Where the estimated incident energy exposure is greater than the arc rating of commercially available arc-rated PPE, then for the purpose of testing for the absence of voltage, the following examples of risk reduction methods could be used to reduce the likelihood of occurrence of an arcing event or the severity of exposure:

(1) Use of noncontact ~~proximity~~ capacitive test instrument(s) ~~or measurement of voltage on the secondary side of a low-voltage transformer (VT) mounted~~ or a permanently installed metering device(s) in the equipment for indication, before using a contact-type test instrument to test for the absence of voltage ~~below 1000 volts~~ .

(2) If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.

(3) Increase the working distance.

(4) Consider system design options to reduce the incident energy level.

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Committee: EEW-AAA

Submittal Date: Thu Aug 05 12:13:57 EDT 2021

Committee Statement

Committee Statement: The previous example of a risk reduction method in list item (1) of this informational note (IN) lacked clarity and may have created confusion. This first revision deletes the reference to “the secondary side of a low-voltage transformer (VT) mounted in the equipment” because this text was confusing. The intent of this risk reduction example is for the employee to get an indication of the absence of voltage before coming in contact with a contact type test instrument. The term “proximity” is deleted and the reference to a noncontact test instrument is correctly stated as a “noncontact capacitive test instrument” as seen in 120.5(7). The limitation “below 1000 volts” is deleted as this risk reduction method is not voltage specific.

Response Message: FR-61-NFPA 70E-2021

Public Input No. 257-NFPA 70E-2021 [Section No. 130.7(C)(1)]

First Revision No. 64-NFPA 70E-2021 [Section No. 130.7(C)(5)]

(5) Hearing Protection.

Employees inside the arc flash boundary shall wear hearing protection ~~whenever working within the arc flash boundary~~ .

Submitter Information Verification

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Committee Statement

Committee Statement: This requirement is modified to clarify that hearing protection is required when an employee is inside of the arc flash boundary. The qualifying term “working” is deleted for clarity.

Response Message: FR-64-NFPA 70E-2021

Public Input No. 75-NFPA 70E-2021 [Section No. 130.7(C)(5)]

Public Input No. 381-NFPA 70E-2021 [Section No. 130.7(C)(5)]

First Revision No. 65-NFPA 70E-2021 [Section No. 130.7(C)(7)]

Global FR-63

(7) Hand and Arm Protection.

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

(a) *Shock Protection.* Employees shall wear rubber insulating gloves with ~~leather~~ protectors where there is a danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with ~~leather~~ protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed. 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.

(b) *Arc Flash Protection.* Hand and arm protection shall be worn where there is possible exposure to arc flash burn. The apparel described in 130.7(C)(10)(d) shall be required for protection of hands from burns. Arm protection shall be accomplished by the apparel described in 130.7(C)(6).

(c) *Maintenance and Use.* Electrical protective equipment shall be maintained in a safe, reliable condition. Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Insulating gloves shall be given an air test, along with the inspection. Maximum use voltages for rubber insulating gloves shall not exceed that specified in Table 130.7(C)(7)(a). The top of the cuff of the protector glove shall be shorter than the rolled top of the cuff of the insulating glove by at least the distance specified in Table 130.7(C)(7)(a).

(d) *Periodic Electrical Tests*. Rubber insulating equipment shall be subjected to periodic electrical tests. Test voltages shall be in accordance with applicable state, federal, or local codes and standards. The maximum intervals between tests shall not exceed that specified in Table 130.7(C)(7)(b).

Informational Note: See OSHA 29 CFR 1910.137; ASTM F478, *Standard Specification for In-Service Care of Insulating Line Hose and Covers*; ASTM F479, *Standard Specification for In-Service Care of Insulating Blankets*; and ASTM F496, *Standard Specification for In-Service Care of Insulating Gloves and Sleeves*, which contain information related to in-service and testing requirements for rubber insulating equipment.

Table 130.7(C)(7)(a) Maximum Use Voltage for Rubber Insulating Gloves

Class Designation of Glove or Sleeve	Maximum ac Use Voltage rms, volts	Maximum dc Use Voltage avg, volts	~~Distances Between Gauntlet and Cuff, minimum~~ Distances Between Protector Cuff and Rubber Insulating Glove Cuff, minimum
00	500	750	13 mm (0.5 in.)
0	1,000	1,500	13 mm (0.5 in.)
1	7,500	11,250	25 mm (1 in.)
2	17,000	25,500	51 mm (2 in.)
3	26,500	39,750	76 mm (3 in.)
4	36,000	54,000	102 mm (4 in.)

Table 130.7(C)(7)(b) Rubber Insulating Equipment, Maximum Test Intervals

Rubber Insulating Equipment	When to Test
Blankets	Before first issue; every 12 months thereafter*
Covers	If insulating value is suspect
Gloves	Before first issue; every 6 months thereafter*
Line hose	If insulating value is suspect
Sleeves	Before first issue; every 12 months thereafter*

*New insulating equipment is not permitted to be placed into service unless it has been electrically tested within the previous 12 months. Insulating equipment that has been issued for service is not new and is required to be retested in accordance with the intervals in this table.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 13:16:50 EDT 2021

Committee Statement

Committee Statement: Table 130.7(C)(7)(a) is modified for clarity by removing “gauntlet”. Both the protectors and the rubber insulating gloves have cuffs.

Response Message: FR-65-NFPA 70E-2021

Public Input No. 53-NFPA 70E-2021 [Section No. 130.7(C)(7)]

First Revision No. 66-NFPA 70E-2021 [Section No. 130.7(C)(8)]

(8) Foot Protection.

Where insulated footwear is used as protection against step and touch potential, dielectric footwear shall be required. Insulated soles shall not be used as primary electrical protection.

Informational Note: Electrical ~~Hazard~~ hazard ~~footwear meeting ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear*~~ , (EH) footwear can provide a secondary source of electric shock protection under dry conditions.

Submitter Information Verification

Committee: EEW-AAA

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Committee Statement

Committee Statement: The standard reference was deleted because attempting to correlate the information in this note with the revised 2020 NEC Style Manual requirements was confusing.

Response Message: FR-66-NFPA 70E-2021

Public Input No. 187-NFPA 70E-2021 [Section No. 130.7(C)(8)]

First Revision No. 112-NFPA 70E-2021 [Section No. 130.7(C)(11)]

(11) Clothing Material Characteristics.

Arc-rated clothing shall meet the requirements described in 130.7(C)(12) and 130.7(C)(14).

Informational Note No. 1: Arc-rated materials, such as flame-retardant-treated cotton, meta-aramid, para-aramid, and poly-benzimidazole (PBI) fibers, provide thermal protection. These materials can ignite but will not continue to burn after the ignition source is removed. Arc-rated fabrics can reduce burn injuries during an arc flash exposure by providing a thermal barrier between the arc flash and the wearer.

Informational Note No. 2: Non-arc-rated cotton, polyester-cotton blends, nylon, nylon-cotton blends, silk, rayon, and wool fabrics are flammable. Fabrics, zipper tapes, and findings made of these materials can ignite and continue to burn on the body, resulting in serious burn injuries.

Informational Note No. 3: Rayon is a cellulose-based (wood pulp) synthetic fiber that is a flammable but nonmelting material.

Clothing consisting of fabrics, zipper tapes, and findings made from flammable synthetic materials that melt at temperatures below 315°C (600°F), such as acetate, acrylic, nylon, polyester, polyethylene, polypropylene, and spandex, either alone or in blends, shall not be used.

Informational Note: These materials melt as a result of arc flash exposure conditions, form intimate contact with the skin, and aggravate the burn injury.

Exception: Fiber blends that contain materials that melt, such as acetate, acrylic, nylon, polyester, polyethylene, polypropylene, and spandex, shall be permitted if such blends in fabrics are arc rated and do not exhibit evidence of melting and dripping during arc testing.

Informational Note: See ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, and ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, ~~contain~~ for information on test methods used to determine the arc rating of fabrics.

Submitter Information Verification

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Committee Statement

Committee Statement: The existing informational note is modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-112-NFPA 70E-2021

Public Input No. 188-NFPA 70E-2021 [Section No. 130.7(C)(11)]

First Revision No. 67-NFPA 70E-2021 [Section No. 130.7(C)(13)]

(13) Care and Maintenance of Arc-Rated Clothing and Arc-Rated Arc Flash Suits.

(a) *Inspection.* Arc-rated apparel shall be inspected before each use. Work clothing or arc flash suits that are contaminated or damaged to the extent that their protective qualities are impaired shall not be used. Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.

(b) *Manufacturer's Instructions.* The garment manufacturer's instructions for care and maintenance of arc-rated apparel shall be followed.

(c) *Storage.* Arc-rated apparel shall be stored in a manner that prevents physical damage; damage from moisture, dust, or other deteriorating agents; or contamination from flammable or combustible materials.

(d) *Cleaning, Repairing, and Affixing Items.* When arc-rated clothing is cleaned, manufacturer's instructions shall be followed. When arc-rated clothing is repaired, the same arc-rated materials used to manufacture the arc-rated clothing shall be used to provide repairs.

Informational Note No. 1: The purpose of following manufacturer's instructions is to avoid the loss of protection and to remove contaminants such as hydrocarbons and metallic and disease-causing contaminants that could compromise safety.

Informational Note No. 2: ~~Additional guidance is provided in~~ See ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, for additional guidance when trim, name tags, logos, or any combination thereof are affixed to arc-rated clothing.

Informational Note No. 3: ~~Additional guidance is provided in~~ See ASTM F1449, *Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing*, and ASTM F2757, *Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal, and Arc Resistant Clothing*, for additional guidance .

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Committee Statement

Committee Statement: Existing Informational Notes No. 2 and 3 are modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text

Response Message: FR-67-NFPA 70E-2021

Public Input No. 189-NFPA 70E-2021 [Section No. 130.7(C)(13)]

First Revision No. 68-NFPA 70E-2021 [Section No. 130.7(C)(14)]

Global FR-63

(14) Standards for PPE.

(a) *General.* PPE shall conform to applicable state, federal, or local codes and standards.

Informational Note No. 1: ~~The standards listed in~~ See Table Informational Note Table 130.7(C)(14)~~, which is part of this Informational Note, are~~ for a list of examples of standards that contain information on the care, inspection, testing, and manufacturing of PPE.

Informational Note No. 2: See 130.7(C)(11) and 130.7(C)(12) ~~Non~~ for requirements on non-arc-rated or flammable fabrics ~~are~~ not covered by any of the standards in Table Informational Note Table 130.7(C)(14)~~, Informational Note~~ . ~~See 130.7(C)(11) and 130.7(C)(12) .~~

(b) *Conformity Assessment.* All suppliers or manufacturers of PPE shall demonstrate conformity with an appropriate product standard by one of the following methods:

(1) Self-declaration with a Supplier's Declaration of Conformity

(2) Self-declaration under a registered quality management system and product testing by an accredited laboratory and a Supplier's Declaration of Conformity

(3) Certification by an accredited independent third-party certification organization

Informational Note No. 1: See Informative Annex H.4 and ANSI/ISEA 125, *American National Standard for Conformity Assessment of Safety and Personal Protective Equipment* , for ~~Examples~~ examples of a process for conformity assessment to an appropriate product standard ~~can be found in ANSI/ISEA 125, *American National Standard for Conformity Assessment of Safety and Personal Protective Equipment* . See H.4~~

Informational Note No. 2: ~~An example of a process to accredit independent third-party certification organizations is~~ See ISO 17065, *Conformity assessment — Requirements for bodies certifying products, processes, and services*, for an example of a process to accredit independent third-party certification organizations .

(c) *Marking.* All suppliers or manufacturers of PPE shall provide the following information on the PPE, on the smallest unit container, or contained within the manufacturer's instructions:

(1) Name of manufacturer

(2) Product performance standards to which the product conforms

(3) Arc rating where appropriate for the equipment

(4) One or more identifiers such as model, serial number, lot number, or traceability code

(5) Care instructions

Table Informational Note Table 130.7(C)(14) ~~Informational Note:~~ Standards for PPE

Subject	Document Title	Document Number
Clothing — Arc Rated	Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arc	ASTM F1506
	Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing	ASTM F1449

Subject	Document Title	Document Number
	Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing	ASTM F2757
	Live working — Protective clothing against the thermal hazards of an electric arc — Part 1-1: Test methods — Method 1: Determination of the arc rating (ELIM, ATPV, and/or EBT) of clothing materials and of protective clothing using an open arc	IEC 61482–1–1
	Live working — Protective clothing against the thermal hazards of an electric arc — Part 2: Requirements	IEC 61482–2
Aprons — Insulating	Standard Specification for Electrically Insulating Aprons	ASTM F2677
Eye and Face Protection — General	American National Standard for Occupational and Educational Professional Eye and Face Protection	ANSI/ISEA Z87.1
Face — Arc Rated	Standard Test Method for Determining the Arc Rating and Standard Specification for Personal Eye or Face Protective Products	ASTM F2178
Fall Protection	Standard Specification for Personal Climbing Equipment	ASTM F887
Footwear — Dielectric Specification	Standard Specification for Dielectric Footwear	ASTM F1117
Footwear — Dielectric Test Method	Standard Test Method for Determining Dielectric Strength of Dielectric Footwear	ASTM F1116
Footwear — Standard Performance Specification	Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear	ASTM F2413
Footwear — Standard Test Method	Standard Test Methods for Foot Protections	ASTM F2412
Gloves — Arc Rated	Standard Test Method for Determining Arc Ratings of Hand Protective Products Developed and Used for Electrical Arc Flash Protection	ASTM F2675/F2675M
Gloves — Leather Protectors	Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens	ASTM F696

Subject	Document Title	Document Number
Gloves — Non-Leather Protectors	Standard Specification for Protectors for Rubber Insulating Gloves Meeting Specific Performance Requirements	ASTM F3258
Gloves — Rubber Insulating	Standard Specification for Rubber Insulating Gloves	ASTM D120
Gloves and Sleeves — In-Service Care	Standard Specification for In-Service Care of Insulating Gloves and Sleeves	ASTM F496
Head Protection — Hard Hats	American National Standard for Head Protection	ANSI/ISEA Z89.1
Rainwear — Arc Rated	Standard Specification for Arc and Flame Resistant Rainwear	ASTM F1891
Rubber Protective Products — Visual Inspection	Standard Guide for Visual Inspection of Electrical Protective Rubber Products	ASTM F1236
Sleeves — Insulating	Standard Specification for Rubber Insulating Sleeves	ASTM D1051

Supplemental Information

File Name	Description	Approved
FR-68_Table_130.7_C_14_.docx	Table revision for FR 68. For staff use	
70E_FR-68_1307_C_14_.docx	FINAL FOR PRODUCTION	

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Committee Statement

Committee Statement: Existing informational notes are modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

A new standard (ASTM F3258 published in 2021) is referenced to recognize non-leather protectors for rubber gloves to correlate with global revisions.

Response Message: FR-68-NFPA 70E-2021

Public Input No. 190-NFPA 70E-2021 [Section No. 130.7(C)(14)]

First Revision No. 108-NFPA 70E-2021 [Section No. 130.7(C)(15)]

Detail FR-142

(15) 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.

Informational Note: ~~The~~ For both ac and dc systems, the arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

(a) *Alternating Current (ac) Equipment.* When the arc flash risk assessment performed in accordance with 130.5 indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for ac systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(a) shall be used to determine the arc flash PPE category. The estimated maximum available fault current, maximum fault-clearing times, and minimum working distances for various ac equipment types or classifications are listed in Table 130.7(C)(15)(a). An incident energy analysis shall be required in accordance with 130.5(G) for the following:

(1) Power systems with greater than the estimated maximum available fault current

(2) Power systems with longer than the maximum fault clearing times

(3) Less than the minimum working distance

(b) *Direct Current (dc) Equipment.* When the arc flash risk assessment performed in accordance with 130.5(G) indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for dc systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(b) shall be used to determine the arc flash PPE category. The estimated maximum available fault current, maximum arc duration, and working distances for dc equipment are listed in 130.7(C)(15)(b). An incident energy analysis shall be required in accordance with 130.5(G) for the following:

(1) Power systems with greater than the estimated maximum available fault current

(2) Power systems with longer than the maximum arc duration

(3) Less than the minimum working distance

~~Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.~~

~~Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).~~

(c) *Protective Clothing and Personal Protective Equipment (PPE).* Once the arc flash PPE category has been identified from Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b), Table 130.7(C)(15)(c) shall be used to determine the required PPE. Table 130.7(C)(15)(c) lists the requirements for PPE based on arc flash PPE categories 1 through 4. This clothing and equipment shall be used when working within the arc flash boundary. The use of PPE other than or in addition to that listed shall be permitted provided it meets 130.7(C)(7).

Informational Note No. 1: See Informative Annex H for a suggested simplified approach to ensure adequate PPE for electrical workers within facilities with large and diverse electrical systems.

Informational Note No. 2: The PPE requirements of this section are intended to protect a person from arc flash hazards. While some situations could result in burns to the skin even with the protection described in Table 130.7(C)(15)(c), burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of this section do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

Informational Note No. 3: The arc rating for a particular clothing system can be obtained from the arc-rated clothing manufacturer.

Table 130.7(C)(15)(a) Arc Flash PPE Categories for Alternating Current (ac) Systems

Equipment	Arc Flash PPE Category	Arc Flash Boundary
Panelboards or other equipment rated 240 volts and below	1	485 mm (19 in.)
Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)		
Panelboards or other equipment rated greater than 240 volts and up to 600 volts	2	900 mm (3 ft)
Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)		
600-volt class motor control centers (MCCs)	2	1.5 m (5 ft)
Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)		
600-volt class motor control centers (MCCs)	4	4.3 m (14 ft)
Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18 in.)		
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards	4	6 m (20 ft)
Parameters: Maximum of 35 kA available fault current; maximum of up to 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18 in.)		
Other 600-volt class (277 volts through 600 volts, nominal) equipment	2	1.5 m (5 ft)
Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)		
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV	4	12 m (40 ft)

Equipment	Arc Flash PPE Category	Arc Flash Boundary
Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)		
Metal-clad switchgear, 1 kV through 15 kV	4	12 m (40 ft)
Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)		
Metal enclosed interrupter switchgear, fused or unfused type construction, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant equipment up to 600-volt class Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	N/A	N/A
Arc-resistant equipment 1 kV through 15 kV	N/A	N/A
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*		

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

(1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.

(2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.

(3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.

(4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., “no intentional delay”).

(5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.

(6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): ~~An~~ See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults* , for an example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) ~~is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*~~ .

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

Table 130.7(C)(15)(b) Arc Flash PPE Categories for dc Systems

Equipment	Arc Flash PPE Category	Arc Flash Boundary
~~Storage batteries, dc switchboards, and other dc supply sources~~		
~~Parameters: Greater than or equal to 100 volts and less than or equal to 250 volts~~		
~~Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)~~		
~~Available fault current less than 4 kA~~	~~2~~	~~900 mm~~
		~~(3 ft)~~
~~Available fault current greater than or equal to 4 kA and less than 7 kA~~	~~2~~	~~1.2 m~~
		~~(4 ft)~~
~~Available fault current greater than or equal to 7 kA and less than 15 kA~~	~~3~~	~~1.8 m~~
		~~(6 ft)~~
Storage batteries, dc switchboards, and other dc supply sources		
Parameters: Greater than ~~250~~150 volts and less than or equal to 600 volts		
Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 1.5 kA	2	900 mm
		(3 ft)
Available fault current greater than or equal to 1.5 kA and less than 3 kA	2	1.2 m
		(4 ft)
Available fault current greater than or equal to 3 kA and less than 7 kA	3	1.8 m
		(6 ft.)
Available fault current greater than or equal to 7 kA and less than 10 kA	4	2.5 m
		(8 ft)

Notes:

(1) Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:

(a) Be evaluated for electrolyte protection

Informational Note: See ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, ~~contains~~ for information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

Informational Note: See ASTM F1891, *Standard Specification for Arc and Flame Resistant Rainwear*, ~~contains~~ for information on evaluating arc-rated apparel.

(2) A two-second arc duration is assumed if there is no overcurrent protective device (OCPD) or if the fault clearing time is not known. If the fault clearing time is known and is less than 2 seconds, an incident energy analysis could provide a more representative result.

Informational Note No. 1: See D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment. When determining available fault current, the effects of cables and any other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. ~~See D.5 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgment.~~

Informational Note No. 2: The methods for estimating the dc arc flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table.

Informational Note No. 3: See the following references for dc voltages below 150 volts nominal:

(1) J. G. Hildreth and K. Feeney, “Arc Flash Hazards Station Battery Systems,” 2018 IEEE Power & Energy Society General Meeting (PESGM), 2018, pp. 1–5,

(2) US Department of Energy Bonneville Power Administration Engineering and Technical Services Report BPA F 5450.05, “DC Arc Flash: 125V, 1300 amp-hour battery,” May 11, 2017, doi: 10.1109/PESGM.2018.8586181.

(3) K. Gray, S. Robert, and T. L. Gauthier, "Low Voltage 100–500 Vdc Arc Flash Testing," 2020 IEEE IAS Electrical Safety Workshop (ESW), 2020, pp. 1–7, doi: 10.1109/ESW42757.2020.9188336.

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

Arc-Flash PPE Category	PPE
1	**Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm^2 (16.75 J/cm^2)**[a]
	Arc-rated long-sleeve shirt and pants or arc-rated coverall
	Arc-rated face shield[b] or arc flash suit hood
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f]
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts)[c]
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with ~~leather~~ protectors (SR)[d]
	Leather footwear[e] (AN)
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm^2 (33.5 J/cm^2)**[a]
	Arc-rated long-sleeve shirt and pants or arc-rated coverall

Arc-Flash PPE Category	PPE
	Arc-rated flash suit hood or arc-rated face shield[b] and arc-rated balaclava
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f]
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts)[c]
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with ~~leather~~ protectors (SR)[d]
	Leather footwear[e]
3	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm^2 (104.7 J/cm^2)[a]**
	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 or rubber insulating gloves with ~~leather~~ protectors (SR)[d]
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f]
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts)[c]
	Leather footwear[e]
4	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm^2 (167.5 J/cm^2)[a]**
	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 or rubber insulating gloves with ~~leather~~ protectors (SR)[d]
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN)[f]
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)

Arc-Flash PPE Category	PPE
	Hearing protection (ear canal inserts)[c]
	Leather footwear[e]

AN: As needed (optional). AR: As required. SR: Selection required.

[a]*Arc rating* is defined in Article 100.

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

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

[d]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.

[e]Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting or dripping at the minimum arc rating for the respective arc flash PPE category.

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

Supplemental Information

File Name	Description	Approved
FR-108_Clean_informational_notes_for_staff_only.docx		

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 06:38:28 EDT 2021

Committee Statement

Committee Statement: Informational Note No. 1 following 130.7(C)(15)(b) is editorially relocated to follow the parent text of 130.7(C)(15) as it applies to both ac and dc systems. This IN is editorially revised to clarify that it applies to both ac and dc systems.

Informational Note No. 2 following 130.7(C)(15)(b) is relocated to follow Section 130.5(B). This relocation is accurate as this informational note (IN) applies to all arc flash risk assessments.

Existing informational notes following Tables 130.7(C)(15)(a) and 130.7(C)(15)(b) are modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-108-NFPA 70E-2021

Public Input No. 191-NFPA 70E-2021 [Section No. 130.7(C)(15)]

Public Input No. 355-NFPA 70E-2021 [Section No. 130.7(C)(15)]

Public Input No. 350-NFPA 70E-2021 [Section No. 130.7(C)(15)]

First Revision No. 69-NFPA 70E-2021 [Section No. 130.7(D)(1)]

(1) Insulated Tools and Equipment.

Tools and handling equipment used within the restricted approach boundary shall be insulated. Insulated tools shall be protected from damage to the insulating material.

Informational Note: See 130.4(E), Shock Protection Boundaries.

(a) *Requirements for Insulated Tools.* The following requirements shall apply to insulated tools:

(1) Insulated tools shall be rated for the voltages on which they are used.

(2) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.

(3) Insulated tools and equipment shall be inspected prior to each use. The inspection shall look for damage to the insulation or damage that can limit the tool from performing its intended function or could increase the potential for an incident (e.g., damaged tip on a screwdriver).

(b) *Fuse or Fuseholder Handling Equipment.* Fuse or fuseholder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.

(c) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary shall be nonconductive.

(d) *Fiberglass-Reinforced Plastic Rods.* Fiberglass-reinforced plastic rod and tube used for live-line tools shall meet the requirements of applicable portions of electrical codes and standards dealing with electrical installation requirements.

Informational Note: ~~For further information concerning electrical codes and standards dealing with installation requirements, refer to~~ See ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools* , for further information concerning electrical codes and standards dealing with installation requirements .

(e) *Portable Ladders.* Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: ~~The standards listed in~~ See Table Table 130.7(E), Informational Note ~~are examples~~ for a list of standards that contain information on portable ladders.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 13:47:24 EDT 2021

Committee Statement

Committee Existing informational notes are modified to comply with the NEC Style Manual.

Statement:	Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.
Response Message:	FR-69-NFPA 70E-2021

Public Input No. 192-NFPA 70E-2021 [Section No. 130.7(D)(1)]

First Revision No. 70-NFPA 70E-2021 [Section No. 130.7(D)(2)]

(2) Barriers.

Exposed energized electrical conductors or circuit parts operating at 50 volts or more shall be guarded by a barrier in accordance with 130.7(D)(2)(a) through 130.7(D)(2)(c)to prevent unintentional contact while an employee is working within the restricted approach boundary of those conductors or circuit parts. Barriers shall be supported to remain in place and shall prevent unintentional contact by a person, tool, or equipment.

(a) *Rubber Insulating Equipment.* Rubber insulating equipment used for protection from unintentional contact with energized conductors or circuit parts shall be rated for the voltage and shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: ~~The standards listed in~~ See ~~Table 130.7(G),~~ Informational Note Table 130.7(E) ~~are~~ for a list of examples of standards that contain information on rubber insulating equipment.

(b) *Voltage-Rated Plastic Guard Equipment.* Plastic guard equipment for protection of employees from unintentional contact with energized conductors or circuit parts, or for protection of employees or energized equipment or material from contact with ground, shall be rated for the voltage and shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: ~~The standards listed in~~ See ~~Table 130.7(G),~~ Informational Note Table 130.7(E) ~~are~~ for a list of examples of standards that contain information on voltage-rated plastic guard equipment.

(c) *Physical or Mechanical Barriers.* Physical or mechanical (field-fabricated) barriers shall be installed no closer than the restricted approach boundary distance given in Table 130.4(E)(a) and Table 130.4(E)(b). While the barrier is being installed, the restricted approach boundary distance specified in Table 130.4(E)(a) and Table 130.4(E)(b) shall be maintained, or the energized conductors or circuit parts shall be placed in an electrically safe work condition.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 13:48:19 EDT 2021

Committee Statement

Committee Statement: Existing informational notes are modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-70-NFPA 70E-2021

Public Input No. 193-NFPA 70E-2021 [Section No. 130.7(D)(2)]

First Revision No. 71-NFPA 70E-2021 [Section No. 130.7(E)]

(O) Alerting Techniques.

(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~~ See Informational Note Table 130.7(E), ~~Informational Note are~~ for a list of examples of standards that contain information on safety signs and tags.

(2) Barricades.

Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(E)(a) and Table 130.4(E)(b). Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.

(3) Attendants.

If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 13:49:40 EDT 2021

Committee Statement

Committee Statement: This action editorially relocates requirements for alerting techniques previously located in 130.7(E). Alerting techniques were misplaced in 130.7 which addresses personal and other protective equipment. This action properly relocates alerting techniques into 130.8 which addresses other precautions for personnel activities for clarity and usability.

Editorial revisions are made in informational Note No. 2 for compliance with the NEC Style Manual.

Response Message: FR-71-NFPA 70E-2021

Public Input No. 194-NFPA 70E-2021 [Section No. 130.7(E)(1)]

Public Input No. 82-NFPA 70E-2021 [Section No. 130.7(E)]

First Revision No. 72-NFPA 70E-2021 [Section No. 130.7(F)]

(P) Look-Alike Equipment.

Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, one of the alerting methods in 130.8(O), or shall be employed to prevent the employee from entering look-alike equipment.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 13:55:23 EDT 2021

Committee Statement

Committee Statement: This action is editorial in nature and relocates first level subdivision 130.7(F) Look Alike Equipment to 130.8(P). Requirements for look alike equipment were misplaced in 130.7 which addresses personal and other protective equipment. This action properly relocates look alike equipment into 130.8 which addresses other precautions for personnel activities for clarity and usability.

Response Message: FR-72-NFPA 70E-2021

Public Input No. 81-NFPA 70E-2021 [Section No. 130.7(F)]

Public Input No. 83-NFPA 70E-2021 [New Section after 130.8]

First Revision No. 73-NFPA 70E-2021 [Section No. 130.7(G)]

(E) Standards for Other Protective Equipment.

Other protective equipment required in 130.7(D) shall conform to the applicable state, federal, or local codes and standards.

Table Informational Note: ~~The standards listed in~~ See Informational Note Table 130.7(E), ~~which is part of this~~ Informational Note~~, are~~ for a list of examples of standards that contain information on other protective equipment.

Table Informational Note Table 130.7(E) Standards on Other Protective Equipment

Subject	Document	Document Number
Arc Protective Blankets	Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards	ASTM F2676
Arc Protective Blankets — Selection, Care, and Use	Standard Guide for Selection, Care, and Use of Arc Protective Blankets	ASTM F3272
Blankets	Standard Specification for Rubber Insulating Blankets	ASTM D1048
Blankets — In-service Care	Standard Specification for In-Service Care of Insulating Blankets	ASTM F479
Covers	Standard Specification for Rubber Insulating Covers	ASTM D1049
Fiberglass Rods — Live Line Tools	Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools	ASTM F711
Insulated Hand Tools	Standard Specification for Insulated and Insulating Hand Tools	ASTM F1505
Ladders	American National Standard for Ladders — Wood — Safety Requirements	ANSI/ASC A14.1
	American National Standard for Ladders — Fixed — Safety Requirements	ANSI/ASC A14.3
	American National Standard Safety Requirements for Job Made Wooden Ladders	ANSI/ ASC A14.4
	American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements	ANSI/ ASC A14.5
Line Hose	Standard Specification for Rubber Insulating Line Hoses	ASTM D1050
Line Hose and Covers — In-service Care	Standard Specification for In-Service Care of Insulating Line Hose and Covers	ASTM F478
Plastic Guard	Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers	ASTM F712
Sheeting	Standard Specification for PVC Insulating Sheeting	ASTM F1742
	Standard Specification for Rubber Insulating Sheeting	ASTM F2320
Safety Signs and Tags	Series of Standards for Safety Signs and Tags	ANSI Z535

Subject	Document	Document Number
Shield Performance on Live Line Tool	Standard Test Method for Determining the Protective Performance of a Shield Attached on Live Line Tools or on Racking Rods for Electric Arc Hazards	ASTM F2522
Temporary Protective Grounds — In-service Testing	Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-energized Electric Power Lines and Equipment	ASTM F2249
Temporary Protective Grounds — Test Specification	Standard Specification for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment	ASTM F855

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 13:59:28 EDT 2021

Committee Statement

Committee Statement: The existing informational note is modified to comply with the NEC Style Manual. Section 3.1.3.1 of the 2020 NEC Style Manual requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-73-NFPA 70E-2021

Public Input No. 195-NFPA 70E-2021 [Section No. 130.7(G)]

First Revision No. 74-NFPA 70E-2021 [Section No. 130.8(J)]

(J) Occasional Use of Flammable Materials.

Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be permitted to be used, unless measures are taken to prevent hazardous conditions from developing. Such materials shall include, but are not limited to, flammable gases, vapors, or liquids, combustible dust, and ignitible fibers or flyings.

Informational Note: See *NFPA 70* , *National Electrical Code* , for ~~Electrical~~ electrical installation requirements for locations where flammable materials are present on a regular basis ~~are contained in *NFPA 70* , *National Electrical Code* .~~

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:02:53 EDT 2021

Committee Statement

Committee Statement: The informational note is revised to comply with the 2020 NEC Style Manual. Specifically, 3.1.3.1 requires informational notes that reference a requirement, or another standard be structured with the referenced requirement or standard identified first followed by the explanatory text.

Response Message: FR-74-NFPA 70E-2021

Public Input No. 196-NFPA 70E-2021 [Section No. 130.8(J)]

First Revision No. 75-NFPA 70E-2021 [Section No. 130.8(M)]

(M) Reclosing Circuits After Protective Device Operation.

After a circuit is de-energized by the automatic operation of a circuit protective device, the circuit shall not be manually re-energized until ~~it has been determined that~~ a qualified person or persons determines the equipment and circuit can be safely energized. ~~The repetitive manual~~ Manually reclosing ~~of~~ circuit breakers or re-energizing circuits through replaced fuses shall be prohibited until the fault has been cleared . ~~When it is determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, examination of the circuit or connected equipment shall not be required before the circuit is re-energized.~~

Exception: When it is determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, examination of the circuit or connected equipment shall not be required before the circuit is re-energized.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:14:49 EDT 2021

Committee Statement

Committee Statement: This action removes “repetitive” which could be interpreted as an allowance to replace a fuse or reset a circuit breaker at least once before determining the cause of the automatic operation of a circuit protective device. Further, the requirement allowing for re-energizing for conditions caused by overload has been relocated as an exception as it is more appropriately addressed an exception to the requirement.

Response Message: FR-75-NFPA 70E-2021

Public Input No. 362-NFPA 70E-2021 [Section No. 130.8(M)]

First Revision No. 76-NFPA 70E-2021 [Section No. 130.11]

130.11 Cutting or Drilling.

Before cutting or drilling into equipment, floors, walls, or structural elements where a likelihood of contacting energized electrical lines or parts exists, the employer shall perform a risk assessment to do the following :

(1) Identify and mark the location of conductors, cables, raceways, or equipment

(2) ~~Create~~ Establish and verify an electrically safe work condition

(3) Identify safe work practices, risk control methods, additional protective measures, and ~~PPE to be used~~ any required shock or arc flash PPE

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:23:21 EDT 2021

Committee Statement

Committee Statement: This revision editorially revises 130.11 to be consistent with 120.5.

Response Message: FR-76-NFPA 70E-2021

Public Input No. 375-NFPA 70E-2021 [Section No. 130.11]

First Revision No. 77-NFPA 70E-2021 [Section No. 130.12]

130.12 Cutting, Removing, or Rerouting of Electrical ~~of~~ Conductors and Circuit Parts .

Where electrical conductors and circuit parts are de-energized in order to cut, remove, reroute, or ~~reroute~~ otherwise work on them and the conductor terminations or circuit parts are not within sight from the point of work, such as where the electrical conductors or circuit parts are remote from the source of supply in a junction or pull box, additional steps to verify absence of voltage or identify the electrical conductors and circuit parts shall be taken prior to cutting, removing, rerouting, or ~~rerouting~~ otherwise work on the conductors and circuit parts .

Informational Note No. 1: Additional steps to be taken where conductors are de-energized in order to cut, remove, or reroute them include, but are not limited to, remotely spiking the conductors, pulling conductors to visually verify movement, remotely cutting the conductors, or other approved methods. Nonshielded conductors could be additionally verified with a noncontact test instrument, and shielded conductors could be verified with devices that identify the conductors.

Informational Note No. 2: De-energizing is only one of several steps in lockout/tagout procedures and in establishing an electrically safe work condition.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:25:36 EDT 2021

Committee Statement

Committee Statement: This first revision revises the requirement to parallel the text of other 70E requirements such as in 110.2 and 110.3 where the phrase "electrical conductors and circuit parts" is used. The requirement is also revised to include any work that occurs where an electrically safe work condition has not been established, not only cutting, removing, or rerouting conductors. An informational note is added to provide the critical distinction that de-energizing as used in 130.12 is not the same as electrical conductors and circuit parts being under lockout/tagout or an electrically safe work condition being established.

Response Message: FR-77-NFPA 70E-2021

Public Input No. 379-NFPA 70E-2021 [Section No. 130.12]

First Revision No. 91-NFPA 70E-2021 [Section No. 200.1]

200.1 Scope.

Chapter 2 addresses the requirements that follow.

(1) Chapter 2 covers practical safety-related maintenance requirements for electrical equipment and installations in workplaces as included in 90.3(A). These requirements identify only that maintenance directly associated with employee safety.

(2) Chapter 2 does not prescribe specific maintenance methods or testing procedures. It is left to the employer to choose from the various maintenance methods available to satisfy the requirements of Chapter 2.

(3) For the purpose of Chapter 2, maintenance shall be defined as preserving or restoring the condition of electrical equipment and installations, or parts of either, for the safety of employees who work where exposed to electrical hazards. Repair or replacement of individual portions or parts of equipment shall be permitted without requiring modification or replacement of other portions or parts that are in a safe condition.

Informational Note: ~~Refer to~~ See NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*; ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*; and IEEE 3007.2, *Recommended Practice for the Maintenance of Industrial and Commercial Power Systems*, for guidance on maintenance frequency, methods, and tests.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:32:56 EDT 2021

Committee Statement

Committee Statement: The informational note was revised in accordance with 3.1.3.1 of the 2020 NEC Style Manual.

Response Message: FR-91-NFPA 70E-2021

Public Input No. 197-NFPA 70E-2021 [Section No. 200.1]

First Revision No. 93-NFPA 70E-2021 [Section No. 205.5]

205.6 Spaces About Electrical Equipment.

All working space and clearances required by electrical codes and standards shall be maintained.

Informational Note: ~~For further information concerning spaces about electrical equipment, see~~ See Article 110, Parts II and III, of *NFPA 70*, *National Electrical Code*, for further information concerning spaces about electrical equipment .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:40:47 EDT 2021

Committee Statement

Committee Statement: The informational note was revised in accordance with 3.1.3.1 of the 2020 NEC Style Manual.

Response Message: FR-93-NFPA 70E-2021

Public Input No. 198-NFPA 70E-2021 [Section No. 205.5]

First Revision No. 95-NFPA 70E-2021 [Section No. 220.1]

220.1 Scope.

This article ~~shall apply to~~ covers specific safety-related maintenance practices for controllers, ~~including~~ which includes electrical equipment that governs the starting, stopping, direction of motion, acceleration, speed, and protection of rotating equipment and other power utilization apparatus in the workplace.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:52:25 EDT 2021

Committee Statement

Committee Statement: Scope statement was modified in accordance with 2.2.1 of the 2020 NEC Style Manual. Scope statements cannot contain requirements

Response Message: FR-95-NFPA 70E-2021

Public Input No. 135-NFPA 70E-2021 [Section No. 220.1]

First Revision No. 97-NFPA 70E-2021 [Section No. 235.1]

235.1 Scope.

This article covers specific safety-related maintenance ~~requirements~~ practices in those areas identified as hazardous (classified) locations.

Informational Note No. 1: These locations need special types of equipment and installation to ensure safe performance under conditions of proper use and maintenance. It is important that inspection authorities and users exercise more than ordinary care with regard to installation and maintenance. The maintenance for specific equipment and materials is covered elsewhere in Chapter 2 and is applicable to hazardous (classified) locations. Other maintenance will ensure that the form of construction and of installation that makes the equipment and materials suitable for the particular location are not compromised.

Informational Note No. 2: The maintenance needed for specific hazardous (classified) locations depends on the classification of the specific location. The design principles and equipment characteristics~~,~~ — for example, use of positive pressure ventilation, explosionproof, nonincendive, intrinsically safe, and purged and pressurized equipment~~,~~ — that were applied in the installation to meet the requirements of the area classification must also be known. With this information, the employer and the inspection authority are able to determine whether the installation as maintained has retained the condition necessary for a safe workplace.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 17:02:33 EDT 2021

Committee Statement

Committee Statement: Scope statement was modified in accordance with 2.2.1 of the 2020 NEC Style Manual and to align with other scope statements within this Chapter.

Response Message: FR-97-NFPA 70E-2021

Public Input No. 138-NFPA 70E-2021 [Section No. 235.1]

First Revision No. 115-NFPA 70E-2021 [Section No. 235.2]

235.2 Maintenance Requirements for Hazardous (Classified) Locations.

Equipment and installations in these locations shall be maintained such that the following criteria are met:

(1) No energized parts are exposed.

Exception to (1): Intrinsically safe and nonincendive circuits shall be permitted to be exposed .

(2) There are no breaks in conduit systems, fittings, or enclosures from damage, corrosion, or other causes.

(3) All bonding jumpers are securely fastened and intact.

(4) All fittings, boxes, and enclosures with bolted covers have all bolts installed and bolted tight.

(5) All threaded conduit are wrenchtight and enclosure covers are tightened in accordance with the manufacturer's instructions.

(6) There are no open entries into fittings, boxes, or enclosures that would compromise the protection characteristics.

(7) All close-up plugs, breathers, seals, and drains are securely in place.

(8) Marking of luminaires (lighting fixtures) for maximum lamp wattage and temperature rating is legible and not exceeded.

(9) Required markings are secure and legible.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 08:51:40 EDT 2021

Committee Statement

Committee Statement: Exception sentences are required to be complete sentences in accordance with 3.1.4.1 of the 2020 NEC Style Manual.

Response Message: FR-115-NFPA 70E-2021

Public Input No. 157-NFPA 70E-2021 [Section No. 235.2]

First Revision No. 119-NFPA 70E-2021 [Section No. 250.3(B)]

(B) Testing.

Prior to being returned to service, temporary protective grounding equipment that has been repaired or modified shall be tested. Temporary protective grounding equipment shall be tested as service conditions require.

Informational Note: ~~Guidance for inspecting and testing safety grounds is provided in~~ See ASTM F2249, *Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-energized Electric Power Lines and Equipment*, for guidance for inspecting and testing safety grounds .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 09:14:54 EDT 2021

Committee Statement

Committee Statement: The informational note was revised in accordance with 3.1.3.1 of the 2020 NEC Style Manual.

Response Message: FR-119-NFPA 70E-2021

Public Input No. 199-NFPA 70E-2021 [Section No. 250.3(B)]

First Revision No. 120-NFPA 70E-2021 [Section No. 250.3(C)]

(C) Grounding and Testing Devices.

Grounding and testing devices shall be stored in a clean and dry area. Grounding and testing devices shall be properly inspected and tested before each use.

Informational Note: ~~Guidance for testing of grounding and testing devices is provided in~~ See Section 9.5 of IEEE C37.20.6, *Standard for 4.76 kV to 38 kV Rated Ground and Test Devices Used in Enclosures*, for guidance for testing of grounding and testing devices .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 09:17:38 EDT 2021

Committee Statement

Committee Statement: The informational note was revised in accordance with 3.1.3.1 of the 2020 NEC Style Manual.

Response Message: FR-120-NFPA 70E-2021

Public Input No. 200-NFPA 70E-2021 [Section No. 250.3(C)]

First Revision No. 99-NFPA 70E-2021 [Section No. 310.1]

310.1 Scope.

The requirements of this article shall apply to the electrical safety-related work practices used in the types of electrolytic cell areas.

Informational Note No. 1: See Informative Annex L for a typical application of safeguards in the cell line working zone.

Informational Note No. 2: ~~For further information about electrolytic cells, see~~ See *NFPA 70*, *National Electrical Code*, Article 668 for further information about electrolytic cells .

Informational Note No. 3: See IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones* , ~~For~~ for further information about electrical safety-related work practices in electrolytic cell lines~~, see IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones*~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 17:33:10 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-99-NFPA 70E-2021

Public Input No. 201-NFPA 70E-2021 [Section No. 310.1]

First Revision No. 149-NFPA 70E-2021 [Definition: Battery Effect.]

Battery Effect.

A voltage that exists on the cell line after the power supply is disconnected. (310)

Informational Note: Electrolytic cells can exhibit characteristics similar to an electrical storage battery and a shock hazard could exist after the power supply is disconnected from the cell line.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:09:47 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-149-NFPA 70E-2021

Public Input No. 120-NFPA 70E-2021 [Section No. 310.2]

Public Input No. 289-NFPA 70E-2021 [Global Input]

First Revision No. 150-NFPA 70E-2021 [Definition: Safeguarding.]

Global FR-137

Safeguarding.

Safeguards for personnel include the consistent administrative enforcement of safe work practices. Safeguards include training in safe work practices, cell line design, safety equipment, PPE, operating procedures, and work checklists. (310)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:11:20 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-150-NFPA 70E-2021

First Revision No. 101-NFPA 70E-2021 [Section No. 320.1]

320.1 Scope.

This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed ~~50~~ 100 volts, nominal, or exceed a short-circuit power of 1000 watts .

Informational Note: ~~For~~ See the following documents for additional information on best practices for safely working on stationary batteries~~, see the following documents~~ :

(1) NFPA 1, *Fire Code*, Chapter 52, Stationary Storage Battery Systems, ~~2015~~ 2021

(2) *NFPA 70*, *National Electrical Code*, Article 480, Storage Batteries, ~~2014~~ 2020

(3) IEEE 450, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, ~~2010~~ 2020

(4) IEEE 937, *Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems*, ~~2007~~ 2019

(5) IEEE 1106, *IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, 2005 (R 2011)

(6) IEEE 1184, *IEEE Guide for Batteries for Uninterruptible Power Supply Systems*, ~~2006 (R 2011)~~ 2015

(7) IEEE 1188, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*, 1188a-2014

(8) IEEE 1657, *Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Batteries,*~~2009~~ 2018

(9) OSHA 29 CFR 1910.305(j)(7), “Storage batteries”

(10) OSHA 29 CFR 1926.441, “Batteries and battery charging”

(11) DHHS (NIOSH) Publication No. 94-110, *Applications Manual for the Revised NIOSH Lifting Equation,* 1994

(12) IEEE/ASHRAE 1635, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*~~,~~ ~~2012~~ 2018

(13) NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems* , 2020

(14) UL 9540, *Energy Storage Systems and Equipment* , 2020

(15) UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems* , 2019

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 17:44:51 EDT 2021

Committee Statement

Committee Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1.

Statement: Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Additional reference documents are added to improve usability of the article. Dates are revised to reflect the most recent published edition.

A 1000-watt level is provided to address the concern for heating of tools and jewelry. The voltage was revised from 50 volts to 100 volts to align with the DC voltage thresholds within this article.

Response Message: FR-101-NFPA 70E-2021

Public Input No. 267-NFPA 70E-2021 [Section No. 320.1]

Public Input No. 202-NFPA 70E-2021 [Section No. 320.1]

Public Input No. 280-NFPA 70E-2021 [Section No. 320.1]

First Revision No. 151-NFPA 70E-2021 [Definition: Authorized Personnel.]

Global FR-137

Authorized Personnel.

The person in charge of the premises, or other persons appointed or selected by the person in charge of the premises who performs certain duties associated with stationary storage batteries. (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:13:32 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-151-NFPA 70E-2021

First Revision No. 153-NFPA 70E-2021 [Definition: Battery Room.]

Battery Room.

A room specifically intended for the installation of batteries that have no other protective enclosure. (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:14:23 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-153-NFPA 70E-2021

First Revision No. 152-NFPA 70E-2021 [Definition: Battery.]

Global FR-137

Battery.

A system consisting of two or more electrochemical cells connected in series or parallel and capable of storing electrical energy received and that can give it back by reconversion. (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:14:02 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-152-NFPA 70E-2021

First Revision No. 154-NFPA 70E-2021 [Definition: Cell.]

Global FR-137

Cell.

The basic electrochemical unit, characterized by an anode and a cathode used to receive, store, and deliver electrical energy. (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:14:48 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-154-NFPA 70E-2021

First Revision No. 155-NFPA 70E-2021 [Definition: Electrolyte.]

Global FR-137

Electrolyte.

A solid, liquid, or aqueous immobilized liquid medium that provides the ion transport mechanism between the positive and negative electrodes of a cell. (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:15:14 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-155-NFPA 70E-2021

First Revision No. 160-NFPA 70E-2021 [Definition: Nominal Voltage.]

Global FR-137

Voltage, Nominal (as applied to cell or battery). (Nominal Voltage).

The value assigned to a cell or battery of a given voltage class for the purpose of convenient designation; the operating voltage of the cell or system may vary above or below this value. (320)

Informational Note: The most common cell voltages are 2.0 volts per cell for lead-acid batteries, 1.2 volts per cell for alkali batteries, and 3.2 to 3.8 for Li-ion batteries. Nominal voltages might vary with different chemistries.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:18:15 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

The definition of “nominal voltage” is adjusted to comply with NEC Style Manual regulations and an informational note clarifies the intent of the definition.

Response Message: FR-160-NFPA 70E-2021

Public Input No. 90-NFPA 70E-2021 [Definition: Nominal Voltage.]

First Revision No. 156-NFPA 70E-2021 [Definition: Pilot Cell.]

Global FR-137

Pilot Cell.

One or more cells chosen to represent the operating parameters of the entire battery (sometimes called “temperature reference” cell). (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:15:52 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-156-NFPA 70E-2021

First Revision No. 157-NFPA 70E-2021 [Definition: Prospective Short-Circuit Current.]

Global FR-137

Prospective Short-Circuit Current.

The highest level of fault current that could theoretically occur at a point on a circuit. This is the fault current that can flow in the event of a zero impedance short circuit and if no protection devices operate. (320)

Informational Note : Some batteries have built-in management devices to limit maximum short-circuit current. The determination of the prospective short-circuit current for these batteries assumes that the internal battery management system protection devices are operable.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:16:37 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-157-NFPA 70E-2021

First Revision No. 158-NFPA 70E-2021 [Definition: Valve-Regulated Lead Acid (VRLA) Cell.]

Global FR-137

Valve-Regulated Lead Acid (VRLA) Cell.

A lead-acid cell that is sealed with the exception of a valve that opens to the atmosphere when the internal pressure in the cell exceeds atmospheric pressure by a pre-selected amount, and that provides a means for recombination of internally generated oxygen and the suppression of hydrogen gas evolution to limit water consumption. (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:17:07 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-158-NFPA 70E-2021

First Revision No. 159-NFPA 70E-2021 [Definition: Vented Cell.]

Vented Cell.

A type of cell in which the products of electrolysis and evaporation are allowed to escape freely into the atmosphere as they are generated. (Also called "*flooded cell*.") (320)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:17:31 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-159-NFPA 70E-2021

First Revision No. 102-NFPA 70E-2021 [Sections 320.3(A)(1), 320.3(A)(2)]

(1) ~~Energy~~ Electrical Hazard Thresholds.

~~Energy exposure~~ 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 and 40 milliamperes

(3) Thermal: 1000 watts short-circuit power

Informational Note: ~~This information is extracted from the~~ See Department of Energy, ~~(~~ *DOE*~~)~~ *Electrical Safety Handbook*, DOE-HDBK-1092, for electrical hazard thresholds .

(2) Battery Risk Assessment.

Prior to any work on a battery system, a risk assessment shall be performed to identify the chemical, thermal, electrical shock, and arc flash hazards and assess the risks associated with the type of tasks to be performed.

Informational Note: See F.7 and Figure F.7 ~~For~~ for an example of a risk assessment method for work on batteries~~, see F.7 and Figure F.7 in Informative Annex F~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 18:23:47 EDT 2021

Committee Statement

Committee Statement: The title of Section 320.3 is revised to accurately reflect the thresholds. The informational note is revised to comply with the 2020 NEC Style Manual.

Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Adding "40 milliamperes" as a part of the dc threshold makes this consistent with the remainder of Chapter 3.

The threshold for exposure to a thermal hazard is added to instruct when controls are needed to prevent a thermal contact injury.

Thermal is added to the list of hazards associated with batteries and battery rooms for completeness.

Response Message: FR-102-NFPA 70E-2021

Public Input No. 284-NFPA 70E-2021 [Section No. 320.3(A)(2)]

Public Input No. 203-NFPA 70E-2021 [Section No. 320.3(A)(1)]

Public Input No. 283-NFPA 70E-2021 [Section No. 320.3(A)(1)]

Public Input No. 204-NFPA 70E-2021 [Section No. 320.3(A)(2)]

First Revision No. 104-NFPA 70E-2021 [Section No. 320.3(A)(5)]

(5) Abnormal Battery Conditions.

Instrumentation that provides alarms for early warning of abnormal conditions of battery operation, if present, shall be tested annually.

Informational Note: ~~Battery monitoring systems~~ See IEEE 1491, *Guide for the Selection and Use of Battery Monitoring Equipment in Stationary Applications* , for guidance on battery monitoring systems. Battery monitoring systems typically include alarms for such conditions as overvoltage, undervoltage, overcurrent, ground fault, and overtemperature. The type of conditions monitored will vary depending upon the battery technology. ~~One source of guidance on monitoring battery systems is IEEE 1491, *Guide for the Selection and Use of Battery Monitoring Equipment in Stationary Applications*~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 18:44:53 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-104-NFPA 70E-2021

Public Input No. 205-NFPA 70E-2021 [Section No. 320.3(A)(5)]

First Revision No. 105-NFPA 70E-2021 [Section No. 320.3(B)(1)]

(1) Battery Activities That Include Handling of Liquid Electrolyte.

The following protective equipment shall be available to employees performing any type of service on a battery with liquid electrolyte:

(1) Goggles and face shield appropriate for the electrical hazard and the chemical hazard

(2) Gloves and aprons appropriate for the chemical hazards

(3) Portable or stationary eye wash facilities and equipment within the work area that are capable of drenching or flushing of the eyes and body for the duration necessary to mitigate injury from the electrolyte hazard.

Informational Note: ~~Guidelines for the use and maintenance of eye wash facilities for vented batteries in nontelecom environments can be found in~~ See ANSI/ISEA Z358.1, *American National Standard for Emergency Eye Wash and Shower Equipment*, for guidelines for the use and maintenance of eye wash facilities for vented batteries in nontelecom environments .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 18:47:06 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-105-NFPA 70E-2021

Public Input No. 206-NFPA 70E-2021 [Section No. 320.3(B)(1)]

First Revision No. 103-NFPA 70E-2021 [Section No. 320.3(C)]

(C) Tools and Equipment.

(1) Handles.

Tools and equipment for work on batteries shall be equipped with insulated handles ~~listed as insulated~~ rated for the ~~maximum working~~ voltage on which they are used . The length of tools for work on batteries shall be selected to minimize the risk of inadvertent contact.

(2) Contact.

Battery terminals and all electrical conductors shall be kept clear of unintended contact with tools, test equipment, liquid containers, and other foreign objects.

(3) Nonsparking Tools.

Nonsparking tools shall be required when the risk assessment required by 110.3(H) justifies their use.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 18:30:00 EDT 2021

Committee Statement

Committee Statement: The insulation on a tool has a rating rather than a listing. Many incidents involving batteries are a result of a worker inadvertently shorting a tool between terminals or a grounded surface. An additional requirement is added to include consideration of tool length is added to the risk assessment.

Response Message: FR-103-NFPA 70E-2021

Public Input No. 285-NFPA 70E-2021 [Section No. 320.3(C)(1)]

First Revision No. 126-NFPA 70E-2021 [Section No. 330.1]

330.1 Scope.

This article ~~applies to~~ covers safety-related work practices for maintaining lasers and their associated equipment.

Informational Note No. 1: ~~For recommendations on laser safety requirements for laser use, see~~ See ANSI Z136.1, *Standard for Safe Use of Lasers*, for recommendations on laser safety requirements for laser use .

Informational Note No. 2: ~~For laser product requirements for laser manufacturers, see~~ See 21 CFR Part 1040, “Performance Standards for Light-Emitting Products,” Sections 1040.10 “Laser products” and 1040.11, “Specific purpose laser products~~.~~ ” for laser product requirements for laser manufacturers.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 10:45:15 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-126-NFPA 70E-2021

Public Input No. 207-NFPA 70E-2021 [Section No. 330.1]

First Revision No. 166-NFPA 70E-2021 [Definition: Field Evaluated.]

Global FR-137

Field Evaluated.

A thorough evaluation of nonlisted or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction. (330, 350)

Informational Note No. 1: The evaluation approval ensures that the equipment meets appropriate codes and standards or is similarly found suitable for a specified purpose.

Informational Note No. 2: See NFPA 791, *Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation*, for additional information on recommended practices and procedures for the field evaluation of nonlisted equipment.

Informational Note No. 3: See NFPA 790, *Standard for Competency of Third-Party, Field Evaluation Bodies*, for help in evaluating whether third-party entities are acceptable to an authority having jurisdiction.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:29:29 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Informational notes to the definition of “Field Evaluated” are revised to comply with 2020 NEC Style Manual. The term is used in multiple articles and not exclusive to Article 330.

Informational notes (2) and (3) are captured from the same definition in 350.2 since the term will be relocated to Article 100 only once to cover application in both Article 330 and Article 350 They are placed into list item format for readability.

Response Message: FR-166-NFPA 70E-2021

Public Input No. 209-NFPA 70E-2021 [Definition: Field Evaluated.]

First Revision No. 162-NFPA 70E-2021 [Definition: Laser Energy Source.]

Laser Energy Source.

Any device intended for use in conjunction with a laser to supply energy for the excitation of electrons, ions, or molecules. (330)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:26:05 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-162-NFPA 70E-2021

First Revision No. 163-NFPA 70E-2021 [Definition: Laser Radiation.]

Laser Radiation.

All electromagnetic radiation emitted by a laser or laser system between 180 nm (nanometers) and 1 mm (millimeters) that is produced as a result of a controlled stimulated emission. (330)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:26:46 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-163-NFPA 70E-2021

First Revision No. 164-NFPA 70E-2021 [Definition: Laser System.]

Laser System.

A laser in combination with an appropriate laser energy source with or without additional incorporated components. (330)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:27:20 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-164-NFPA 70E-2021

First Revision No. 161-NFPA 70E-2021 [Definition: Laser.]

Laser.

A device that produces radiant energy at wavelengths between 180 nm (nanometer) and 1 mm (millimeter) predominantly by controlled stimulated emission. Laser radiation can be highly coherent temporally, spatially, or both. (330)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:25:27 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-161-NFPA 70E-2021

First Revision No. 165-NFPA 70E-2021 [Definition: Protective Barrier.]

Protective Barrier.

Prevents user access to a hazardous voltage, current, or stored energy area. (330)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:27:52 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected article in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-165-NFPA 70E-2021

First Revision No. 127-NFPA 70E-2021 [Section No. 330.3]

330.3 ~~Hazardous Energy~~ Electrical Hazard Thresholds .

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 and 40 milliamperes

(3) Capacitor stored energy:

a. Less than 100 volts and greater than 100 joules of stored energy

b. Greater than or equal to 100 volts and greater than 1.0 joule of stored energy

c. Greater than or equal to 400 volts and greater than 0.25 joule of stored energy

Informational Note No. 1: See Department of Energy, *DOE Electrical Safety Handbook* , DOE-HDBK-1092, for information on electrical safety thresholds.

Informational Note No. 2: See 360.3 and Informative Annex R for information on capacitor hazards and controls.

~~**(A)** Voltage and Current.~~

~~For the purpose of this section, hazardous voltage and current for ac systems is considered greater than or equal to 50 volts ac and 5 mA. For dc systems, hazardous voltage or current is considered greater than or equal to 100 volts dc and 40 mA.~~

~~**(A)** Stored Energy.~~

~~For the purpose of this article, hazardous stored energy is considered greater than or equal to 0.25 joules at 400 volts or greater, or 1 joule at greater than 100 volts up to 400 volts.~~

Supplemental Information

File Name	Description	Approved
70E_FR-127_330.3.docx	FINAL FOR PRODUCTION	

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 10:49:20 EDT 2021

Committee Statement

Committee Statement: The title of 330.3 is revised to accurately reflect the content. The format of the section is revised for consistency with other parts of Chapter 3 and for usability of the standard.

Two new informational notes provide a basis for the hazard thresholds and directs the user to additional information on capacitor hazards associated with lasers.

Response Message: FR-127-NFPA 70E-2021

Public Input No. 325-NFPA 70E-2021 [Section No. 330.3]

First Revision No. 146-NFPA 70E-2021 [Section No. 330.4(B)]

(B) Electrical Safety Training for Work on or with Lasers.

Training in electrical safe work practices shall include, but is not limited to, the following:

(1) Chapter 1 electrical safe work practices

(2) Electrical hazards associated with laser equipment

(3) Stored energy hazards, including capacitor capacitors and banks ~~explosion potential~~

(4) Ionizing radiation, including X-rays at voltages greater than 5 kV in a vacuum

(4) ~~X-ray hazards from high-voltage equipment (>5 kV)~~

(5) Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment

Supplemental Information

File Name	Description	Approved
70E_FR-146_330.4_B_.docx	FINAL FOR PRODUCTION	

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 11 08:32:00 EDT 2021

Committee Statement

Committee Statement: Changes are made to the text for accuracy, usability and to remove redundancy. “Explosion potential” is a vague term and capacitor safety is now covered in Article 360 and Informative Annex R. An X-ray is an example of ionizing radiation when the voltage exceeds 5 kV in a vacuum.

Response Message: FR-146-NFPA 70E-2021

Public Input No. 287-NFPA 70E-2021 [Section No. 330.4(B)]

First Revision No. 129-NFPA 70E-2021 [Section No. 330.5(E)]

(E) Listing.

Laser system electrical equipment presenting electrical hazards shall be listed or field evaluated prior to use.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 11:03:53 EDT 2021

Committee Statement

Committee Statement: The text is revised to clarify the requirement does not apply to low-hazard devices such as laser pointers.

Response Message: FR-129-NFPA 70E-2021

Public Input No. 339-NFPA 70E-2021 [Section No. 330.5(E)]

First Revision No. 136-NFPA 70E-2021 [Section No. 340.1]

340.1 Scope.

This article ~~shall apply to~~ covers safety-related work practices around power electronic equipment, including the following:

(1) Electric arc welding equipment

(2) High-power radio, radar, and television transmitting towers and antennas

(3) Industrial dielectric and radio frequency (RF) induction heaters

(4) Shortwave or RF diathermy devices

(5) ~~Process equipment~~ Equipment that includes rectifiers and inverters such as the following:

a. Motor drives

b. Uninterruptible power supply systems

c. Lighting controllers

(6) Generators producing sub RF (1 kHz to 3 kHz) and (3 kHz to 100 MHz) fields

(7) Ionizing radiation field generators including X-rays, magnetrons, klystrons, thyratrons, vacuum tubes, and similar high-voltage vacuum devices

(8) Nonionizing radiation field generating equipment, including:

a. Antennas and RF transmission lines

b. Radar equipment

c. Industrial scientific and medical equipment

d. RF induction and dielectric heaters

e. Industrial microwave heaters and diathermy radiators

f. Magnetic resonance imagers (MRIs)

g. Large electromagnets

Informational Note: ~~The~~ See the following standards ~~provide~~ for specific guidance ~~for~~ on safety-related work practices around power electronic equipment:

(1) IEEE C95.1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz* , 2019

(2) International Electrotechnical Commission IEC 60479-1, *Effects of Current on Human Beings and Livestock, Part 1: General Aspects*~~, and the~~

(3) International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*~~.~~

Supplemental Information

File Name	Description	Approved
FR_136_Revised_70E_340.1_Scope_-_For_Staff_Use.docx	revised 340.1 - For Staff Use	

FR_136_Revised_70E_340.1_Scope_-_For_Staff_Use.docx	FINAL FOR PRODUCTION

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 13:55:26 EDT 2021

Committee Statement

Committee Statement: The word “process” is removed from line item (6) because the scope of Article 340 is not limited to process equipment.

The list of equipment covered by Article 340 is expanded to address advances in technology.

This revision adds an additional reference that applies to nonionizing radiation fields in the US to provide users a broader base of information on the subject.

Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text. The notes are formatted into list form for readability.

Response Message: FR-136-NFPA 70E-2021

Public Input No. 208-NFPA 70E-2021 [Section No. 340.1]

Public Input No. 363-NFPA 70E-2021 [Section No. 340.1]

Public Input No. 335-NFPA 70E-2021 [Section No. 340.1]

First Revision No. 121-NFPA 70E-2021 [Section No. 340.2]

~~**340.2** Definition.~~

~~For the purposes of this article, the definition that follows shall apply.~~

~~**Radiation Worker.**~~

~~A person who is required to work in electromagnetic fields, the radiation levels of which exceed those specified for nonoccupational exposure.~~

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 09:28:22 EDT 2021

Committee Statement

Committee Statement: Neither the term “radiation worker” nor the term “nonionizing radiation worker” is used in Article 340 and is removed to comply with the NEC 2020 Style Manual Section 2.2.2.

Response Message: FR-121-NFPA 70E-2021

Public Input No. 338-NFPA 70E-2021 [Section No. 340.2 [Excluding any Sub-Sections]]

Public Input No. 296-NFPA 70E-2021 [Definition: Radiation Worker.]

Public Input No. 123-NFPA 70E-2021 [Section No. 340.2]

Public Input No. 292-NFPA 70E-2021 [Global Input]

First Revision No. 167-NFPA 70E-2021 [New Section after 340.3]

340.4 Electrical Hazard Thresholds.

Exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented:

(1) DC (0 Hz to 1 Hz): 100 volts and 40 milliamperes

(2) 60/50 Hz power: 50 volts and 5 milliampere

(3) AC (1 Hz to 3 kHz): 50 volts and 3 milliamperes

(4) AC (3 kHz to 100 kHz): 1 x f mA, f in kHz

(5) AC (100 kHz to 3 MHz): 100 mA

(6) AC (3 MHz to 30 MHz):100 (f/3)* $\frac{0.3}{}$, f in MHz

(7) AC (30 MHz to 110 MHz): 200 mA

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:44:01 EDT 2021

Committee Statement

Committee Statement: The electrical hazard threshold for power electronic equipment is added to be consistent with the remainder of Chapter 3. The electrical hazard thresholds are from IEEE C95.1.

Response Message: FR-167-NFPA 70E-2021

First Revision No. 131-NFPA 70E-2021 [Section No. 340.4]

~~**340.4** Hazards Associated with Power Electronic Equipment.~~

~~The employer and employees shall be aware of the hazards associated with the following:~~

(0) ~~High voltages within the power supplies~~

(0) ~~Radio frequency energy–induced high voltages~~

(0) ~~Effects of RF fields in the vicinity of antennas and antenna transmission lines, which can introduce electrical shock and burns~~

(0) ~~Ionizing (X-radiation) hazards from magnetrons, klystrons, thyratrons, cathode-ray tubes, and similar devices~~

(0) ~~Nonionizing RF radiation hazards from the following:~~

0. ~~Radar equipment~~
0. ~~Radio communication equipment, including broadcast transmitters~~
0. ~~Satellite–earth-transmitters~~
0. ~~Industrial scientific and medical equipment~~
0. ~~RF induction heaters and dielectric heaters~~
0. ~~Industrial microwave heaters and diathermy radiators~~

Submitter Information Verification

Committee: EEW-AAA
Submittal Date: Fri Aug 06 11:17:49 EDT 2021

Committee Statement

Committee Statement: Section deleted to remove redundancy to the list of equipment in 340.1.
Response Message: FR-131-NFPA 70E-2021

Public Input No. 300-NFPA 70E-2021 [Section No. 340.4]

Public Input No. 328-NFPA 70E-2021 [New Section after 340.5]

First Revision No. 168-NFPA 70E-2021 [Definition: Competent Person.]

Global FR-137

Competent Person.

A person who meets all the requirements of *qualified person*, ~~as defined in Article 100 in Chapter 1 of this standard~~ and who, in addition, is responsible for all work activities or safety procedures related to custom or special equipment and has detailed knowledge regarding the exposure to electrical hazards, the appropriate control methods to reduce the risk associated with those hazards, and the implementation of those methods. (350)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:48:45 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-168-NFPA 70E-2021

First Revision No. 169-NFPA 70E-2021 [Definition: Field Evaluated.]

~~**Field Evaluated.**~~

~~A thorough evaluation of nonlisted or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction.~~

~~Informational Note No. 1: The evaluation approval ensures that the equipment meets appropriate codes and standards or is similarly found suitable for a specified purpose.~~

Submitter Information Verification

Committee: EEW-AAA
Submittal Date: Wed Aug 18 10:50:15 EDT 2021

Committee Statement

Committee Statement: The definition of “field evaluated” is relocated to Article 100 by another FR associated with Article 330.
Response Message: FR-169-NFPA 70E-2021

First Revision No. 170-NFPA 70E-2021 [Definition: Laboratory.]

Global FR-137

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)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 10:56:01 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-170-NFPA 70E-2021

First Revision No. 123-NFPA 70E-2021 [Section No. 350.7(A)(1)]

(1) Marking.

Marking of equipment shall be required for, but not limited to, equipment fabricated, designed, or developed for research testing and evaluation of electrical systems. Marking shall sufficiently list all voltages entering and leaving control cabinets, enclosures, and equipment.

Caution, Warning, or Danger labels shall be affixed to the exterior describing specific hazards and safety concerns.

Informational Note: ~~Refer to~~ See ANSI Z535, *Series of Standards for Safety Signs and Tags*, for more information on precautionary marking of electrical systems or equipment.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 09:50:41 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-123-NFPA 70E-2021

Public Input No. 210-NFPA 70E-2021 [Section No. 350.7(A)(1)]

First Revision No. 132-NFPA 70E-2021 [Section No. 350.9]

350.9 ~~Energy~~ Electrical Hazard Thresholds.

Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented as approved by the ESA:

(1) AC: 50 volts and 5 milliamperes

(2) DC: 100 volts and 40 milliamperes

Informational Note No. 1: ~~This information is extracted from the~~ See Department of Energy, *DOE Electrical Safety Handbook*, DOE-HDBK-1092, for information on electrical hazard thresholds .

Informational Note No. 2: See 360.3 and Informative Annex R for information on capacitor hazards and controls.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 12:11:09 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

The term “energy thresholds” is replaced by “electrical hazard thresholds” to accurately reflect the content of the section.

Response Message: FR-132-NFPA 70E-2021

Public Input No. 211-NFPA 70E-2021 [Section No. 350.9]

Public Input No. 321-NFPA 70E-2021 [Section No. 350.9]

First Revision No. 124-NFPA 70E-2021 [Section No. 360.1]

360.1 Scope.

This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with capacitors that present an electrical hazard.

Informational Note: See Informative Annex R ~~For~~ for more information on working safely with capacitors~~, see Informative Annex R , Working with Capacitors~~ .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 09:53:00 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-124-NFPA 70E-2021

Public Input No. 212-NFPA 70E-2021 [Section No. 360.1]

First Revision No. 171-NFPA 70E-2021 [Definition: Arc Blast Hazard.]

Global FR-137

Arc Blast Hazard. (as applied to capacitors).

A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:04:39 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-171-NFPA 70E-2021

First Revision No. 172-NFPA 70E-2021 [Definition: Bleed Resistor.]

Resistor, Bleeder. (~~Bleed~~ Bleeder Resistor) .

A resistor network connected in parallel with a capacitor's terminals that drains the charge after power has been disconnected. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:06:48 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

"Bleeder" is the more common term in industry, laboratories, and electronics. It can be a single resistor or a network. The sequence is reversed to be consistent with other terms in Article 100 and comply with the NEC Style Manual.

Response Message: FR-172-NFPA 70E-2021

Public Input No. 341-NFPA 70E-2021 [Definition: Bleed Resistor.]

First Revision No. 173-NFPA 70E-2021 [Definition: Charge Transfer.]

Charge Transfer.

Improper discharging of capacitor networks that results in transferring charge from one capacitor to another ~~charge~~ instead of fully discharging the stored energy. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:09:44 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

The language is revised for readability.

Response Message: FR-173-NFPA 70E-2021

Public Input No. 309-NFPA 70E-2021 [Definition: Charge Transfer.]

First Revision No. 174-NFPA 70E-2021 [Definition: Dielectric Absorption.]

Global FR-137

Dielectric Absorption.

The property of certain capacitors to recharge after being discharged. (360)

Informational Note: A voltage recharge ~~of~~from 0.02 percent (polystyrene and polypropylene) up to 10 percent (some electrolytics) can occur a few minutes after the grounding or shorting device has been removed.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:12:26 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

The informational note is revised for accuracy. The rate of 10% is exceedingly high and applies to only a few capacitors. The rate for most capacitors is less than 1%.

Response Message: FR-174-NFPA 70E-2021

Public Input No. 342-NFPA 70E-2021 [Definition: Dielectric Absorption.]

First Revision No. 175-NFPA 70E-2021 [Definition: Discharge Time.]

Discharge Time.

The time required to discharge a capacitor to below ~~a stored energy hazard threshold~~ electrical thresholds . (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:16:54 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

The limit is revised to correlate with the electrical hazard thresholds listed in 360.3.

Response Message: FR-175-NFPA 70E-2021

Public Input No. 311-NFPA 70E-2021 [Definition: Discharge Time.]

First Revision No. 176-NFPA 70E-2021 [Definition: Ground Stick.]

Global FR-137

Ground Stick.

A device that is used to ensure that the capacitor is discharged by applying it to all terminals of the capacitor element. (360)

Informational Note: This is also called a ground hook and could incorporate power-rated discharge resistors for high-energy applications.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:19:28 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-176-NFPA 70E-2021

First Revision No. 177-NFPA 70E-2021 [Definition: Hard Grounding (Low-Z).]

Global FR-137

Hard Grounding (Low-Z).

The practice of discharging a capacitor through a low impedance, also called Low-Z (impedance) grounding. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:20:11 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-177-NFPA 70E-2021

First Revision No. 178-NFPA 70E-2021 [Definition: Hearing Protection Boundary.]

Global FR-137

Hearing Protection Boundary.

Worker distance at which a 1 percent probability of ear damage exists from a 20 kPa (3.0 psi) shock wave. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:21:05 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-178-NFPA 70E-2021

First Revision No. 179-NFPA 70E-2021 [Definition: Lung Protection Boundary.]

Global FR-137

Lung Protection Boundary.

Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:22:30 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-179-NFPA 70E-2021

First Revision No. 180-NFPA 70E-2021 [Definition: Soft Grounding (High-Z).]

Global FR-137

Soft Grounding (High-Z).

The practice of connecting a capacitor to ground through a power resistor to avoid the hazards related with hard grounding. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:22:55 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-180-NFPA 70E-2021

First Revision No. 181-NFPA 70E-2021 [Definition: Time Constant.]

Global FR-137

Time Constant.

The time it takes for voltage to drop by ~63 percent (1/e) during discharge. (360)

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Wed Aug 18 11:23:21 EDT 2021

Committee Statement

Committee Statement: Definitions are relocated to the appropriate location in Article 100 to comply with the 2020 NEC Style Manual 2.2.2. Relocated terms indicate a specific application by placing the affected. article. in parenthesis following the definition to comply with 2.2.2.3.2 of the 2020 NEC Style Manual.

Response Message: FR-181-NFPA 70E-2021

First Revision No. 135-NFPA 70E-2021 [Section No. 360.4(B)]

(B) Performing a Risk Assessment for Capacitors.

The risk assessment process for capacitors shall follow the overall risk assessment procedures in Chapter 1. If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.3(H)(3). When the additional protective measures include the use of PPE, the following shall be determined:

(1) Capacitor voltage and stored energy for the worker exposure. An exposure shall be considered to exist when a conductor or circuit part that could potentially remain energized with hazardous stored energy is exposed.

(2) Thermal hazard. The appropriate thermal PPE shall be selected and used if the stored energy of the exposed part is greater 100 joules.

(3) Shock hazard. The appropriate shock PPE in accordance with 130.7 shall be selected and used if the voltage is greater than or equal to 100 volts.

(4) Arc flash and arc blast hazard at the appropriate working distance. The appropriate protection for the arc flash and arc blast hazard shall be selected, as follows:

a. Arc flash PPE in accordance with 130.7 shall be selected and used if the incident energy exceeds 1.2 cal/cm^2 (5 J/cm^2) at the working distance.

b. Hearing protection shall be required where the stored energy exceeds 100 joules.

c. The lung protection boundary shall be determined if stored energy is above 122 kJ. Employees shall not enter the lung protection boundary.

d. Alerting techniques in accordance with 130.8(O) shall be used to warn employees of the hazards.

(5) Required test and grounding method. Soft grounding shall be used for stored energy greater than 1000 joules. If capacitors are equipped with bleed resistors, or if using a soft grounding system, the required discharge wait time shall be determined where applicable.

(6) Develop a written procedure that captures all of the required steps to place the equipment in an electrically safe work condition. Include information about the amount of stored energy available, how long to wait after de-energization before opening the enclosure, how to test for absence of voltage, and what to do if there is still stored energy present.

Informational Note No. 1: See Informative Annex R ~~For~~ for more information on calculating capacitor stored energy, arc flash, and arc blast boundaries~~, see Informative Annex R, Working Safely with Capacitors~~ .

Informational Note No. 2: Heavy duty leather with a minimum thickness of 0.03 in. (0.7 mm) provides protection from thermal hazards.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 13:32:57 EDT 2021

Committee Statement

Committee Statement: Informational notes are revised to comply with the 2020 NEC Style Manual 3.1.3.1. Informational notes that reference a requirement or another standard are structured to

identify the referenced requirement or standard first, followed by the explanatory text.

Response Message: FR-135-NFPA 70E-2021

Public Input No. 213-NFPA 70E-2021 [Section No. 360.4(B)]

First Revision No. 133-NFPA 70E-2021 [Section No. 360.5(B)]

(B) Safe Work Practices.

In order to place the capacitor(s) into an electrically safe work condition, a qualified person shall use the appropriate safe work practices and PPE and shall apply the following process for establishing and verifying an electrically safe work condition:

(1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

(2) After properly interrupting the load current, open the disconnecting device(s) for each source.

(3) Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.

(4) Apply lockout/tagout devices in accordance with a documented and established policy.

(5) If bleed resistors or automatic discharge systems are applicable, wait the prescribed time for the capacitors to discharge to less than the thresholds in 360.3 and proceed to step (6). For systems without bleed resistors or automatic discharge systems, discharge the capacitors with an adequately rated grounding device (e.g., ground stick). Soft grounding shall be performed above 1000 joules, and remote soft grounding shall be performed above 100 kJ.

(6) Verify that the capacitors are discharged. For capacitors less than 1000 joules, verification shall be permitted to be done either by testing or by grounding. For capacitors between 1000 joules and less than 100 kJ, verification shall be done using testing or soft grounding, then hard grounding. Above 100 kJ, an engineered and redundant system shall be used for remote testing and grounding. An adequately rated grounding device (ground stick) or portable test instrument shall be used to test between each capacitor terminal and from each terminal to ground to assure that the capacitor is de-energized.

(7) ~~Before and after each verification, determine that the test instrument is operating satisfactorily through verification~~ When test instruments are used for testing the absence of voltage, the operation of the test instrument shall be verified on a known dc voltage source before and after each absence of voltage procedure is performed . If voltage remains, determine and correct the cause, and repeat step (5) to discharge the capacitors. Where recharging can occur due to dielectric absorption or induced voltages, all the capacitor terminals shall be connected together and grounded with a bare or transparent-insulated wire.

(8) For series capacitors the shorting wires shall be attached across each individual capacitor, and to case.

For single capacitors or for a parallel capacitor bank, the grounding device shall be permitted to be left attached to the capacitor terminals for the duration of the work (e.g., a ground stick).

Exception: Lockout/tagout shall not be required for work on cord- and plug-connected equipment for which exposure to the hazards of unexpected energization of the equipment is controlled by the unplugging of the equipment from the energy source, provided that the plug is under the exclusive control of the employee performing the servicing and maintenance for the duration of the work.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 13:15:39 EDT 2021

Committee Statement

Committee Statement: Line item (6) is revised to include the use of ground sticks as an appropriate method to verify an absence of voltage of capacitors. Line item (7) is revised to correlate with language used elsewhere in the standard and clarify that the operability test is performed at the beginning and end of the sequence of absence of voltage tests, rather than after each terminal is checked.

Response Message: FR-133-NFPA 70E-2021

Public Input No. 314-NFPA 70E-2021 [Section No. 360.5(B)]

First Revision No. 134-NFPA 70E-2021 [Section No. 360.6]

360.6 ~~Grounding~~ Ground Sticks.

~~Grounding~~ Ground sticks shall be provided for qualified persons to safely discharge any residual stored energy contained in capacitors or to hold the capacitor potential at 0 volts. The ~~grounding~~ ground sticks shall be designed, constructed, installed, and periodically inspected so that the full energy and voltage of the capacitors can be safely discharged.

(A) Visual Inspection.

The ground stick shall be visually inspected for defects before each use. All mechanical connections shall be examined for loose connections. Resistors shall be visually inspected for cracks or other defects and electrically tested for proper resistance. The following shall occur if defects or contamination are found:

(1) If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the ground stick is present, the tool shall be removed from service.

(2) If the defect or contamination exists on the grounding stick, then it shall be replaced or repaired and tested before returning to service.

(3) If the defect or contamination exists on the cable, then it shall be replaced or repaired and tested before returning to service.

(B) Electrical Testing.

All ground sticks shall be electrically tested as follows:

(1) The ground stick cable shall be tested to verify that the impedance is less than 0.1 ohms to ground every 2 years.

(2) The testing shall be documented.

Exception: The test shall be performed annually if the ground stick is utilized outdoors or in other adverse conditions.

(3) Soft grounding (High-Z) ground sticks with resistors shall be measured and compared to the specified value before each use.

(C) Storage and Disposal.

Any residual charge from capacitors shall be removed by discharging before servicing or removal.

(1) All uninstalled capacitors capable of storing 10 joules or greater at their rated voltage shall be short-circuited with a conductor of appropriate size.

(2) When an uninstalled capacitor is discovered without the shorting conductor attached to the terminals, it shall be treated as energized and charged to its full rated voltage until determined safe by a qualified person.

Informational Note: A capacitor that develops an internal open circuit could retain substantial charge internally even though the terminals are short-circuited. Such a capacitor can be hazardous to transport, because the damaged internal wiring could reconnect and discharge the capacitor through the short-circuiting conductor. Any capacitor that shows a significant change in capacitance after a fault could have this problem. Action should be taken to reduce the risk associated with this hazard when it is discovered.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Fri Aug 06 13:20:53 EDT 2021

Committee Statement

Committee Statement: The term "grounding" is changed to "ground" in 3 places to be consistent with the definition of "ground stick" and how it is used elsewhere in Article 360 and Informative Annex R.

Response Message: FR-134-NFPA 70E-2021

Public Input No. 365-NFPA 70E-2021 [Section No. 360.6]

Public Input No. 373-NFPA 70E-2021 [Section No. 360.6]

First Revision No. 78-NFPA 70E-2021 [Section No. A.3.7]

A.3.7 IEEE Publications.

Institute of Electrical and Electronics Engineers, IEEE Operations Center, 445 Hoes Lane, P. O. Box 1331, Piscataway, NJ 08855-1331.

IEEE C37.20.7, *Guide for Testing Switchgear Rated up to 52 kV for Internal Arcing Faults*, 2007/Corrigendum 1, 2010.

ANSI/IEEE C2, *National Electrical Safety Code*, 2012, 2017.

IEEE C95.1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz* , 2019

IEEE 4, *Standard Techniques for High Voltage Testing*, 2013.

IEEE 450, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, 2010.

IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones*, 2013.

IEEE 516, *Guide for Maintenance Methods on Energized Power Lines*, 2009.

IEEE 937, *Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems*, 2007.

IEEE 946, *Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Systems*, 2004.

IEEE 1106, *Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, 2010.

IEEE 1184, *Guide for Batteries for Uninterruptible Power Supply Systems*, 2006.

IEEE 1188, *Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*, 2005 (R 2010).

IEEE 1491, *Guide for Selection and Use of Battery Monitoring Equipment in Stationary Applications*, 2012.

IEEE 1584™, *Guide for Performing Arc Flash Hazard Calculations*, 2018.

IEEE/ASHRAE 1635, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*, 2018.

IEEE 1657, *Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Batteries*, 2009.

IEEE 3007.1, *Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems*, 2010.

IEEE 3007.2, *Recommended Practice for the Maintenance of Industrial and Commercial Power Systems*, 2010.

IEEE 3007.3, *Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems*, 2012.

Ammerman, R. F., Gammon, T., Sen, P. K., and Nelson, J. P., “DC-Arc Models and Incident-Energy Calculations,” *IEEE Transactions on Industry Applications*, Vol. 46, No. 5, 2010.

Doan, D. R, “Arc Flash Calculations for Exposures to DC Systems,” *IEEE Transactions on Industry Applications*, Vol 46, No. 6, 2010.

Doughty, R. L., T. E. Neal, and H. L. Floyd II, “Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 V Power Distribution Systems,” Record of Conference Papers IEEE IAS 45th Annual Petroleum and Chemical Industry Conference, September 28–30, 1998.

Lee, R., “The Other Electrical Hazard: Electrical Arc Flash Burns,” *IEEE Trans. Applications*, Vol. 1A-18, No. 3, May/June 1982.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:44:55 EDT 2021

Committee Statement

Committee Statement: The reference to the IEEE Standard is being added since it mentioned in Article 340.

Response Message: FR-78-NFPA 70E-2021

Public Input No. 333-NFPA 70E-2021 [Section No. A.3.7]

First Revision No. 79-NFPA 70E-2021 [Section No. A.3.11]

A.3.11 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

~~ANSI/~~ UL 943, ~~*Standard for*~~ *Ground-Fault Circuit Interrupters*, 2006 (R 2012).

UL 943C, *Outline of Investigation for Special Purpose Ground-Fault Circuit-Interrupters*, 2012.

UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*, 2016.

UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements*, 2012.

UL 61010-2-033, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 2-033: Particular Requirements for Hand-Held Multimeters and Other Meters, for Domestic and Professional use, Capable of Measuring Mains Voltage*, 2014.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:47:18 EDT 2021

Committee Statement

Committee Statement: Terms are being removed in A.3.11 to eliminate redundancy and improve clarity.

Response Message: FR-79-NFPA 70E-2021

Public Input No. 263-NFPA 70E-2021 [Section No. A.3.11]

First Revision No. 80-NFPA 70E-2021 [Section No. F.1 [Excluding any Sub-Sections]]

Risk management is the logical, systematic process used to manage the risk associated with any activity, process, function, or product including safety, the environment, quality, and finance. The risk management process and principles can be used by organizations of any type or size.

The following risk management principles can readily be applied to electrical safety. Risk management:

(1) Is an integral part of all organizational processes and decision making

(2) Is systematic, structured, and timely

(3) Is based on the best available information

(4) Takes human and cultural factors into account

(5) Is dynamic, iterative, and responsive to change

(6) Facilitates continual improvement of the organization

Informational Note: ~~For more information on risk management principles see~~ See ISO 31000:2009, *Risk Management — Principles and Guidelines*, for more information on risk management principles .

The risk management process includes the following:

(1) Communication and consultation

(2) Establishing the risk assessment context and objectives

(3) Risk assessment

(4) Risk treatment

(5) Recording and reporting the risk assessment results and risk treatment decisions

(6) Monitoring and reviewing risks

Risk assessment is the part of risk management that involves the following:

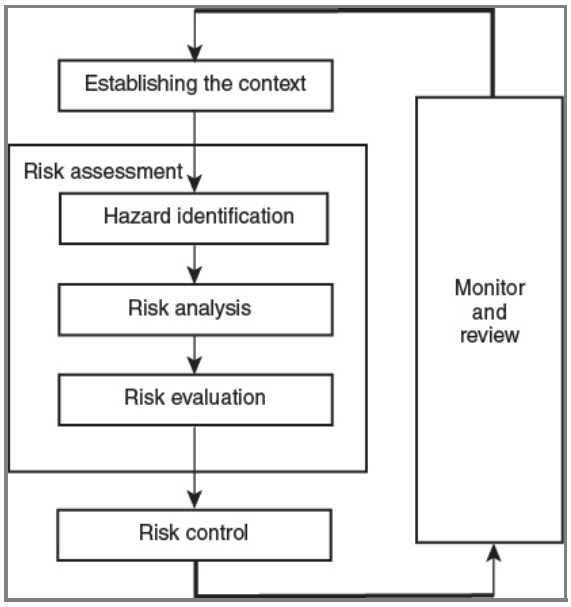
(1) Identifying sources of risk

(2) Analyzing the sources of risk to estimate a level of risk

(3) Evaluating the level of risk to determine if risk treatment is required

(*See Figure F.1.*)

Figure F.1 Risk Management Process (Adapted from ISO 31000 figure 3).



Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 14:58:26 EDT 2021

Committee Statement

Committee Statement: The informational note in list item 6 is revised to format the informational note to the 2020 NEC Style Manual.

Response Message: FR-80-NFPA 70E-2021

Public Input No. 214-NFPA 70E-2021 [Section No. F.1 [Excluding any Sub-Sections]]

First Revision No. 83-NFPA 70E-2021 [Section No. G.5.4]

5.4

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

Informational Note: ~~For tagout, one additional safety measure must be employed, such as~~ Examples of additional safety measures when tagout only is used include opening, blocking, or removing an additional circuit element.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 15:15:38 EDT 2021

Committee Statement

Committee Statement: The informational note has been updated to remove mandatory language in order to conform to the 2020 NEC Style Manual. .

Response Message: FR-83-NFPA 70E-2021

Public Input No. 215-NFPA 70E-2021 [Section No. G.5.4]

First Revision No. 82-NFPA 70E-2021 [Annex G [Excluding any Sub-Sections]]

This informative annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

Lockout is the preferred method of controlling personnel exposure to electrical energy hazards. Tagout is an alternative method that is available to employers. The sample program and procedures that follow are provided to assist employers in developing a lockout/tagout program and procedures ~~that meet the requirements of Article 120 of *NFPA 70E*~~ . The sample program and procedures can be used for a simple lockout/tagout or as part of a complex lockout/tagout. A more comprehensive procedure will need to be developed, documented, and used for the complex lockout/tagout.

LOCKOUT/TAGOUT PROGRAM

FOR [COMPANY NAME]

OR

TAGOUT PROGRAM FOR [COMPANY NAME]

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 15:12:51 EDT 2021

Committee Statement

Committee Statement: The reference to Article 120 is removed for clarity and to comply with the 2020 NEC Style Manual.

Response Message: FR-82-NFPA 70E-2021

Public Input No. 223-NFPA 70E-2021 [Annex G [Excluding any Sub-Sections]]

First Revision No. 140-NFPA 70E-2021 [Section No. K.1]

K.1 General.

Electrical injuries represent a serious workplace health and safety issue to electrical and non-electrical workers. Data from the U.S. Bureau of Labor Statistics (BLS) indicate that there were nearly 6000 fatal electrical injuries to workers in the United States from 1992 through 2012. BLS data also indicate that there were 24,100 non-fatal electrical injuries from 2003 through 2012. From 1992 to 2013, the number of fatal workplace electrical injuries has fallen steadily and dramatically from 334 in 1992 to 139 in 2013. However, the trend with non-fatal electrical injuries is less consistent. Between 2003 and 2009, non-fatal injury totals ranged from 2390 in 2003 to 2620 in 2009, with a high of 2950 injuries in 2005. Non-fatal injury totals between 2010 through 2012 were the lowest over this 10-year period, with 1890 non-fatal injuries in 2010, 2250 in 2011, and 1700 in 2012.

There are two general categories of ~~electrical~~ electric injury: electrical shock and electrical burns. Electrical burns can be further subdivided into burns caused by radiant energy (arc burns), burns caused by exposure to ejected hot gases and materials (thermal burns), and burns caused by the conduction of electrical current through body parts (conduction burns). In addition, hearing damage can occur from acoustic energy, and traumatic injury can be caused by toxic gases and pressure waves associated with an arcing event.

About 98 percent of fatal occupational ~~electrical~~ electric injuries are electrical shock injuries. A corporate case study examining electrical injury reporting and safety practices found that 40 percent of electrical incidents involved 250 volts or less and were indicative of a misperception of electrical safety as a high-voltage issue. In addition, electrical incidents once again were found to involve a large share of non-electrical workers, with approximately one-half of incidents involving workers from outside electrical crafts. Research of electrical fatalities in construction found that the highest proportion of fatalities occurred in establishments with 10 or fewer employees and pointed out that smaller employers could have fewer formal training requirements and less structured training in safety practices.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Mon Aug 09 15:06:30 EDT 2021

Committee Statement

Committee Statement: "Electrical" was revised to "electric" to correlate with the use of the term electric shock as used in K.2 and elsewhere throughout NFPA 70E including numerous existing locations in 130.7.

Response Message: FR-140-NFPA 70E-2021

Public Input No. 37-NFPA 70E-2020 [Annex K]

First Revision No. 145-NFPA 70E-2021 [Section No. O.2.4]

O.2.4 Additional Safety-by-Design Methods.

The following methods have proven to be effective in reducing risk associated with an arc flash or shock hazard:

(1) Installing finger-safe components, covers, and insulating barriers reduces exposure to energized parts.

(2) Installing disconnects within sight of each motor or driven machine increases the likelihood that the equipment will be put into an electrically safe work condition before work has begun.

(3) Installing current limiting cable limiters can help reduce incident energy. Additionally, cable limiters can be used to provide short-circuit protection (and therefore incident energy reduction) for feeder tap conductors that are protected at up to 10 times their ampacity, a situation where the tap conductor can easily vaporize.

(4) Installing inspection windows for noncontact inspection reduces the need to open doors or remove covers.

(5) Installing a single service fused disconnect switch or circuit breaker provides protection for buses that would be unprotected if six disconnect switches are used.

(6) Installing metering to provide remote monitoring of voltage and current levels reduces exposure to electrical hazards by placing the worker farther away from the hazard.

(7) Installing Type 2 “no damage” current limiting protection to motor controllers reduces incident energy whenever the arcing current is within the current limiting threshold of the current-limiting fuse or current-limiting circuit breaker.

(8) Installing adjustable instantaneous trip protective devices and lowering the trip settings can reduce the incident energy.

(9) Installing arc-resistant equipment, designed to divert hot gases, plasma, and other products of an arc-flash out of the enclosure so that a worker is not exposed when standing in front of the equipment with all doors and covers closed and latched, reduces the risk of arc flash exposure.

(10) Installing provisions that provide remote racking of equipment, such as remote-controlled motorized remote racking of a circuit breaker or an MCC bucket, allows the worker to be located outside the arc-flash boundary. An extended length hand-operated racking tool also adds distance between the worker and the equipment, reducing the worker's exposure.

(11) Installing provisions that provide remote opening and closing of circuit breakers and switches could permit workers to operate the equipment from a safe distance, outside the arc flash boundary.

(12) Class C, D, and E special purpose ground fault circuit interrupters exist for circuits operating at voltages outside the range for Class A GFCI protection. See UL 943C for additional information.

(13) Installing high-impedance protected test points for voltage measurement through door.

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Tue Aug 10 13:11:21 EDT 2021

Committee Statement

Committee Statement:	The technology, in new Item 13, helps reduce risk and enhance the effectiveness of safety related work practices.
Response Message:	FR-145-NFPA 70E-2021

Public Input No. 376-NFPA 70E-2021 [New Section after O.2.4]

First Revision No. 85-NFPA 70E-2021 [Annex O [Title Only]]

Employee Safety-Related Design ~~Requirements~~ Concepts and Facility Responsibilities

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 15:39:25 EDT 2021

Committee Statement

Committee Statement: The title has been changed to properly reflect that the annexes are informative and are not permitted to contain requirements.

Response Message: FR-85-NFPA 70E-2021

Public Input No. 55-NFPA 70E-2021 [Annex O]

Public Input No. 226-NFPA 70E-2021 [Annex O]

First Revision No. 87-NFPA 70E-2021 [Section No. R.3.2]

R.3.2 Duration of Discharge.

The duration of a capacitive discharge shock is independent of voltage and is generally assumed to be three times the time constant of the shock circuit. After three time constants, the voltage is reduced by 95 percent, and the energy has been reduced by 99.25 percent. The time constant, τ, (in seconds) is equal to body shock pathway resistance (in ohms) times capacitance (in farads) , as follows:

$$\tau = RC \qquad \textbf{[R.3.2]}$$

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:01:49 EDT 2021

Committee Statement

Committee Statement: Units have been added to various terms in Annex R.3.2 for clarity and usability.

Response Message: FR-87-NFPA 70E-2021

Public Input No. 345-NFPA 70E-2021 [Section No. R.3.2]

First Revision No. 90-NFPA 70E-2021 [Section No. R.3.5]

R.3.5 Response to Shock Levels.

For a given stored energy, there is a difference in response to whether it is a high-voltage, low-capacitance shock, or a low-voltage, high-capacitance shock. At high voltage and low capacitance, a hazardous shock will fully discharge nearly instantaneously (in microseconds) and could miss the vulnerable part of the heart cycle. However, the full energy is delivered to the person and there could be nerve or other tissue damage. At low voltage and high capacitance, the total discharge time can extend several seconds (multiple heart beats), behaving more like a dc shock. Both scenarios remain highly hazardous as fibrillation could still occur.

Informational Note: ~~For more information on impulse shock hazards, see~~ See IEC TS 60479-2, *Effects of Current on Humans and Livestock, Part 2, Special Aspects*, for more information on impulse shock hazards .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:12:22 EDT 2021

Committee Statement

Committee Statement: The informational note is revised to format the informational note to the 2020 NEC Style Manual.

Response Message: FR-90-NFPA 70E-2021

Public Input No. 216-NFPA 70E-2021 [Section No. R.3.5]

First Revision No. 89-NFPA 70E-2021 [Section No. R.10.1]

R.10.1 Hazard.

The arc blast hazard is directly related to the instantaneous (initial) short circuit current. Since capacitors can discharge very rapidly, the shockwave generated by a capacitor discharge can cause barotrauma (overpressure injury) to persons in the area. The most sensitive organs are the ears, lungs, and brain. When a differential pressure across the eardrums exceeds around 20–35 kilopascals (3–5 psi), the eardrum can rupture. At 200 kilopascals (29 psi), lung damage can occur. The following formulas are used to estimate safe boundaries based on total stored energy, where "safe" is less than a 1 percent probability of eardrum rupture or lung injury:

$$R_{ear} = 49.29\sqrt[3]{\frac{E}{1000}} - 5.09 \quad \textbf{[R.10.1a]}$$

$$R_{lung} = 31.32\sqrt[3]{\frac{E}{1000}} - 155.45 \quad \textbf{[R.10.1b]}$$

where:

R_{ear} = eardrum rupture boundary (1 percent probability) in cm

R_{lung} = lung collapse boundary (1 percent probability) in cm

E = capacitor stored energy in joules

Informational Note: ~~For more information about the derivation of these formulas, see~~ See Charles R. Hummer, Richard J. Pearson, and Donald H. Porschet, "*Safe Distances From a High-Energy Capacitor Bank for Ear and Lung Protection*," Army Research Laboratory Report, ARL-TN-608, July 2014, for more information about the derivation of these formulas .

Submitter Information Verification

Committee: EEW-AAA

Submittal Date: Thu Aug 05 16:09:37 EDT 2021

Committee Statement

Committee Statement: The informational note is revised to format the informational note to the 2020 NEC Style Manual.

Response Message: FR-89-NFPA 70E-2021

Public Input No. 217-NFPA 70E-2021 [Section No. R.10.1]